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CONTENT

1	Comparative Economic Analysis of Different Chemical Weed Management Strategies in <i>Boro</i> Rice under SARP Method Ashim Kumar Dolai, Atanu Mahanty, Kajal Das, Sayandip Choudhury, Subham Chakraborty, Souvan Kumar Patra, Gurupada Saren	1-8
2	Innovative Marketing Strategies for Commercialization of Okra in Tapi District of South Gujarat Gaurav Sharma	9-14
3	Makhana Value Chain: Addressing Inefficiencies and Unlocking Rural Prosperity Govind Kumar, Hridesh Jasrotia, Yashvi Nayyar	15-20
4	Improvement in Seed Yield And Quality of French Bean as Influenced by Foliar Application of Ga₃ and Micronutrients Kaustav Choudhury, Manish Bhattacharya, Baishali Bhowmick and Anindya Kumar Hembram	21-27
5	Impact of Climate Smart Agriculture Technology on the Rice-Wheat System of the Indo-Gangetic Plains of India Sanjay Sapkal, Rajendra Hile, Govind Joshi D J Sanap and Pramod Kumar	28-42
6	“Export Potentiality of Millets Grown in India” Rachana Bansal, Riya Parmar and A. S. Shaikh	43-51
7	Export of Marine Fish Products of India: Analysing the Composition. S.A.Diwate, DB Malave and S.A. Wagale	52-55
8	Analysis of Cost and Returns in Broiler Production in Palghar District of Maharashtra State Katkar S.B, Torane S.R and Munde P.V	56-63
9	Market Participation of Smallholder Vegetable Growers in Northern Hills of Chhattisgarh: A Logistic Regression Approach Payal Jaiswal, V.K. Choudhary and Ankita Mukherjee	64-71
10	Economic Analysis of Krushiraj Agro-tourism as Agribusiness in Maharashtra State: A Case Study Kumbhar J. S., Kishor Pansare, T.B.Deokate and A. A. Bhagat	72-75
11	Harvesting Markets: An Analysis of India’s Agricultural Trade Pranjal Sharma, Sonal Dhiman, Shaikh Mohd Mouzam, Arpita Sharma	76-81

12	Retail Marketing of Selected Cashew Processed Products in Rat District P. J. Kshirsagar, A. S. Akhare and A. S. Kamble	82-88
13	Acreage Response of Soybean Crop in Buldhana district of Maharashtra Dr. R.B. Hile, Dr. S.S. Kaware and Mr. S.R. Deshmane	89-95
14	Diversification Analysis an Innovative Practice under Climate Smart Technology of Major Crops in Gujarat Dr.Sujit Mohalkar ' Dr.Kalpesh Thakar and Ganesh Dhonde	96-101
15	Rising Heat, Shifting Seasons: Farmers' Insights on Climate Change in Vidarbha Aishwarya Patil and Nishant Shende	102-109
16	Strengthening Tribal Agriculture: Exploring Opportunities for Minor Millets in Chhattisgarh V. K. Choudhary and S.C.Nagpure	110-120
17	Economic analysis of tomato production under drip irrigation method in Western Maharashtra Amale A.J. and Kalhapure S.P.	121-128
18	Status and Constraints of Agro-Tourism Centers in Ratnagiri District of Maharashtra P. V. Phadte, Dr. P. J. Kshirsagar, P. K. Bante, S. A. Jagtap and P. J. More	129-134
19	Modelling and Forecasting Retail Prices of Maize for Lasalgaon Market of Maharashtra Dr. A. S. Gadakh, Dr. R. B. Hile and Sankalp Thawale	135-140
20	Marketing of White Onion in Raigad District P. J. Kshirsagar, S. R. Torane, A. S. Akhare, A. V. Naik	141-145
21	Status of E-NAM in India and Farmers perception towards adoption of digital Agriculture Shende N. V., U. T. Dangore, A. S. Tingre, S. V. Warade and S.S. Bhaote	146-157
22	Economic Analysis of Production and Value Chain of Millet in Maharashtra Sanap D.J., R.R.Nirgude and P.R.Patil	158-165
23	Economic Analysis of Integrated Farming System for Doubling Farmers Income in Western Maharashtra Thawale S.M. Shendage P.N. and Gadakh A.S.	166-169

24	Economic Analysis of Geranium Processing in Western Maharashtra Amale A.J.	170-177
25	Study on disposal pattern of chengalikodan nendran banana (gi tag variety) in thrissur district of kerala P. J. Enis, D. B. Malave, O. M. Gawas, D. P. Kharat, R. S. Jachak	178-182
26	Seasonality Analysis of Sorghum Prices And Arrivals in Maharashtra P. P. Jagtap, R. B. Hile, Y. C. Sale and R. R. Nirgude	183-189
27	Agri-startups and rural enterprises: A case study of private horticulture nurseries enterprise in Navsari District of Gujarat Gaurav Sharma and Narendra Singh	190-195
28	Growth and Instability in Export of Fresh Papaya from India Hadolikar Sachin B., More Sachin S. and Shelke Rajesh D.	196-203
29	Price forecasting of Chickpea for Minimizing Price Risk in Maharashtra Khairnar K.Y., Dorge J.T., Navgire S.D. and Gade R.R.	204-208
30	Retail Marketing of Selected Mango Processed Products in Ratnagiri District P. J. Kshirsagar, A. S. Akhare and A. S. Kamble	209-216
31	Price Analysis of Soybean in APMC Ahmednagar Dr. S.S. Kaware, Dr. R.B. Hile and Dr. D. J. Sanap	217-221
32	Impact of Farmer Producer Organizations (FPOs) on Farm Economy: A Comparative Analysis Munde P.V., Shendage P.N, Hile R.B.and Shivgaje A.J.	222-226
33	Techno-Economic Analysis of Cotton Stalk Biochar Production Using Continuous Reactor Systems Surendra kalbande, Prajakta Phadtare and Shivaji C.Nagpure	227-239
34	Dimension of Input Cost and Output Prices of Paddy in Andhra Pradesh V. S. Shinde, N. V. Shende, U. T. Dangore, R. D. Vaidkar and V. K. Khobarkar	240-250

Comparative Economic Analysis of Different Chemical Weed Management Strategies in *Boro* Rice under SARP Method

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ABSTRACT

A field experiment was conducted during the boro seasons of 2017–2018 and 2018–2019 at Baruipur Experimental Agricultural Farm, University of Calcutta, to evaluate the efficacy of different weed management practices in boro rice under the System of Assured Rice Production (SARP). The study assessed seven treatments, including various herbicides and hand weeding, in a Randomized Block Design (RBD) with three replications. The results showed that the highest grain yield (5.23 t ha⁻¹) was recorded with hand weeding twice at 20 and 40 DAT (T4), which was statistically at par with Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T6) (4.97 t ha⁻¹). However, Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP (T6) proved to be the most cost-effective treatment, yielding the highest net returns (Rs. 39,332 ha⁻¹) and benefit-cost ratio (1.93). Pyrazosulfuron (T2) and Penoxsulam (T5) also showed promising results. The lowest yield (3.39 t ha⁻¹) and economic returns were recorded in the unweeded control (T7). While hand weeding (T4) was effective, its higher labor costs reduced profitability. The study concluded that Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T6) was the most efficient and economically viable weed management strategy for boro rice under SARP.

Keywords: Boro rice, Economic analysis, Grain yield, Herbicide, Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP, System of Assured Rice Production (SARP).

INTRODUCTION

The System of Assured Rice Production (SARP) is an innovative, resource-saving method for cultivating rice under irrigated or rain-fed conditions. Studies have shown it can significantly increase yields while reducing seed usage (80-90%), water consumption (25-50%), and costs (10-20%) compared to conventional practices. SARP is not a technology but a set of principles aimed at producing healthier, more robust plants. This method, particularly effective for summer season rice, involves extending nursery duration and shortening main field duration, enabling seedlings to withstand adverse environmental conditions. SARP's key objectives include producing vigorous seedlings,

allowing flexibility in seedling age for transplanting based on weather, and minimizing the need for high-quality seeds. As population growth drives increasing food demand, innovative solutions like SARP are essential to boost agricultural productivity. By optimizing resource use and addressing challenges, SARP presents a sustainable approach to achieving higher yields with lower inputs, making it highly suitable for regions like India.

Rice is India's pre-eminent crop and the staple food for people in the eastern and southern regions. It covers about one-fourth of the country's total cropped area and provides sustenance to nearly half of the Indian population. In 2024, India achieved a record rice production of approximately 142 million

tons, with major contributions from states like Uttar Pradesh, Telangana, West Bengal, Punjab, and Chhattisgarh. West Bengal, in particular, produced around 15.48 million tons of rice in 2023, accounting for about 11% of the nation's total production. Globally, India ranks as the second-largest rice producer after China, with world production reaching approximately 532.87 million tons in 2024.

In West Bengal condition, rice cultivation in *boro* season has got certain advantages. The productivity of rice is higher due to congenial weather conditions, better management irrigation and inputs and low incidence of disease & pest.

Rice is a high-energy, staple food rich in carbohydrates (starch), providing instant energy. While low in nitrogenous substances (8%) and fat (1–2.5%), it is considered a complete food. Milled rice has a protein content of 6–7% with high biological value but less protein compared to wheat. It is also rich in B vitamins, though low in calcium. Rice flour is used in various foods, and rice straw is utilized in making porcelain, glass, paper pulp, and livestock bedding. Additionally, brewers sometimes use rice for alcoholic malt production, showcasing its versatility beyond being a dietary staple.

Out of the estimated total loss due to all pests (insect, disease- pathogens, weed etc) amounting Rs.6, 000.00 cores annually in our country. About 33% losses are caused due to weed alone (Kulmi, 1990). It is thus evident that the losses caused by the weeds far exceed the losses from other pests. Weeds are most serve and wide spread biological constraints to crop production in India. Recent estimates show that weeds in India cause an annual loss of Rs.1, 980 cores. It was reported that the weeds reduce the production of wheat by 15-30%, rice by 30-35%, and maize sorghum, pulses, and oil seeds by 18-85%. Besides reduction in yield, weeds removed from soil 30-40, 10-15 & 20-40 kg/ha of nitrogen, phosphorus, potassium, respectively (Sarma et al., 1996).

Weeds in cultivated fields reduce rice yield and quality by competing for nutrients, water and light and intensify the problem of diseases, insects and other pests by serving as their hosts. One estimate at IRRI suggest weed growth in unweeded plots reduces yield by as much as 34% in transplanted rice, 45% in direct-seeded and rainfed lowland rice, and 67% in upland rice.

While in upland rainfed direct seeded dry season rice (*Aus*) in pre-*kharif* season, the losses due to weeds ranges from 40 to 60 per cent and sometimes even total crop failure, in case of transplanted rice in *kharif* (*Aman*) and *rabi* (*Boro*), the losses in yield due to weed infestation range from 15-25% (Mukhopadhyaya, 1987; Mukhopadhyay et al., 1987).

Herbicides were introduced in rice farming after World War II, initially seen as a key solution for weed control. While environmentally safe cultural methods remain a priority, farmers increasingly prefer chemical weed control due to high labor costs, labor shortages during peak periods, and the difficulty of distinguishing rice seedlings from weeds in early stages. Chemical weeding is often cheaper and more effective. In India, sodium arsenate was first used in 1927, followed by 2, 4-D for broad-leaved weeds. Selective herbicides like Butachlor, Propanil, Pendimethalin, Anilofos, and others have since been widely adopted for effective weed management in rice cultivation.

There exist several potential devices to combat the weed menace in the cultivation of rice in India. Out of which the new generation herbicides claim. Closer attention should be given with respect to efficient eradication of weeds and ensure an important berth in the arsenal against this pest. With the above idea, experiment was carried out to find out suitable herbicides with proper effective dose to control weed in system of assured rice production (SARP).

METHODOLOGY

An experiment was conducted during the *boro* season of December, 2017 to June, 2018 and December, 2018 to May, 2019 to study the effect of chemical weed management in *boro* rice under system of assured rice production (SARP) method at Baruipur Experimental Agricultural Farm, University of Calcutta, situated in the *Gangetic* alluvial region of West Bengal.

The topography of the experimental plot was low land, more or less with uniform with a drainage condition. The soil was medium fertile, clay loam in texture, slightly acidic in reaction with Sand (%) 26.6, Silt (%) 31.8 and Clay (%) 41.6, representative of the new *Gangetic* alluvial soil of West Bengal. The farm was situated in the sub-tropical region. The maximum and minimum temperatures recorded during the crop growth period were 41.4° C and 13.3°C.

The name of the variety used in the experiment was IET 4786 (Popularly known as Satabdi). It is a non-scented rice cultivar with super fine grains fetching very high market price.

The experimental field was laid out in a Randomized Block Design (RBD) having seven treatments viz. T₁: Oxadiargyl 80% WP, T₂: Payrazosulfuron ethyl 10 % WP, T₃: Butachlor 50 % EC, T₄: Hand weeding (20 and 40 DAT), T₅: Penoxsulam 21.7 % SC, T₆: Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP and T₇: Untreated plot with three replications. The chemical pre and post emergence herbicides were applied at 3 and 12-20 DAT. Hand weeding twice (at 20 and 40 DAT) was also included to have a

comparison between chemical (herbicidal) and cultural treatment. A general recommended fertilizer dose of 120 kg N, 60 kg P₂O₅ and 60 kg K₂O was applied, out of which ¼th N (30 kg N ha⁻¹) and full dose of P₂O₅ and K₂O were incorporated to the soil at the time of final land preparation i.e., applied as basal and remaining 3/4th of N was applied as top dressing. The half of the total N (60 kg N ha⁻¹) at tillering (i.e., at 21 DAT) and the rest ¼th N (30 kg N ha⁻¹) at 6 days before panicle initiation (ie. at 42 DAT). Biometrical observations were recorded on weed and crop at 30, 60 and 90 DAT whereas data on yield and yield components were taken at harvest.

RESULTS AND DISCUSSION

Observations recorded during investigation in the experiment were analysis and have been presented.

1.1 Weed Flora: Survey on weed flora was made regularly to identify different weed species

The data collected from the field were subjected to statistical analysis appropriate to the design RBD by following the procedure laid out by Gomez and Gomez, 1984. The significance of different sources of variations was tested by Fisher and Snedecor's F-test at probability level of 0.05. For the determination of critical difference at 5% level of significance, the statistical table's formulation by Fisher and Yates (1979) were consulted. The standard error of mean (S.Em. +) and the value of CD at 5% level of significance were indicated in the tables of the results to compare the difference between the mean values.

intercepted in the experimental field throughout the crop season. Details of this study have been presented in Table 1. These predominant weed *Echinochloa crusgali*, *Cyperus rotundus*, *Marsilea quadrifolia* and *Ludwigia parviflora*. Similar types of finding were reported by Bhattacharya (1975) and Pal *et.al* (2008).

Table 1: Weed flora present in the experimental field throughout crop growing season.

Botanical Name	Family	English Name	Common Name	Special Characteristic
A. GRASSES <i>Cynodon dactylon</i>	<i>Poaceae</i>	Bermuda grass	Durba Ghash	Hardy perennials, monocot, leaves flattened, flowers during September to December and from May and July. Reproduced by creeping root stocks and seeds.
Leersiahexandra (SW)	<i>Poaceae</i>	Rice cut grass	Kara Ghash	Aquatic perennial creeping grass that can grow as tall as 100 cm, monocot propagates by seeds, rhizomes and stolons.
Echinochloa crusgalli	<i>Poaceae</i>	Barnyard grass	Shama ghash	Annual monocot grass. Leaves are narrow flat, linear with minutely separated margin, erect stem, longer nodes. Stem is glabrous and ends in 10 to 20 cm long inflorescence, with a slender spike like panicle, green or purplish in colour. Propagates by seeds.
<i>E. colona</i>	<i>Poaceae</i>	Jungle rice	Bunodhan or Janghidhan	Annual grass with fibrous root system. Commonly found in both on dry and moist soil, cultivated fields. Shorter than <i>E. crusgalli</i> , used as green fodder. Panicle green or purplish in colour. Propagation through seed.
B. SEDGES <i>Cyperus iria L.</i>	<i>Cyperaceae</i>	Yellow nut sedge	<i>Jal Motha</i>	Annual sedge, monocot, erect herb with triangular stem, hairy underground stem with chains or nut like tubers. Leaves look like grasses. Propagates by rhizomes or see
Cyperus difformis L.	<i>Cyperaceae</i>	Umbrella sedge	Motha	Annual sedge that can grow as tall as 75 cm. Normally propagated through seeds.
Fimbristylis toralis	<i>Cyperaceae</i>	Yellow nut sedge	Bindi Motha	Annual sedge growing as tall as 75cm. Normally propagated through seeds.
C. BROAD LEAF WEEDS <i>Alternanthera philoxeroides</i>	<i>Amaranthaceae</i>	Umbrella sedge	<i>Chanchi</i>	Annual weed with succulent stem. No milky juice in stem. Propagation through seeds.
<i>Ludwigia parviflora</i> Roxb.	<i>Onagraceae</i>	Hoorah grass or Globe Finger rush	LabangaPho ol	Annual, aquatic with leaves petiolate and succulent propagated by seeds.
<i>Ammania baccifera</i>	<i>Onagraceae</i> or <i>Lythraceae</i>	Alternanthera	Dadmari	Annual weed with succulent stem propagated by seeds.
Marsileaquad rifolia	<i>Marsileaceae</i>	Water Purslane, Water fern	Sushni	Leaves are quadrifoliate propagated by vegetative means.

Among the weeds enlisted above, the predominant ones were *Echinochloa crusgalli*, *Cyperus iria*, *Fimbristylis littoralis*, *Eclipta alba* and *Ludwigia parviflora*. Working at Baruipur, Bhattacharya *et al.*, 1996 and Bhowmick *et al.*, 2000 observed similar types of weeds in rice field.

3.2 Effect of treatments on total weed density:

From the table 2, it is evident that all the chemical and cultural treatments were superior to unweeded control in all the observations taken at 30, 60 and 90 DAT in both year 2018 and 2019 respectively. This result clearly indicates the significant effect of the treatments on the total weed density. At 30 DAT, 60 DAT and 90 DAT, the lowest weed density were recorded with the treatment hand weeding twice at 20 and 40 DAT (T_4) and among the chemical treatments, Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T_6) resulted the lowest weed

density in both the years 2018 and 2019. Whereas the highest weed density was recorded with untreated control (T_7) which was significantly higher than any other treatments used in the investigation. From the above finding it can be stated that the hand weeding treatment was superior to all other treatments in controlling all the three categories of weeds, but it was statistically at par with the treatments T_6 (Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹). This collaborates with the findings of Bhattacharya *et al.* (1997). Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ showed the best performance among the different chemicals tried in the investigation which might be due to the fact that such herbicide mixture was the optimum lethal dose for all the dominant weeds and could persist in the soil up to the critical growth period of paddy crop.

Table 2: Effect of treatments on total weed density m⁻².

Treatments	Total weed population m ⁻²									
	Dosage (g/ kg a.i. ha ⁻¹)	30DAT			60DAT			90 DAT		
		2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T₁: Oxadiargyl 80% WP	25g	18.74	17.22	17.98	27.47	26.08	26.775	33.48	31.72	32.6
T₂: Payrazosulfuron ethyl 10 % WP	30g	15.5	13.46	14.48	24.19	22.43	23.31	29.34	27.74	28.54
T₃: Butachlor 50 % EC	1000g	21.32	19.51	20.415	30.12	28.74	29.43	37.62	35.19	36.405
T₄: Hand weeding (20 and 40 DAT)	-	9	8.46	8.73	14.83	13.71	14.27	21.88	20.41	21.145
T₅: Penoxsulam 21.7 % SC	50g	17.6	16.23	16.915	24.34	22.88	23.61	30.49	28.71	29.6
T₆: Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP	4g	12.54	11.38	11.96	17.4	16.14	16.77	22.76	21.23	21.995
T₇: Untreated plot	-	28.95	26.89	27.92	39.24	37.91	38.575	52.41	50.3	51.355
SEm		0.358	0.327	1.1547	0.527	0.275	1.098	0.795	1.018	1.273
CD at 5%		1.087	1.008	3.56	1.625	0.846	3.38	2.449	3.138	3.657

(WP: Wettable Powder, EC: Emulsifiable Concentrate, DAT: Days After Transplanting, SC: Suspension Concentrate, G: Gram, KG: Kilogram, A.I.: Active Ingredient, SEm: Standard Error of Mean, CD: Critical Difference, HA: Hectare).

3.3 Effect of treatments on total weed biomass:

The data presented in the table indicates the increasing trend of weed biomass with the advance of crop growth. The highest biomass was found in the untreated control treatment (T_7) at all the growth stage which was significantly higher than any other treatments used in the investigation. Hand weeding always recorded the lowest biomass of weeds and was statistically at par with (T_6) Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4g a.i.ha⁻¹.

At 30 DAT, 60 DAT and 90 DAT in 2018, the lowest weed biomass 6.44, 10.32 and 14.46 g m⁻² were recorded respectively with hand weeding treatment given twice at 20 and 40 DAT (T_4) followed by Metsulfuron-methyl 10% + Chlorimuron-ethyl 10%

WP @ 4 g a.i. ha⁻¹ and which registered weed biomass of 5.17, 8.34 and 11.25 g m⁻² respectively. Similar kinds of trend were also followed in next year (Table 3). The above findings thus indicate that hand weeding twice at 20 and 40 DAT always showed the excellent performance by registering the lowest weed biomass and this was mainly due to the reason that two hand weeding or puddling along with constant submergence did not permit the weeds to come up and kept the plots almost weed-free which was reflected in the minimum value of total weed biomass. Similar type of findings was earlier reported by Pilli *et al.* 1976. Among the chemicals used, Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ showed the best performance.

Table 3: Effect of treatments on total weed biomass (g m⁻²).

Treatments	Total weed biomass (g m ⁻²)									
	Dosage (g/ kg a.i. ha ⁻¹)	30DAT			60DAT			90 DAT		
		2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T ₁ : Oxadiargyl 80% WP	25g	10.21	8.79	9.5	13.86	12.92	13.39	17.01	16.25	16.63
T ₂ : Payrazosulfuron ethyl 10 % WP	30g	9.06	6.66	7.86	11.35	9.95	10.65	16.63	14.4	15.515
T ₃ : Butachlor 50 % EC	1000g	9.76	9.04	9.4	14.03	13.92	13.975	17.36	17.02	17.02
T ₄ : Hand weeding (20 and 40 DAT)	-	5.17	3.48	4.325	8.34	6.47	7.405	11.25	10.14	10.695
T ₅ : Penoxsulam 21.7 % SC	50g	7.71	7.28	7.495	12.63	11.52	12.075	16.44	15.33	15.885
T ₆ : Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP	4g	6.44	6.01	6.225	10.32	9.45	9.885	14.46	13.35	13.905
T ₇ : Untreated plot	-	14.06	12.4	13.23	20.44	19.03	19.735	22.81	21.11	21.96
SEm		0.202	0.219	0.261	0.211	0.414	0.798	0.394	0.272	1.028
CD at 5%		0.623	0.675	0.758	0.65	1.274	1.428	1.213	0.837	3.056

(WP: Wettable Powder, EC: Emulsifiable Concentrate, DAT: Days After Transplanting, SC: Suspension Concentrate, G: Gram, KG: Kilogram, A.I.: Active Ingredient, SEm: Standard Error of Mean, CD: Critical Difference, HA: Hectare).

3.4 Effect of treatments on weed control efficiency (%): The highest weed control efficiency (WCE) across all observations was achieved with hand weeding at 20 and 40 DAT (T₄) among all treatments. Among the chemical control methods, the application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T₆) exhibited the highest WCE in both 2018 and 2019, followed by Pyrazosulfuron-ethyl 10% WP @ 30 g a.i. ha⁻¹ (T₂). Hand weeding twice at 20 and 40 DAT

consistently demonstrated superior WCE across all crop growth stages, potentially due to enhanced crop shading, which suppressed weed emergence and growth. Regarding herbicidal efficacy, treatments T₆ (Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹) and T₂ (Pyrazosulfuron-ethyl 10% WP @ 30 g a.i. ha⁻¹) effectively controlled weeds at all growth stages, likely due to their ability to significantly reduce weed biomass.

Table 4: Effect of treatments on weed control efficiency (%).

Treatments	Weed control efficiency (%)									
	Dosage (g/ kg a.i. ha ⁻¹)	30DAT			60DAT			90 DAT		
		2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T ₁ : Oxadiargyl 80% WP	25g	29.11	29.24	29.175	32.11	32.54	32.325	23.02	23.56	23.29
T ₂ : Payrazosulfuron ethyl 10 % WP	30g	46.29	46.49	46.39	47.71	47.84	47.775	31.79	32.24	32.015
T ₃ : Butachlor 50 % EC	1000g	27.1	27.94	27.52	26.85	27.12	26.985	19.37	19.74	19.555
T ₄ : Hand weeding (20 and 40 DAT)	-	71.94	71.51	71.725	66	66.84	66.42	51.97	52.22	52.095
T ₅ : Penoxsulam 21.7 % SC	50g	41.29	41.83	41.56	39.46	40.24	39.85	27.38	28.13	27.755
T ₆ : Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP	4g	51.53	51.72	51.625	50.34	50.67	50.505	36.76	37.21	36.985
T ₇ : Untreated plot	-	0	0	0	0	0	0	0	0	0

(WP: Wettable Powder, EC: Emulsifiable Concentrate, DAT: Days After Transplanting, SC: Suspension Concentrate, G: Gram, KG: Kilogram, A.I.: Active Ingredient, HA: Hectare).

3.5 Effect of treatments on straw and grain yield (t ha⁻¹): Maximum straw yield 5.66 and 6.25 ton ha⁻¹ in 2018 and 2019 respectively (Table 5), were obtained from the treatment T₆ (Hand weeding twice at 20 and 40 DAT), closely followed by the treatment Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T₆) registering 5.24 and 5.95 ton ha⁻¹ straw yield of paddy in 2018 and 2019. It was found that the minimum straw yield (3.60 and 4.12 ton ha⁻¹ in 2018 and 2019, respectively) were recorded with the unweeded control treatment (T₇) which was significantly lower than any other weed control treatments tried in this investigation. Regarding the grain yield, the highest grain yield in both year 2018 and 2019 (Table 5) (5.15 and 5.30 ton ha⁻¹ respectively) were recorded with the hand weeding twice at 20 and 40 DAT (T₄), having no significant difference with the application of Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T₆) which recorded the grain yield of 4.96 and 4.97 ton ha⁻¹ in 2018 and 2019 respectively. This was earlier reported by Ahmed (1978). Lowest grain yield (3.45 and 3.33 ton ha⁻¹ in

both years) was obtained from the unweeded control treatment (T₇) which was significantly lower than other treatments.

Hand weeding at 20 and 40 DAT ensures effective early-season weed control, minimizing competition for nutrients, water, and light. It prevents weed resurgence during critical crop growth stages, allowing rice plants to establish and develop optimally. Enhanced aeration and soil health from manual weeding promote better root growth and nutrient uptake. Additionally, reduced weed biomass minimizes pest and disease incidence, contributing to higher straw and grain yield. Among the different chemical treatments, Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T₆) was the most superior treatment, due to offered minimum weed-crop competition and caused no injury to the rice crop which was congenial for better vegetative and reproductive growth resulting higher straw and grain yield. Bhattacharya *et al.* (1997) were of the same opinion.

Table 5: Effect of treatments on straw and grain yield (t ha⁻¹)

Treatments	Dosage (g/ kg a.i. ha ⁻¹)	Straw yield (t ha ⁻¹)			Grain yield (t ha ⁻¹)		
		2018	2019	Pooled	2018	2019	Pooled
T ₁ : Oxadiargyl 80% WP	25g	4.98	5.05	5.015	4.38	4.71	4.545
T ₂ : Payrazosulfuron ethyl 10 % WP	30g	5.23	5.53	5.38	4.85	4.95	4.9
T ₃ : Butachlor 50 % EC	1000g	4.61	4.84	4.725	4.12	4.34	4.23
T ₄ : Hand weeding (20 and 40 DAT)	-	5.66	6.25	5.955	5.15	5.3	5.225
T ₅ : Penoxsulam 21.7 % SC	50g	5.08	5.38	5.23	4.56	4.81	4.685
T ₆ : Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP	4g	5.24	5.95	5.595	4.96	4.97	4.965
T ₇ : Untreated plot	-	3.6	4.12	3.86	3.45	3.33	3.39
SEM		0.043	0.219	0.862	0.151	0.038	0.876
CD at 5%		0.133	0.675	1.054	0.466	0.199	1.587

(WP: Wettable Powder, EC: Emulsifiable Concentrate, DAT: Days After Transplanting, SC: Suspension Concentrate, G: Gram, KG: Kilogram, A.I.: Active Ingredient, SEM: Standard Error of Mean, CD: Critical Difference, T: Tonne, HA: Hectare).

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.6 Economics of weed control treatments: The economics of different weed control treatments were worked out and relevant data have been presented in table no. 6. Among the different treatments, T₆ (Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹) gave the highest net profit (Rs.39507.50 and 39156.5 ha⁻¹ in 2018 and 2019 respectively) which was economically more sound. This was followed by the treatment Payrazosulfuron

(T₂) (Rs. 36270.5 and Rs. 38143.5 respectively in both years) and Penoxsulam (T₅) (Rs. 31194.5 and Rs. 35063.5 in both years respectively). The treatment untreated control (T₇) recorded the lowest profit Rs. 15029.5 and Rs. 12615.5 in both the years 2018 and 2019. Other remaining treatments are unable to show satisfactory net profit in this experiment.

So far as the benefit cost ratio is concerned, the highest value (1.95 and 1.91 respectively in 2018 and 2019) was obtained with the treatment T₆ (Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i ha⁻¹) followed by treatment (T₂) Payrazosulfuron (1.86 and 1.87 respectively in both years). Hand weeding treatment (T₄) showed lower

benefit cost ratio value (1.61 and 1.60) in comparison to the above mentioned herbicidal treatments due to higher expenditure on labour wages and lowest value was obtained in the treatment T₇ (untreated control) of 1.36 and 1.29 respectively in both years. These types of finding are supported by Bhattacharya *et al.* (1997) and by Mukherjee and Singh (2005).

Table 6: Economics of weed control treatments.

Treatments	Dosage (g/ kg a.i. ha ⁻¹)	Net return (Rs. ha ⁻¹)			Benefit cost ratio		
		2018	2019	Pooled	2018	2019	Pooled
T ₁ : Oxadiargyl 80% WP	25g	30530.72	34586.72	32558.72	1.73	1.79	1.76
T ₂ : Payrazosulfuron ethyl 10 % WP	30g	36270.5	38143.5	37207	1.86	1.87	1.865
T ₃ : Butachlor 50 % EC	1000g	24717.5	28386.5	26552	1.59	1.65	1.62
T ₄ : Hand weeding (20 and 40 DAT)	-	31845.5	32981.5	32413.5	1.61	1.6	1.605
T ₅ : Penoxsulam 21.7 % SC	50g	31194.5	35063.5	33129	1.73	1.78	1.755
T ₆ : Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP	4g	39507.5	39156.5	39332	1.95	1.91	1.93
T ₇ : Untreated plot	-	15029.5	12615.5	13822.5	1.36	1.29	1.325

(WP: Wettable Powder, EC: Emulsifiable Concentrate, DAT: Days After Transplanting, SC: Suspension Concentrate, G: Gram, KG: Kilogram, A.I.: Active Ingredient, SEM: Standard Error of Mean, CD: Critical Difference, RS.: Rupees, HA: Hectare).

CONCLUSION

The experiment revealed that the highest grain yield in both 2018 and 2019 (5.15 and 5.30 ton ha⁻¹, respectively) was recorded with hand weeding twice at 20 and 40 DAT (T₄). However, this was statistically similar to Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T₆), which yielded 4.96 and 4.97 ton ha⁻¹. T₆ also provided the highest net profit (Rs. 39,507.50 and Rs. 39,156.50) and benefit-cost ratio (1.95 and 1.91) in both years, followed by Pyrazosulfuron (T₂) and Penoxsulam (T₅). The lowest grain yield (3.45 and 3.33 ton ha⁻¹) and benefit-cost ratio (1.36 and 1.29) were observed in the unweeded control (T₇). Hand weeding (T₄) resulted in a lower benefit-cost ratio (1.61 and 1.60) due to higher labor costs. Overall, Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T₆) was the most economically viable weed management strategy. Hence, Metsulfuron-methyl 10% + Chlorimuron-ethyl 10% WP @ 4 g a.i. ha⁻¹ (T₆) is recommended as a cost-effective alternative to labor-intensive hand weeding for maximizing both yield and profitability in rice production.

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Innovative Marketing Strategies for Commercialization of Okra in Tapi District of South Gujarat

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ABSTRACT

The commercialization of okra in Tapi's agricultural scenario is primarily the result of institutional interventions carried out through participation over the previous forty years, with a primary concentration on production followed marketing interventions. It has been observed that these interventions are successful in changing the agricultural sector of the region from parochial paddy cultivation to commercial okra farming. In current scenario, the major marketing-centric institutional interventions of the export promoting agencies have highlighted the relevance of institutional innovations in the promotion of okra in the region. A comparative gain of Rs. 37,475 per hectare has been reported for growers following export-oriented okra production. The study has shown the potential benefits of comprehensive institutional interventions persuaded by the export agencies in Tapi. A comparative analysis of marketing has revealed that marketing channel of okra via. exporting agency is the most efficient. The benefits of informal community participation under appropriate supervision and leadership have been shown by the study.

Key Words: Participatory approach, Livelihood security, Institutional innovations, Technology Transfer, Nutritive, Scientific, Marketing Efficiency

INTRODUCTION

The production scenario of Indian agricultural receives numerous innovations, institutions support and researches but the same impetus has not been provided to post production activities which can be broadly categorized in Rural Non-Farm activities. In spite of the fact that a number of non-agriculture activities are categorised under RNF viz., Cementary, manufacturing, mining but all these activities leads to movement of the peasantry away from the main land and later on migration. Thus, at current stage we need to focus on the activities which enhance the agriculture as well as provide the employment to the nascent growers at village and taluka level which mainly involves the development of secondary agriculture. Many studies have attempted to evaluate the impact of RNF on agriculture (Abraham 2009, Acharya and Mitra 2000, Ahluwalia 1978, Basant et al. 1998, Basant 1994, Basu and Kashyap 1992, Bhalla and Singh 1997, Bhalla 1993, Bhattacharya et al. 2004, Chadha 2001, Chandrasekhar and Ghosh 2004, Chenery and Syrquin 1975, Chinna 2004, Dholakia 2007, Harriss 1987, Hazell and Haggblade 1991, Hymer and Resnick 1969 and

Kundu 1991). However, these studies have not separately dealt with the employing the rural population in Secondary Agriculture.

The Tapi district of Gujarat offers inherent opportunities to practice Okra. In the current era okra is commercially produced in the district. Although the production and demand of the crops is continuously increasing, the marketing of the crop relies on tiers of intermediaries. Owing to high demand of the crop around three-fourth of the produce is routed outside district with the help of middlemen. These middlemen are mainly involved in the supply chain as commission agents and doesn't impart /help in the improving the production scenario of the region. With the event of time, new marketing channels including exporting agencies have evolved. However, the area of operation of such agencies is limited. In this background the present study has been undertaken to evaluate the impact of the both production and post productions interventions of okra on the commercialization of okra in Tapi district of South Gujarat with the following specific objectives:

- To access the Rural Livelihood Security through transformed agricultural landscape in Tapi with the institutionalized introduction of Okra,
- To examine the role of the export agencies in technology transfer, processing and marketing of okra in Tapi

METHODOLOGY

The study is both exploratory and analytical, involving qualitative as well as quantitative methods and is drawn from the two projects completed during the period of 2016 to 2019 and extension of a M. Sc. Research work based on primary data collected for the year 2022-23. To examine the technology transfer by the institutionalised set up of export agencies Dolvan block of Tapi was purposively selected as the export agency is mainly concentrating their work in Dolvan block of the district. The Kay Bee Exports Pvt. Ltd. and Vadilal Industries Ltd. were the key export players in the region and thus selected for the study. The cluster sampling was used for selection 60 vegetable growers in consultation with the Agency. Three clusters of villages involved with the agency were selected. Finally, 20 farmers per cluster were selected randomly. For the comparative analysis, 30 growers selling to the export agency as well 30 growers selling elsewhere were selected. Thus, a total of 60 vegetable growers were selected for accessing the extent of technology transfer. In order to achieve the objective, simple statistical tools like averages and percentages were used.

RESULTS AND DISCUSSION

3.1 Rural Livelihood Security through transformed agricultural landscape in Tapi with the institutionalized introduction of Okra

The commercial production of okra in Tapi is more than four decade old. A unique feature embedded to the process of development of Okra sector in the region has been a mutually reinforcing collaborative approach between the Government of Gujarat and the state agricultural universities network. The notable outcomes of the collaborative initiatives are comprehensive policy approaches to the emerging issues over time.

The Okra was introduced in the region as an extension persuaded initiative during the beginning of 1980's. The region is predominantly a tribal belt of South Gujarat, the livelihood pattern during early eighties was mainly dependent on the parochial paddy cultivation. The viscous circle of the subsistence livelihood pattern of the fledgling

growers was break through with the introduction of Okra. The benefits of the high value crops percolated slowly in the region and its commercial viability was exploded only with the commencement of the proper marketing interventions from 1990's onwards. Thereafter, the major interventions were initiated for the promotion of Okra sector in Tapi, which can broadly be classified under four phases, viz. Phase I (1982-1991), Phase II (1991-2004), Phase III (2004-2014) and Phase IV (2014 onwards).

Phase I(1982-1991) – The introductory phase was initiated with experimental planting of Okra crop without any organized back up of production and marketing efforts. The major institutional interventions during this phase were the persuasion by the extension agencies of Agricultural Universities for plantation of High Value crops and slowly development of the marketing channels for efficient marketing the crop. The agriculture sector in the region relies mainly on the traditional paddy production with low productivity resulting in poverty ridden livelihood of the growers. During this phase, the extension activity has persuaded few growers to adopt a new crop. Initially, the type of Okra produced was not as per the market demand i.e. thick, lopsided, long and infested etc. The crude form of ungraded okra was sold to the dealers operating at Surat. The known how provided by the extension agencies of SAU's and market stakeholders help the growers for further improving the quality of the produce.

Phase II(1991-2004) - This phase witnessed major changes in the production sector with steady growth in the share of small and marginal farmers. The major breakthrough during this phase is active involvement of private vegetable seed producing companies, which supplies the necessary inputs, equipment and services to the growers through the extension support of public agencies. These supports were crucial to sustain the income base of the slowly developing sector. Despite differences in the extent of services delivery by private and public agencies, they are complementary at a functional level.

Phase III(2004-2014) - This phase heralded a new era in the sphere of Okra marketing in Tapi. The major innovation is development of the new marketing channels to other states, development of Vyara Mandis and Dolvan Mandis to cater the marketing needs of the nascent growers and the mushroom growth of both licensed and as un-licensed commission agent providing better opportunities for the realization of higher prices.

Phase IV(2014 onwards) - This current stage has seen vertical integration of the Okra sector, especially with the establishment of an export oriented processing plant in the private sector by the Kay Bee group in 2015 and with the entry of export oriented cut vegetable segment of Vadilal group Pvt. Ltd. These export oriented processing units has transformed the cachet of Okra sector in the region. The industry sources a major share of its produce from farm gate by opening an informal Producers cooperative in different part of Tapi. Apparently, with inception of the export catering units, the Okra sector of Tapi has been comprehensively evolved into two groups, viz. the informally formed Farmers cooperatives selling a significant share of their graded produce to exporting agencies, and the growers in the unorganized sector who primarily market their produce as either graded or ungraded to the Market stakeholders. In effect, understanding the marketing need of the region the State Marketing Board has started operating sub yards in the major producing areas of Tapi.

3.2.1 Technology Transfer backed by Export agencies

The production of Okra backed by exporters in the study area is mainly dealt by two agencies viz., Kay Bee Exports Pvt. Ltd. and Vadilal Industries Ltd. The processing cum export oriented unit of Kayee Export Pvt. Ltd. was working in the region from 2015 onwards. The Kay bee exports was found to be deeply involved in the production process and works through the year whereas the Vadilal group procures Okra with the network of NGOs (or sometimes through Kay bee Exports) and operates during monsoon season. The Kay Bee group was found merchandising in the fresh produce while the Vadilal Industries Ltd was involved in frozen cut vegetables. The group persuades the growers in formation of informal farmer's producers groups. The kaybee has developed a unique model where by all the plant inputs and plant protection products are bought by the company for its entire group of informally formed producers cooperative directly from the manufacturers. These are supplied to the growers of these cooperatives on credit basis. The technical team of the agencies periodically visits growers field and provides integrated pest management practices based on modern agronomic principles. It was observed that scientific farming methods have resulted in production of the crop as per the laid down parameters at international level. The groups offer a fair-priced fixed contract rate

to the growers. Farmers also have the assurance of a full buy-back from these agencies.

The processing unit in the region provides technical support to the growers in producing the nutritive okra on scientific grounds without compromising with the income. The unit is opened in vicinity of the major okra producing villages which provide easy technical know-how as well provide the employment to the growers of the area. Thus the unit is creating secondary source of income by generating new jobs whereby helping in checking poverty. Moreover it is bridging the gap between export oriented demand and farm production by cultivation crop as per the specifications by specific country.

3.2.2 A comparative assessment of Production Scenario under Organized growers of Export oriented agencies vis-à-vis Unorganized growers

As discussed in previous section, the exporters agencies backed Okra production in the study area is dealt by two agencies viz., Kay Bee Exports Pvt. Ltd. and Vadilal Industries Ltd. The present section is for quantitative analysis of the production scenario based on primary survey of the growers. The table 1 shows the production and cost pattern of the growers involved with the export agencies. The Export agencies provide a platform for different services to the growers (for mandating the plantation as per their specifications) followed by efficient grading and marketing. They supplies seeds, equipment and on farm extension services to growers. Despite the differences in the extent of services rendered to different villages they are complementary at a functional level. The seeds were supplied to the growers on the loan basis and the amount was found to be recovered as the harvesting initiates. Apparently, an amount of Rs. 28,532 per hectare (table 1) was indirectly availed by the growers as a credit for initiating the okra plantation. The Export agency emphasize on the minimum use of the pesticides which helps to maintain the standards set at the international level. They were found using the organic pesticides like Neem oil and Nilgiri etc. The sprays as well pesticides were found to be provided by the agency for ensuring the use of recommended pesticides. The cost incurred for insecticide and pesticide is Rs 2,464 which predominantly involves the fuel used for spraying chemicals. In case of heavy infestation the growers were allowed to spray other chemical pesticides but during the residual effect period the agency was not found to procure Okra.

Table 1. Details of Production activities and cost associated per hectare of okra production in export oriented chain

Sr.No.	Items	Physical unit	Value (Rs.)	
1.	Pre Land preparation (Mainly Mechanical)	-	10472	
2.	Seed Rate	8.82	28532	
3.	Chemical Fertilizer	-	5792	
4.	Irrigation	-	10157	
5.	Insecticides/ Pesticides	-	2464*	
6.	Human Labour	i) Pre Harvesting		
		A. Family (man days)	124.43	14932
		B: Hired (man days)	6.06	728
		ii) Plucking/ harvesting		
		Plucking/season	40.43	-
		Labour/ Plucking		
		A: Family (man days)	6.16	-
		B: Hired (man days)	0.70	-
		Total labour requirement for plucking		
		A: Family (man days)	249.07	34870
		B: Hired (man days)	28.30	3962
Total human labourA: Family (man days)	373.50	49801		
B: Hired (man days)	34.37	4690		

Note: *The cost mainly involve the fuel charge used for spraying chemicals

The Table 2 shows the production and cost pattern of the unorganised growers involved with the of Okra production. The production is done in the absence of any extension exposure rather based on the expertise of the grower on its own. Thus all the cost in the production scenario was found higher in

comparison to the cost involved in the export oriented growers. Moreover the advantage of receiving seeds on credit is foregone in this pattern. Apparently, the quality as well quantity of the seeds during the peak season depends on the whims and fancies of the seed stakeholders.

The growers of the regions were also found to visit other districts in the search of the premium quality seed.

Table 2. Production activities and cost associated per hectare of okra production for unorganised growers

Sr.No.	Items	Physical unit	Value(Rs.)	
1.	Pre Land preparation (Mainly Mechanical)	-	11046	
2.	Seed Rate	9.10	29379	
3.	Chemical Fertilizer	-	7313	
4.	Irrigation	-	9793	
5.	Insecticides/ Pesticides	-	11876	
6.	Human Labour	i) Pre Harvesting		
		A. Family (man days)	115.21	13826
		B: Hired (man days)	6.65	798
		ii) Plucking/ harvesting		
		Plucking/season	40.93	-
		Labour/ Plucking		
		A: Family (man days)	8.96	-
		B: Hired (man days)	1.62	-
		Total labour requirement for plucking		
		A: Family (man days)	366.76	51347
		B: Hired (man days)	189.11	26476
Total human labourA: Family (man days)	481.98	65172		
B: Hired (man days)	195.76	27274		

In comparative sense, the key difference in production framework of export and unorganised growers lies in plant protection and plucking. The growers in unorganised segment were found to incur a cost of Rs. 11,876 per ha. for Plant protection use due to comparatively higher use of pesticides. Moreover, the farmers in the export précis were found to use minimum quantity of chemical pesticides making the produce more nutritive. Apparently, the okra produced for local or national level consumption shall be having high doses of pesticides which is hazardous for human health. The labour requirement for harvesting in export chain was found to be low as the grading labour was provided by the agency. Thus a comparative gain of Rs. 37,475 per hectare was found for export oriented okra production. As the production process of okra involves 5-6 months, farmers were not found to maintain precise production record.

CONCLUSION

The study on transforming landscape has focused on the potential benefits of comprehensive institutional interventions persuaded by the export agencies in Tapi. The informal set up of farmers has been found effective in scientific and nutritive okra production. The export oriented set up has been instrumental in providing good quality seeds on credit supplemented with periodic supervision. Linkages with exporting companies ensure availability of good quality inputs at reasonable rates. In addition, the linkages are helpful to the smallholders in processing and marketing of Okra. The study has demonstrated the benefits of informal community participation with proper guidance and monitoring.

Way Forward

The further development of the Okra sector in Tapi, requires to develop the marketing sector for keeping pace with the quickly developing production sector. The stakeholders like Exporting agencies needs to be encouraged for establishing procurement-cum-processing centers in rural areas for farm gate purchase as well for development of secondary agriculture and rural economy as a whole. The New innovative marketing router like online trading, e-NAM are also needed to be developed for bridging the gap between the growers and consumers.

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Makhana Value Chain: Addressing Inefficiencies and Unlocking Rural Prosperity

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ABSTRACT

*This study examines the value addition of Makhana (*Euryale ferox*), an economically and nutritionally significant aquatic crop primarily cultivated in the Mithila region of Bihar, India. Renowned for its rich nutritional content, including carbohydrates, proteins, essential amino acids, and minerals, Makhana has emerged as a popular super food. However, its value chain faces critical inefficiencies that hinder growth and profitability. Makhana processing remains predominantly manual, with minimal mechanization, resulting in low profit margins despite the high market price of the crop. Women play a central role in processing, contributing over 70 per cent of labour in activities such as roasting and grading, though the prevalence of child labour presents significant social challenges. Financing of the Makhana value chain is primarily through private money lenders, who fund 85 per cent of processors with small loan amounts at high interest rates (40-45 per cent per annum), placing additional financial strain on the sector. The lack of affordable and efficient processing technologies, along with heavy reliance on informal credit, limits the scalability and sustainability of the Makhana industry. This study highlights the urgent need for mechanization, innovative financing solutions, and streamlined marketing strategies to address these challenges. By improving value addition, these interventions could enhance the livelihoods of small-scale farmers and processors, drive rural economic development, and establish Makhana as a competitive player in global markets.*

Keywords: Makhana, Value Addition, Processing, Financing, Women Empowerment, Nutritional Value, Value Chain

Introduction

Makhana, also known as Gorgon Nut or Foxnut (*Euryale ferox* Salisb.), is an aquatic crop that belongs to the Nymphaeaceae family. It is primarily found in South and East Asian countries, including India, China, Nepal, Bangladesh, Japan, Russia, and Korea. In India, its cultivation is mainly restricted to a few states such as Bihar, Assam, Manipur, West Bengal, Tripura, and Odisha (Kumar et al., 2011). Makhana is traditionally grown in stagnant, perennial water bodies like ponds, lakes, ditches, wetlands, and land depressions, where the water remains shallow, typically between 4-6 feet deep. The ideal conditions for its growth include a temperature range of 20-35°C, relative humidity between 50-90 per cent, and annual rainfall of 100-250 cm (Mandal et al., 2010).

The edible part of the plant is its small, round seeds, which have a black to brownish outer

covering. These seeds are processed into popped makhana, also known as "lava," which is widely consumed due to its high nutritional value. Popped makhana contains 12.8 per cent moisture, 76.9 per cent carbohydrates, 9.7 per cent protein, 0.1 per cent fat, 0.5 per cent total minerals, 0.02 per cent calcium, 0.9 per cent phosphorus, and 0.004 per cent iron (Shankar et al., 2010). It is a staple in Indian households and is commonly eaten as fried snacks, added to vegetable curries, or used in sweet porridge. Its demand significantly rises during festivals such as Navratri, Kojagara, Eid, and weddings, as it plays an important role in religious rituals and is often consumed as a fasting food. However, makhana cultivation, harvesting, and processing require intense labor and effort, making it a highly time-consuming and physically demanding activity (Khadatakar et al., 2015).

In regions where makhana cultivation takes place, an estimated 10 to 15 village ponds are utilized for this purpose. Most of these ponds are government-owned and are leased out through short-term auctions conducted by the fishermen's cooperative society. However, some ponds are privately owned. The primary cultivators of makhana belong to the Malla caste (Mishra et al., 2003). The average yield of makhana is approximately 0.85 tons per acre, with maximum productivity reaching up to 2 tons per acre.

Makhana cultivation follows a distinct seasonal pattern. To maintain steady production levels, clay should be periodically removed from the ponds, typically every three to four years, with this process usually carried out in October and November. Sowing of the new crop takes place in January or February, and germination occurs within 30 to 40 days. In commercial makhana cultivation, young seedlings are transplanted from nurseries into ponds or rice fields, a practice similar to rice transplantation that generally results in higher yields. Harvesting begins in late July and continues until the end of September or early October, often occurring in multiple stages, with the first harvest being the largest. Processing of makhana seeds into popped makhana can extend until December, but before processing can begin, the seeds must first be dried for approximately 10 days.

Popped makhana has multiple culinary uses and is enjoyed in various forms such as *namkeen*, *kheer*, and curry (Mishra et al., 2003). Beyond its nutritional value, makhana holds significant cultural and social importance in Bihar. It is traditionally considered essential for the bride's parents to send makhana to the groom's family before the wedding as a customary gesture. It is often consumed alongside betel leaves and betel nuts. Additionally, makhana plays a role in final rites and rituals following a person's passing.

METHODOLOGY

This study employed a descriptive research design during the years 2024-25 in the districts of Purnea, Saharsa, and Darbhanga in Bihar. A total of 60 Makhana processors were randomly selected as respondents using a multistage random sampling technique. One block from each district was purposively chosen based on the estimated area under Makhana cultivation. Subsequently, two to three villages were also purposively selected from each block following the same criteria of estimated area and production.

The study aimed to analyze the economics of Makhana processing, assess the profitability of Makhana-based processing systems, and identify the key factors contributing to high processing costs. Instead of following the conventional approach of categorizing costs into fixed and variable components, this research focused on identifying and documenting the expenses associated with each stage of Makhana processing. The analysis was conducted using a structured schedule specifically developed for this study.

Additionally, data on the work participation of male, female, and child labourers was gathered in terms of their percentage contribution to the total labour force. Information on value chain financing, including loan amount, sources of credit, loan duration, documentation requirements, and collateral security, was also collected using a semi-structured interview schedule.

RESULTS AND DISCUSSION

The study also examined the work participation of adult male, female, and child laborers in Makhana processing activities. Unlike the Makhana production process, the labor participation patterns in processing were found to be quite different. Adult male laborers were primarily responsible for tasks such as washing raw seeds (74.03%), sun drying, and popping (100%). In contrast, female laborers played a significant role in grading (62.36%), first roasting (74.45%), and second roasting (72.19%). A concerning issue identified in Makhana processing was the involvement of child laborers. Their participation was notably high in tasks such as washing (12.83%), grading (21.54%), first roasting (13.08%), and second roasting (14.41%) of the seeds.

Makhana processing is a labor-intensive activity that lacks any mechanization. The analysis of processing costs shows that for each quintal of raw Makhana seeds processed, a total cost of Rs. 10,296 is incurred. The largest portion of this cost (Rs. 7,783) is attributed to the purchase of raw seeds, followed by labor charges (Rs. 2,064). Costs related to other factors, such as transportation, processing equipment, room rent, packing materials, and electricity, are much lower, each contributing less than 5 per cent of the total processing cost. The net returns were calculated based on pop recovery percentage and average sale price. The average pop recovery percentage ranged from 40-45 kg per quintal of raw seeds, and the average sale price of popped Makhana was Rs. 250 per kg. The economic analysis

revealed that the processors earn Rs. 204.14 per quintal of raw seeds processed after deducting the processing costs from the gross return (Rs. 10,675).

Characteristics of makhana farmers

Almost half of the farmers cultivate Makhana in a single pond, while 13 per cent of households reported cultivating Makhana in more than three ponds. The average pond area cultivated per household is 4.8 acres. In terms of Makhana production in 2009, the average output per household was 3.1 tons, which translates to about 635 kg per acre. The majority of Makhana is marketed in the form of raw seeds, with only 32 per cent of farmers selling processed (popped) Makhana. Key informant interviews highlighted regular complaints about delayed harvesting and processing due to limited processing capacity or labor shortages, which sometimes led to product deterioration. However, this appeared to be a minor issue in practice, as only 12 per cent of producers delayed harvesting when seeds were already ready, and the average delay between harvesting and processing was 5 days. This time was primarily needed for drying the seeds. About 27 per cent of producers reported that the quality of seeds deteriorated during drying, with all of them believing that the quality of the popped Makhana would have been better had processing occurred sooner. As a result, more than a quarter of the producers seemingly suffered losses due to delayed processing.

Makhana production and input use

We initially interviewed 36 Makhana processors, with an average processing capacity of approximately 68 tons of Makhana seeds per year. Most of these processors have been involved in this work for a long period, averaging 24 years. Due to the specialized and challenging nature of the popping technique, processors often undergo years of apprenticeship, typically with family members, to master the skill and achieve high popping rates. The required investment for processing is relatively low, with investment levels reaching as high as Rs. 6,986 (approximately \$155). Processors report achieving a conversion rate of 40 kg of popped Makhana from 100 kg of seeds, with the best quality pop, known as lava, constituting around 78 per cent of the total popped quantity.

In a second phase, 24 wholesalers were interviewed across various markets, with 57 per cent located in Patna, 26 per cent in the production areas of Dharbhanga and Madhubani, and 17 per cent in Delhi. These wholesalers reported an average procurement

of 7 tons per week at the beginning of the harvest season (July to September), which increases to about 11 tons per week from January to March. Over the past five years, wholesalers have doubled their procurement quantities, reflecting the rapid growth of the commercial Makhana sector, as suggested by several key informants. The number of suppliers they source from also shows significant seasonal variations. During the July-September period, the average number of suppliers is 11, while it rises to 17 during the January-March period.

Next, 154 retailers were interviewed in the city of Patna. While some of these retailers are street hawkers, the majority of Makhana is sold through kirana stores (97 per cent of those interviewed), which are small, family-owned shops. The quantities sold are relatively low, averaging only 5 kg per day per store. Makhana contributes just over 4 per cent of the total sales and profits for these stores, making it a minor product in their overall sales portfolio. Data on asset values and working capital, as presented in Table 5, reveals that most of these retail stores are small-scale operations. The average value of assets is estimated at \$1,100, while the average working capital is around \$2,600.

Market structure

In traditional Makhana markets, four quality types of popped Makhana are recognized: lava, murha, turi, and mix. The quality distinctions are primarily based on the size of the pop. Transactions in these markets typically involve gunny bags, which are standardized in size. The weight of the gunny bag is often an indicator of the Makhana's quality. If the Makhana is processed properly, the pops are larger and lighter, so a lighter bag generally signifies better quality. For example, an 8 kg bag is considered to contain high-quality lava Makhana, while bags weighing more than 10 kg usually indicate lower-quality Makhana.

The previous section discussed the rise of branded products among wholesalers, which we will refer to as low-cost branding. The packaging and branding process involves purchasing designed bags, with half of the wholesalers buying pre-made branded bags. While some of these bags are sourced from the production area of Dharbhanga, the majority are ordered from specialized manufacturers in Kanpur or Delhi. In 18 per cent of cases, wholesalers design the bags themselves. Outsourcing the design incurs a one-time cost of Rs. 22,000. The average cost per empty bag is Rs. 2.1.

Almost half of the wholesalers (47per cent) own a packaging machine, which costs approximately Rs. 1,862 (or \$41). Labor costs for filling and sealing the bags amount to Rs. 0.4 per bag. Therefore, the total variable cost for packing is Rs. 2.5 per bag or Rs. 10 per kg (since bags typically weigh 0.25 kg). Wholesalers were asked to evaluate the benefits of the packing and branding process, and they estimated that products sold in branded bags fetch an average price Rs. 15 higher than if sold loose. However, some wholesalers pointed out that the products in branded bags are of lower quality and could not be sold as loose items.

Cost and profit analysis of branding, traditional wholesalers

According to wholesalers, the quality of Makhana in branded bags is generally not considered superior to that of loose products. 19per cent of wholesalers believe the quality of Makhana in branded bags is better, 38per cent assess it to be the same, and 38per cent think it is worse. Most wholesalers also indicate that the Makhana used for branding can come from various suppliers (58per cent), and the inclusion in the branded bags is not dependent on specific characteristics of the suppliers. This suggests that there are minimal exclusion effects from branding, unlike those sometimes found in other modernizing markets (e.g., Reardon *et al.*, 2009). None of the wholesalers involved in branding employ salesmen or invest in advertising on television, radio, or in newspapers.

When asked why they do not sell more branded products, wholesalers cited that many customers prefer to check the quality of the product in person, which is not possible with pre-packed branded products. The lack of demand for branded Makhana does not appear to be related to higher prices (only 5per cent of wholesalers) or the longer time required to sell branded products (11per cent of

wholesalers), nor is it due to insufficient quality available for branding (6per cent of wholesalers).

Price effects of branding in the retail market

Branding has a notable price effect in the retail market, though its exact impact is still not fully understood. To explore this further, retailers were asked several questions. While nearly all wholesalers sell branded products, only 19per cent of retailers in the Patna market offer branded Makhana, suggesting that a large portion of branded bags handled by wholesalers is sold outside Patna, likely in larger cities beyond the state. For the retailers who do sell branded products, these items make up a significant portion of their total sales (92per cent), meaning they focus almost exclusively on branded Makhana.

In contrast to wholesalers, who have better insight into the contents of branded bags, most retailers (73per cent) believe that the quality of branded Makhana is higher. Additionally, 90per cent of retailers report that the prices of branded products are higher than those of loose products, supporting the quantitative findings.

When asked why consumers are interested in branded products, all retailers agreed that branding assures customers of receiving the right quantity. Just over half of the retailers (50per cent) believe customers are also drawn to brands due to better quality. Retailers selling branded Makhana were further asked why they prefer these products. A small number mentioned higher profits, but most highlighted the reduction in hassle—since there is no need for customers to weigh or check the quality of the product—and the increased demand from customers for branded items. Regarding the type of customers who purchase branded products, the majority (68per cent) indicated that these are wealthier customers compared to those who buy loose Makhana.

Table.1 Work Participation in Processing (n=60)

Sl. No.	Activity	Per cent work contribution		
		Adult male	Adult female	Children
1	Washing	74.03	13.14	12.83
2	Sun Drying	100.00	0.00	0.00
3	Grading	16.10	62.36	21.54
4	First Roasting	12.47	74.45	13.08
5	Seconding Roasting	13.40	72.19	14.41
6	Popping	100.00	0.00	0.00

Table.2 Economics of Makhana processing (n=60)

Sl. No.	Items	Mean cost (Rs./q raw seed)	Per cent
1	Labour Wages	2064	20.05
2	Transportation	82	0.80
3	Processing equipment	45	0.44
4	Packaging	73	0.71
5	Fuel	204	1.98
6	Room Rent	30	0.29
7	Electricity	16	0.16
8	Cost of raw seed	7783	75.59
9	Total cost of processing	10296	-
10	Average production of popped Makhana per quintal	40-45	-
11	Sale price (Rs./Unit)	250	-
12	Gross selling cost	10675	-
13	Net Income per quintal popping	204.14	-
14	B:C ratio	1:1.03	-

Table.3 Financing practice of processor (n=60)

Sl. No	Financing Body	Frequency	Per cent	Average loan amount	Average % interest rate per annum
1	Money Lender	51	85.00	257083	44.64
2	Financial Institution	-	-	-	4 to 18
3	Fellow Farmer & Friends	09	15.00	268333	40.44

CONCLUSION

This study highlights the significant potential of Makhana (*Euryale ferox*) as a high-value, nutritious aquatic crop with growing market demand. Despite its rich nutritional profile and cultural importance, the Makhana value chain in Bihar faces several inefficiencies that hinder its growth and profitability. Key issues include the labor-intensive nature of Makhana processing, the limited mechanization, and the heavy reliance on informal, high-interest financing. These challenges limit the scalability and sustainability of the sector, which largely impacts small-scale farmers and processors.

While Makhana processing provides substantial employment, particularly for women, the sector remains constrained by high labor costs and poor financial accessibility. The role of child labor in processing further exacerbates the social issues associated with Makhana production. Moreover, the proliferation of branded products in the market, while increasing sales, has not directly benefited farmers, as branding often serves more as a packaging tool than a quality indicator. The absence of proper regulations and consumer protection in the branding process further complicates market dynamics.

To unlock the potential of the Makhana value chain, significant improvements are needed in mechanization, financial access, and marketing strategies. The introduction of affordable processing technologies could help reduce labor costs and improve productivity, while the development of improved Makhana varieties could benefit small-scale farmers in flood-prone areas. Additionally, enhancing the relationship between financial institutions and value chain actors is essential for making credit more accessible and affordable.

Finally, addressing the social issues such as child labour and improving the transparency and accountability in branding practices will ensure that the growth of the Makhana sector benefits all stakeholders, including farmers and processors. With these interventions, Makhana has the potential to become a major player in both domestic and international markets, contributing to rural prosperity and economic development.

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Improvement in Seed Yield and Quality of French Bean as Influenced by Foliar Application of Ga_3 and Micronutrients

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ABSTRACT

Foliar application of gibberellic acid (Ga_3) and micronutrients can help plants better adapt to climate change by boosting growth, improving resistance to stress, especially drought, and potentially increasing crop production, making them more resilient to extreme weather events. So, with an objective of assessing the influence of foliar application of Ga_3 and micronutrients on seed yield and its components as well as seed quality parameters, an investigation was carried out with three French bean varieties viz., Anupma, Contender and Serengeti. Four foliar sprays viz., 100 ppm solution of Ga_3 , 0.2% solution each of boron (B) and molybdenum (Mo) and combination of those three i.e., Ga_3 @ 100 ppm + B @ 0.2% + Mo @ 0.2%, along with control were compared in a randomized block design (RBD), replicated thrice at 45 DAS and 60 DAS. Observations on number of pods per plant, number of seeds per pod, seed yield per plant (g) and seed yield per plot (kg) as well as seed index (100 seed weight) were recorded. Seed quality parameters like germination percentage, seedling length (cm), dry weight of seedlings (g) and vigour index-I and II were also examined. Results confirmed that foliar spray displays positive contribution towards improving the yield attributes and seed quality. Among all the treatments, influence of Ga_3 @ 100 ppm was found to be superior in most of these seed yield and quality parameters as well as it could be noticed that response of Contender towards all the treatments was maximum in almost all cases of the seed yield and quality parameters.

Keywords: French bean, Foliar application, Gibberellic acid, Growth regulator, Micronutrients, Yield.

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) belongs to family *Fabaceae* and sub family *Papilionaceae*. It has many synonyms like snap bean, kidney bean, haricot bean and also called 'Rajma' in Hindi. French bean originated from Central America and Peruvian Andes in South America, from where it spread to Europe during 16th and 17th centuries and it was introduced in India during the 17th century from Europe (Simmonds, 1976). Total area under cultivation of all beans including French bean was 228 and 5.50 thousand hectares and production was 2277 and 55.48 thousand metric tons during 2017-18 in India and Maharashtra, respectively (Anonymous, 2018). Beans contribute essential proteins and

vitamins to the under-nourished people of the developing countries. Medicinal properties include control of diabetes, cardiac problems and natural cure for bladder burn. It has both carminative and reparative properties against constipation and diarrhoea respectively (Duke, 1981).

As climate change intensifies, extreme heat waves and extended droughts in certain regions will likely lead to significant declines in crop yield and seed quality due to severe stress on plant growth and reproduction cycles. The yield of various crops is severely affected by abiotic stresses, especially drought when it occurs during the stage from flowering to the end of the seed set (Nath *et al.*, 2016; Ahmad *et al.*, 2021). Exogenous application of growth hormones and micronutrients increases a

plant's resistance to such environmental stresses along with improving yield (Parveen *et al.*, 2021; Das *et al.*, 2016).

Gibberellins (GA_3) play an important role in the growth and development of plants by improving cell division, cell elongation, the development of pollen, growth of the pollen tube, growth of fruit, development, and germination of seeds (Whitehead, 2008). GA_3 act at all stages in the plant life cycle, which display a remarkable diversity of physiological processes of plants (Choudhari, 2012) and foliar application of GA_3 was found to have positive impact on the yield contributing attributes of French bean (Noor *et al.*, 2017; Rajani *et al.*, 2016). Gibberellic acid (GA_3) has been widely used to improve germination rate, seedling growth, and, consequently, yield (Chunthaburee *et al.*, 2014).

Boron (B) seems to have a strong effect on legume nodulation and nitrogen fixation. Development of the symbiosis depends of the concentration of B and it is essential for nodule structure and function (Redondo-Nieto *et al.*, 2003). Studies revealed that the soil and foliar fertilization with boron had favorable effect on the seed yield and yield components of bean (Singh *et al.*, 2014; Sinha *et al.*, 1999).

Molybdenum (Mo) stimulates N-fixing activity of *Phaseolus vulgaris* (Vakhaniya *et al.*, 1990). It is essential for certain nitrogen transformations in microorganisms as well as in plants. Mo is a known cofactor of enzymes involved in the metabolism of sulfur (S) and S-amino acids, and is directly linked to the protein content, acting directly on N metabolism, mainly via nitrate reductase (Malavolta, 2006; Marschner, 2012). Mo has a positive effect on biological nitrogen fixation (BNF) and seed physiological quality, leading to an increase in grain yield (Milaniet *al.*, 2010) and produces seeds with high Mo concentrations (Jacob-Neto and Rossetto, 1998; Moraes *et al.*, 2008).

So, knowledge on response of different French bean varieties towards foliar application with growth regulator viz., GA_3 and micronutrients viz., boron and molybdenum, in respect of yield and quality seed production will be of immense use to seed industry and farming community. On this background, the present investigation was conducted with the objective of assessing the influence of foliar application of micronutrients and growth regulator on seed yield and its components as well as seed quality parameters.

METHODOLOGY

The present field experiment was carried out at Agricultural Experimental Farm of University of Calcutta, Baruipur, South 24 Parganas, West Bengal in the *Rabi* season 2018-19 and all the laboratory experiments were conducted at the laboratory of Department of Seed Science and Technology, Institute of Agricultural Science, University of Calcutta with the three French bean varieties viz., Anupma, Contender and Serengeti. Seeds of these varieties were collected from Uttar Pradesh and West Bengal for the purpose of experimental investigation, selection of which was based on its contrast characters for some important morphological parameters. The field experiment was consisted of fifteen treatment combinations in randomized block design (RBD) with factorial concept. In each replication, three varieties were placed randomly in the main plots, and seeds of each variety were sown in each sub-plot in two rows for every treatment in a particular fashion at 45 cm x 45 cm apart within each sub-plot. A distance of 50 cm was adjusted between two sub-plots and foliar spray was given twice with following treatments as furnished below:

T₀- Control

T₁- Foliar spray with GA_3 @ 100 ppm at 45 DAS and 60 DAS

T₂- Foliar spray with B @ 0.2% at 45 DAS and 60 DAS

T₃- Foliar spray with Mo @ 0.2% at 45 DAS and 60 DAS

T₄-Foliar spray with GA_3 @ 100 ppm + B @ 0.2% + Mo @0.2% at 45 DAS and 60 DAS

Boric acid and sodium molybdate were used as sources of B and Mo. In the experimental plots, five plants in each treatment from each sub-plot marked randomly at the initial stage of crop growth. Those five plants were harvested finally for making observations on number of pods per plant, number of seeds per pod, seed yield per plant (g) and seed yield per plot (kg) as well as for determining 100 seed weight or seed index. In case of laboratory studies, the parameters viz., germination (%), seedling length (cm) and dry weight of seedlings (g) were recorded at final count stage (9 days after germination setting) from the harvest fresh seeds of the French bean varieties grown in the field conditions.

Experimental data collected was subjected to statistical analysis by adopting appropriate methods as outlined by Panse and Sukhatme (1978). Critical Difference (CD) values were calculated wherever the 'F' test was found significant at 5 per cent level.

RESULTS AND DISCUSSION

Treatment influences were found to be significant for seed yield parameters but no definite pattern could be observed. Significant treatment influences were noted for number of pods per plant, seed yield per plant, seed yield per plot and seed index. On the contrary significant varietal response was recorded for all the yield parameters except for number of pods per plant and it could be noticed that response of Contender towards all the treatments was maximum in almost all cases of the seed yield and quality parameters. Among all the treatments, influence of GA₃ @ 100 ppm was found to be better in most of the seed quality parameters followed by B @ 0.2%.

In case of numbers of pods, significantly highest value for this parameter was recorded in Contender when foliar spraying was done with Mo @ 0.2% (Table 1.1). Study of Duarte-Junior and Coelho (2008), Bambara and Ndakidemi (2010), Gad and El-Moez (2013) and Heidarzade *et al.* (2016) corroborates this finding.

Serengeti produced significantly maximum number of seeds per pod followed by Anupma and Contender. Foliar application with B @ 0.2% resulted in highest number of seeds per pod in Serengeti over control. In case of Anupma, influence of GA₃ @ 100 ppm, B @ 0.2% and Mo @ 0.2% was found to be significantly higher over control. Highest interaction effect could be recorded for B @ 0.2% in Serengeti (Table 1.2). Shabban *et al.* (2006) and Mustafa *et al.* (2008) may support this finding.

Influence of all the treatments was noted to be similar in all the varieties for both seed yield per plant and seed yield per plot. Significantly better performance was exhibited by Contender over other two varieties and significantly better influence of all the treatments could be noted over control except GA₃ @ 100 ppm + B @ 0.2% + Mo @ 0.2%. Interaction between variety and treatment was recorded significantly highest in case of GA₃ @ 100 ppm on Contender for both the parameters (Table 1.3 and 1.4). Mustafa *et al.* (2008) and Mondal *et al.* (2012) reported similar findings to this.

In case of Seed index significantly highest magnitude of this parameter could be noted for Contender over rest two varieties when treated with Mo @ 0.2% and also influence of all the treatments

was recorded to be significantly better than control except GA₃ @ 100 ppm + B @ 0.2% + Mo @ 0.2% (Table 1.5). Among the varieties, in Serengeti, all the treatments exhibited statistically similar performance as control. Reports made by Araujo *et al.* (2009) and Heidarzade *et al.* (2016) are in conformity of present finding.

The micronutrients might have positive influence in seed setting that resulted in improvement in number of seeds per pod. Greater mobilization of photosynthates during seed development by application of micronutrients might be the reason behind increase in seed weight (Kavya *et al.*, 2021).

Laboratory experiment results showed that among all the treatments, B @ 0.2% exerted better influence for seedling length (Table 2.1) and among the varieties Contender has highest seedling length. Significantly highest seedling dry weight was recorded for Contender. Among the treatments, influence of B @ 0.2% was found to be better for seedling dry weight (Table 2.2).

Significantly maximum germination (%) was noted in case of Contender, but for this parameter Serengeti and Contender exhibited similar performance. Among the treatments, influence of GA₃ @ 100 ppm + B @ 0.2% + Mo @ 0.2% in Serengeti and that of GA₃ @ 100 ppm in Contender could be recorded as maximum (Table 2.3). In case of vigour status, varietal response towards both the parameters was recorded maximum for Contender with the exception of statistically similar vigour index II for Anupma and Serengeti and foliar application with GA₃ @ 100 ppm exhibited higher vigour index I and II (Table 2.4 and 2.5) in comparison to other treatments.

CONCLUSION

Findings of the present study demonstrated that foliar applications with GA₃ and micronutrients (B and Mo) were able to improve yield attributes in French bean varieties as well as seeds produced after foliar nutrition also exhibited its quality status. Response towards different foliar application can be identified as variety specific while considering all the parameters studied throughout the experimentation. Foliar spraying with GA₃ at flowering and pod initiation stage can be recommended for farming community for better quality seed production.

Table 1: Effect of foliar application of GA₃ and micronutrients on seed yield parameters.

1.1: Effect of foliar application on average number of pods per plant in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	23.750	22.700	24.775	21.500	20.875	22.720
Serengeti	24.700	21.750	22.600	24.050	20.500	22.720
Contender	22.275	23.000	21.750	25.300	20.000	22.465
Mean	23.575	22.483	23.042	23.617	20.458	
	V		T		V X T	
SE(m)±	0.378		0.488		0.845	
C.D. at 5%	NS		1.421		2.461	
1.2: Effect of foliar application on average number of seeds per pod in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	4.667	6.467	8.133	6.267	4.667	6.040
Serengeti	8.667	7.867	10.200	8.133	8.733	8.720
Contender	5.933	6.333	5.133	5.6	5.467	5.693
Mean	6.422	6.889	7.822	6.667	6.289	
	V		T		V X T	
SE(m)±	0.291		0.375		0.650	
C.D. at 5%	0.846		NS		1.892	
1.3: Effect of foliar application on average seed yield (g) per plant in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	14.474	25.008	38.518	24.364	13.694	23.212
Serengeti	26.851	23.925	28.939	24.317	23.928	25.592
Contender	30.719	41.117	29.794	39.803	28.016	33.890
Mean	24.015	30.017	32.417	29.495	21.879	
	V		T		V X T	
SE(m)±	1.249		1.613		2.793	
C.D. at 5%	3.637		4.696		8.133	
1.4: Effect of foliar application on seed yield (kg) per plot in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	1.013	1.751	2.696	1.706	0.959	1.625
Serengeti	1.88	1.675	2.026	1.702	1.675	1.791
Contender	2.15	2.878	2.086	2.786	1.961	2.372
Mean	1.681	2.101	2.269	2.065	1.532	
	V		T		V X T	
SE(m)±	0.087		0.113		0.196	
C.D. at 5%	0.255		0.329		0.569	
1.5: Effect of foliar application on seed index in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	13.111	17.300	19.112	18.347	13.987	16.371
Serengeti	12.549	13.927	12.579	12.380	13.307	12.948
Contender	23.270	28.080	26.983	28.651	25.957	26.588
Mean	16.310	19.769	19.558	19.793	17.750	
	V		T		V X T	
SE(m)±	0.458		0.592		1.025	
C.D. at 5%	1.334		1.723		2.984	

V = Variety, T0 = Control, T1 = GA₃ @ 100 ppm, T2 = B @ 0.2%, T3 = Mo @ 0.2% and T4 = GA₃ @ 100 ppm + B @ 0.2% + Mo @ 0.2%

Table 2: Effect of foliar application of GA3 and micronutrients on seed quality parameters of harvest fresh seeds.

2.1: Effect of foliar application on average seedling length (cm) in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	38.093	39.353	37.947	30.600	35.033	36.205
Serengeti	34.267	40.333	43.567	30.367	45.667	38.840
Contender	48.933	47.720	47.067	48.167	44.367	47.251
Mean	40.431	42.469	42.860	36.378	41.689	
	V		T		V X T	
SE(m)±	1.580		2.040		3.534	
C.D. at 5%	4.586		NS		NS	
2.2: Effect of foliar application on average seedling dry weight in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	0.079	0.083	0.082	0.076	0.068	0.078
Serengeti	0.048	0.060	0.068	0.046	0.069	0.058
Contender	0.171	0.152	0.166	0.161	0.148	0.160
Mean	0.099	0.098	0.105	0.094	0.095	
	V		T		V X T	
SE(m)±	0.004		0.005		0.009	
C.D. at 5%	0.012		NS		NS	
2.3: Effect of foliar application on germination (%) of harvest fresh seeds in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	46.5(42.993)	68.5(55.863)	46.06(43.077)	43.3(41.153)	53.9(47.213)	46.06
Serengeti	58.6(49.927)	68.4(55.780)	87.0(68.857)	68.4(55.780)	90.0(71.570)	60.383
Contender	90.0(71.570)	90.0(71.570)	81.06(64.637)	87.0(68.857)	74.6(59.710)	67.269
Mean	54.830	61.071	58.857	55.263	59.498	
	V		T		V X T	
SE(m)±	2.729		3.524		6.103	
C.D. at 5%	7.921		NS		NS	
2.4: Effect of foliar application on vigour index-I of harvest fresh seeds in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	1735.33	2621.13	1771.53	1314.60	1961.33	1880.79
Serengeti	2124.00	2714.67	3756.67	2231.67	4110.00	2987.40
Contender	4404.00	4294.80	3806.00	4173.33	3243.67	3984.36
Mean	2754.44	3210.20	3111.40	2573.20	3105.00	
	V		T		V X T	
SE(m)±	230.94		295.14		516.39	
C.D. at 5%	670.23		NS		NS	
2.5: Effect of foliar application on vigour index-II of fresh harvested seeds in French bean varieties						
Variety	T0	T1	T2	T3	T4	Mean
Anupma	3.693	5.611	3.867	3.286	4.065	4.104
Serengeti	2.531	4.251	5.928	3.247	6.246	4.441
Contender	15.408	13.680	13.112	13.901	11.137	13.448
Mean	7.211	7.848	7.636	6.812	7.149	
	V		T		V X T	
SE(m)±	0.527		0.68		1.177	
C.D. at 5%	1.528		NS		NS	

V = Variety, T0 = Control, T1 = GA₃ @ 100 ppm, T2 = B @ 0.2%, T3 = Mo @ 0.2% and T4 = GA₃ @ 100 ppm + B @ 0.2% + Mo @ 0.2%

*Figures in Parentheses are Arc sine transformed values

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Impact of Climate Smart Agriculture Technology on the Rice-Wheat System of the Indo-Gangetic Plains of India

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ABSTRACT

The impact of laser land levelling technology in Rice-Wheat (RW) systems of Indo Gangetic Plains of India was assessed by using primary data collected from household surveys of Indo Gangetic Plains of India for the year 2022-23. The crop yield, resource use efficiency, socio cost-benefit analysis and total irrigation time required per season between laserlevelled (LLL) and traditionally levelled (TLL) fields were considered. A shift from traditional land levelling to laser land levelling reduced on an average total irrigation time per season by 8.2 hr per ha in wheat and 32.5 hr per ha in paddy. The scaling up of LLL technology was found to be crucial as it has the potential to save 5065 thousands litres of water per hectare per LLL operation in the rice-wheat system of Indo Gangetic Plains of India. Total duration of irrigation in laser levelled field was significantly lower, this reduced the electricity use for irrigation by 2200 Kwh per ha in the rice-wheat system. Along with these benefits, LLL also helped to reduce about 209 Kg CE per ha per LLL operation. It was observed that there was improvement in crop yield with reduced amounts of irrigation water use under LLL. Adoption of laser land levelling over conventional tillage helped to reduce operational cost for wheat and paddy cultivation together by Rs. 4996 per ha in north-west IGP of India and Rs.2816/ha in north-east IGP of India. However, the incremental returns over per hectare operational cost were Rs.14772 and Rs.9815 in north-west and north-east IGP of India, respectively. The yield of wheat and paddy at overall level, increased by 275 kg per ha and 291 kg/ha, respectively. If 50 per cent of total area under wheat and paddy in IGP of India were to be brought under laser land levelling, it will help to get additional outputs of Rs. Rs.18572 million per year. The analysis of productivity difference revealed that the LLL technology increased 46 to 55 per cent productivity of paddy in IGP of India. As such, laser levelling contributes to increase returns and socio-economic status of the farm community.

Keywords: Indo Gangetic Plains of India, Laser Land Levelling, Traditional Land Levelling, Efficiency, Yield, Rice-wheat system, Irrigation.

INTRODUCTION

With increasing climate variability and rapid melting of glaciers, water scarcity is expected to be a major challenge to agricultural production and food security in North Asia (Hijioka *et al.* 2014). Increasing temperature, which has been observed in most of the region, increases the demand for irrigation water. The groundwater table is observed to be declining in India (Aggarwal *et al.* 2004; Joshi and Tyagi 1994; Kerr 2009; Kumar *et al.* 2007). As agriculture is the largest beneficiary of groundwater, a declining groundwater table will impact the sustainability of agriculture and the overall food security of the country. Furthermore, the use of

motorised pump to extract groundwater for irrigation raised the demand for energy by the agriculture sector in India. Given the existing consumption pattern, India will need to produce at least 37 per cent more rice and wheat by 2025 as compared to that of the year 2000, with nearly 10% less water that will be available for irrigation (Jatet *et al.* 2006). Therefore, there is a need of technologies that reduces water requirement, increasing the efficiency of energy use and enhances agricultural productivity. But, in the rice-wheat (RW) system of the Indo-Gangetic Plains (IGP), about 10– 25 per cent of irrigation water is lost due to poor water management and uneven fields (Kahlownet *et al.* 2000). To overcome such a situation,

the Laser land levelling (LLL) is a technology that has the primary benefit of reduction in the loss of irrigation water occurring due to highly undulating land with achieving the desired level of accuracy through laser equipped drag buckets. It also facilitates uniformity in the placement of seeds/seedlings and promotes better crop stands, which eventually contributes to higher crop yields. A uniform field improves irrigation efficiency through better control of water distribution and reduces the potential for nutrient loss through improved runoff control, leading to greater efficiency of fertilizer use and higher yields. Despite this, there has been no comprehensive study which examines the impact of LLL on crop yield, irrigation duration, energy saving, and overall farm profitability. Hence, the major focus of this objective is to assess the impact of LLL on cost of inputs, crop yield, irrigation duration, energy saving, and farm profitability.

Methodology

The study was conducted in two Indian states: Haryana and Bihar. Two blocks from Karnal district of Haryana (Nilokheri and Gharaunda) and two blocks from Vaishali district of Bihar (Patepur and Rajapakar) were selected for the household survey. Karnal and Vaishali represent high and low input production systems typical of the western and eastern IGP, respectively. The study sites captured contrasting soil types as well as the diversity of production systems. A total of 184 farmers in each of the two states were surveyed. These states are considered to be the breadbaskets of North Asia with primarily irrigated agriculture and rice-wheat (RW) as the dominant cropping system. Although the area is served by a developed canal irrigation system, groundwater is still a major source of irrigation (Krishna *et al.* 2011). In Haryana, the groundwater reserve has been depleted over time as the number of farmers using shallow and deep tube wells has increased. There are approximately 14 groundwater extraction structures per square kilometre (Kumar *et al.* 2007). The depletion of water tables is related to the cropping systems has more serious issues of falling water tables than those with other cropping systems. Data for this study were collected in 2017 from 184 households in Haryana and Bihar, using a structured household level questionnaire. The data included yields of rice and wheat, input use, input costs, hiring cost of LLL services, time taken to laser level the land, farmers' perceptions regarding the impacts of LLL, number of irrigations per season and time required for irrigation. In order to assess the

impact of using LLL on crop yield and saving of irrigation water, we collected all the information from both laser levelled fields and traditionally levelled fields from farm households. The farm households were randomly selected from each block. As the number of farm households adopting LLL varied across the selected blocks, random sample selection resulted in larger samples from the block with larger numbers of adopters.

The farm management cost concept was used to analyse the impact of LLL technology on farm income. The sample farmers were classified into two categories based on their adoption of technology i.e. LLL technology adopter and non-adopter. The impact of the adapted technology was assessed in terms of enhancement in yield, income, and improvement in efficiency. In which the various cost components such as Costs A1, B1, B2, C2, and C3 was calculated to analyse the profitability of the wheat and paddy production.

Productivity difference between LLL technology adopter and non-adopter

The present section caters to the analysis of input-use pattern and productivity difference between LLL technology adopters and non-adopter cultivators of wheat and paddy crop and its constituent sources. But before analyzing the factors responsible for productivity difference, it was imperative to test whether there exists a shift in production function (technological change) in the cultivation of crops in both the states. If there existed a technological change then the further investigation was conducted to test whether technological change existed due to change in slope (non-neutral technological change) or due to shift in the intercept (Neutral technological change) or both. Chow's F statistic was used for this purpose. To sort out the contribution of technology and resource-use differentials to the total productivity difference between LLL technology adopter and non-adopter, the log linear production function (Cobb-Douglas version) was used for both the groups. However, due to problem of multicollinearity the land variable was dropped and per hectare production functions were estimated. This way the size effect was removed and the problem of multicollinearity solved. In view, the final equation fitted was as follows.

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} \exp(U) \quad (1)$$

Where,

$$Y = \text{Output(ctl)};$$

X₁= Human Labour (man days);
 X₂= Machine labour (hrs);
 X₃= Seed (kg);
 X₄= Fertilizer(kg);
 X₅= Plant Protection Chemicals (gm);
 X₆= Irrigation (hrs);
 U= Random disturbance term, in conformity with the OLS assumptions;
 a = scale parameter, and
 b_i= slope parameters of the regression function (Production elasticities, i=1,...,7)

For analyzing the technological difference in productivity, production function approach was used because for any given input-output relationship, the change in productivity could be depicted by shifts in production function either in intercept or slope or both, as well as by movement along the same function(i.e. by changing the input levels).

Factors responsible for productivity difference between technologies

To decompose the total productivity difference between the CSA technology adopter farms and conventional tilled farms into the constituent sources, Bisaliah (1976) output decomposition model was used. The model requires the production function to be specified on unit area basis. Hence, with the help of functional form specified in equation (1), the Cobb-Douglas productions on per hectare basis, as specified below in log-linear form, were estimated separately for LLL technology adopter farms and conventional tilled farms.

$$\ln Y_{LL} = \ln b_0 + b_1 \ln X_{1LL} + b_2 \ln X_{2LL} + b_3 \ln X_{3LL} + b_4 \ln X_{4LL} + b_5 \ln X_{5LL} + b_6 \ln X_{6LL} + U_{LL} \dots (2)$$

$$\ln Y_{ct} = \ln a_0 + a_1 \ln X_{1ct} + a_2 \ln X_{2ct} + a_3 \ln X_{3ct} + a_4 \ln X_{4ct} + a_5 \ln X_{5ct} + a_6 \ln X_{6ct} + U_{ct} \dots (3)$$

Where, all the variables are as defined in equation (1) and that the term ‘U’ is the random variable and the subscripts ‘LL’ stand for “Laser Levelled farms” and ‘ct’ stands for conventional tilled farms. The specified equations were estimated using Ordinary Least Squares Technique. A zero order correlation suggested that multi-collinearity was not a problem for the data set and the model specification. Taking difference between the equation (2) and (3), the following decomposition model was arrived as follows:

$$\ln [Y_{LL}/Y_{ct}] = \{ \ln (b_0/a_0) \} + \{ (b_1-a_1) \ln X_{1ct} + (b_2-a_2) \ln X_{2ct} + (b_3-a_3) \ln X_{3ct} +$$

$$(b_4-a_4) \ln X_{4ct} + (b_5-a_5) \ln X_{5ct} + (b_6-a_6) \ln X_{6ct} \} + \{ b_1 \ln (X_{1LL}/X_{1ct}) + b_2 \ln (X_{2LL}/X_{2ct}) + b_3 \ln (X_{3LL}/X_{3ct}) + b_4 \ln (X_{4LL}/X_{4ct}) + b_5 \ln (X_{5LL}/X_{5ct}) + b_6 \ln (X_{6LL}/X_{6ct}) \} + \{ U_{LL} - U_{ct} \} \dots (4)$$

The left hand side of the equation (4) gives the total difference in productivity expressed as an approximate percentage over conventional tilled farm. The natural logarithm of the ratio of per hectare net returns of LLL technology adopter farms and conventional tilled farms is approximately a measure of percentage difference in net outputs of the two categories of farmers. The first bracketed term on the right hand side, the natural logarithm of constant terms, is the gap attributable to the neutral component of technology. It is a measure of neutral technological gap. The second bracketed term is the gap attributable to the non-neutral component of technology weighted by input use expenditure for conventional tilled farms. That is, it is a measure of non-neutral technological gap, after adjustment in the level of input use expenditure weighted by the slope coefficients of the production function fitted for the LLL technology adopter farms. Hence, it is the gap due to difference in the levels of input use between two category of farmers after making due adjustment for production elasticities of different inputs. The last component is a random term which the model could not take into account.

Groundwater extraction

The LLL technology plays an important role in saving ground water extraction at substantial amount. Hence, in order to find out how much of water is saved under LLL technology as compared to CT, the volume of groundwater extraction (in liters) was calculated from the following formula (Eyhomet al., 2005):

$$Q = t * 129574.1 * BHP / [d + (255.5998 * BHP^2) / d^2 * D^4]$$

Where,

Q = Quantity of groundwater extracted (in liters)

t = Total duration of irrigation (in hours)

BHP = Engine power of pump (in HP)

d = Average depth of Water (in meters)

D = Diameter of the suction pipe (in inches)

The estimated saved ground water extraction is further used for computing the potential of technology to bring additional area under irrigation and also additional yield can be produced with saved

water. It is also used for assessing the socio-economic benefit of the technology.

Monetary benefits of laser land leveling

The incremental benefit generated over conventional tillage farm under LLL is computed on per hectare and per LLL operation by equation (Aryalet.al., 2014) as follows:

$$\text{Incremental Benefit (Rs/LLL)} = \sum_{i=1}^n [P_{Wi}\Delta Y_{Wi} + P_{Ri}\Delta Y_{Ri}] - C_L H_L$$

Where,

P_{Wi} = Price of wheat per unit

ΔY_{Wi} = Additional yield of wheat in laser levelled field over CT farm

P_{Ri} = Price of rice per unit

ΔY_{Ri} = Additional yield of rice in laser levelled field over CT farm

C_L = Cost of hiring laser leveling service per hour

H_L = Time required to laser level the land

$i=1, \dots, n$ i.e. frequency of LLL operation (years)

RESULTS AND DISCUSSION

Impact on crop yields

To assess the impact of LLL on crop yield, we compared the yield of rice and wheat under LLL and TLL. In comparing yield, we included only those farmers who cultivated the two crops on both laser levelled and traditionally levelled plots in agiven year. The results of impact of adoption of LLL technology on sample farm is presented in Table 1.

Table 1 Impact of LLL on yield of wheat and paddy production (Per hectare)

Particulars	Laser Land Leveling				Conventional Tillage			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
North-west IGP of India (Haryana)								
Wheat								
Yield (Qtl)	54.1	53	55.4	54.2	52.8	50	51.4	51.1
Paddy								
Yield (Qtl)	58.1	56.51	55.08	56.5	55	53	52.1	53.38
North-east IGP of India (Bihar)								
Wheat								
Yield (Qtl)	40.5	39	42	40	39.4	38	36.2	37.6
Paddy								
Yield (Qtl)	46.5	44	45	45.1	43.1	41	42.5	42.4

In North-west IGP of India, at overall level, the yield of wheat crop under LLL was observed to be 6.07 per cent higher i.e. 3.10 quintals more per hectare as compared to that of CT farms. The maximum rise in yield was observed on large farms by 4 quintals per hectare under LLL. In case of paddy on an average, the yield was 3.12 quintals more per hectare (5.84 per cent). The yield was recorded to the high on medium farms (3.51 quintals per hectare more).While in case of North-east IGP of India, yield of wheat crop was 6.38 per cent (2.4 quintals per hectare) higher with LLL as compared to that under the CT farms. The maximum increase in yield was observed on large farms i.e. 5.8 quintals per hectare (16.02 per cent). The increase in yield of paddy was by 2.7 quintals per hectare (6.37 per cent) and it was more on small farms by 3.4 quintals per hectare as compared to that of CT farm.

Impact on Cost and Return : The adoption of LLL saved the major farm inputs to some extent but these all are expressed in physical term. Hence, it is important to investigate the impact of technology in monetary terms to know actual in terms of saving in cost and increase in return through the adoption of technology. The cost and return from wheat and paddy production under LLL and CT on sample farm of north-west IGP of India is presented in Table 2.

In case of wheat, it is observed from the table that the adoption of LLL technology leads to reduction in the operational cost by 3.06 per cent (Rs.1251 per ha). The gross income is also raised by 6.03 per cent. In all, LLL helps to increase return over operational cost by Rs.6366 per hectare which is 12.84 per cent of the return from CT. In case of farm size wise distribution, the technology was more profitable on large farms followed by medium and small farms.

Table 2 Cost and return from rice-wheat production system in north-west IGP of India

(Rupees per hectare)

Particulars	Laser Land Leveling				Conventional Tillage			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Wheat								
Total Operational cost	34523	32817	32448	33483	35376	34044	34013	34734
Gross income	89265	87450	91410	89430	87120	82500	84810	84315
Return over operational cost	54742	54633	58963	55947	51744	48456	50797	49581
Paddy								
Total Operational cost	41516	37020	37288	38633	45103	39850	41243	42078
Gross income	92379	89851	87577	89835	87450	84270	82839	84874
Return over operational cost	50863	52831	50289	51202	42347	44420	41596	42796

While in case of paddy crop the total operational cost was reduced by Rs.3445 which account for 8.19 per cent reduction, in which the substantial reduction in cost of irrigation was noticed. The gross income of the farmer was increased by Rs.4961 which was accounting for 5.85 per cent more. In total, the return over operational cost is increased by Rs.8406 which is 19.64 per cent of return from CT. In case of paddy the technology was

found more profitable on large farms followed by small and medium farms.

However, LLL was adapted to a limited extent on sample farms in north-east IGP of India and it was more skewed towards medium and large farmers. However its resource conserving and cost saving features argues opportunity for its adoption at small farms also. The cost and return from wheat and paddy production under LLL and CT on sample farm of north-east IGP of India is presented in Table 3.

Table: 3 Cost and return from rice-wheat production system in north-east IGP of India

(Rupees per hectare)

Particulars	Laser Land Levelling				Conventional Tillage			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Wheat								
Total Operational cost	28762	27184	26223	27318	29715	28489	27826	28545
Gross income	61155	58890	63420	60400	59494	57380	54662	56776
Return over operational cost	32393	31706	37197	33082	29779	28891	26836	28231
Paddy								
Total Operational cost	32832	29389	29066	30358	34530	30991	31099	31947
Gross income	58125	55000	56250	56375	53875	51250	53125	53000
Return over operational cost	25293	25611	27184	26017	19345	20259	22026	21053

In case of wheat, it is observed that the adoption of LLL technology leads to reduction in the operational cost by Rs.1227 per hectare which accounts for 4.30 per cent reduction. The gross income is also increased by 6.38 per cent. In all, LLL

helps to increase return over operational cost by Rs.4851 per hectare which is 17.18 per cent of the return from CT. In case of farm size wise distribution the technology was found to be more profitable on large farms followed by that under medium and small

farms. However, in case of paddy crop the total operational cost was reduced by Rs.1589 accounting for 4.97 per cent reduction. The gross income (Rs.3375) of the farmer increased by 6.37 per cent. In total, the return over operational cost increased by Rs.4964, which is 23.58 per cent of the return of CT farms. In case of paddy the maximum reduction in operation cost was noticed in large farms while the increase in gross income was more on small farms.

Production Response and the Nature of Technological Change

The production response was examined with the help of Cobb-Douglas production function. The results of estimated production functions for the two groups of sample farms, the pooled data, and the pooled data with dummy are presented in Tables 4, 5, 6 and 7 for wheat and paddy crops in north-west and north-east IGP of India, respectively. The F-ratios of all the estimated production functions were statistically significant at 1 per cent level indicating the goodness of fit of the model. In most of the cases coefficient of multiple determinations was more than

60 per cent implying that the included explanatory variables explained more than 60 per cent variations in the outputs of the technology adopters, non-adopters, the pooled data and the pooled data with dummy indicating adopter and non-adopter of LLL technology, respectively.

An analysis of production response for wheat (LLL) in north-west IGP of India reveals that four variables namely, human labour, machine labour, seed, and irrigation were significant factors which influenced the crop yield positively. While the plant protection chemical was found to be negative and significant. In case of production function of wheat (CT) the variables namely, human labour and fertilizer were found positively significant while seed was observed to be negatively significant. The human labour and seed were found to be positively significant in case of production function of paddy. While human labour and fertilizer were found positively significant for paddy under CT and the seed was observed negatively significant.

Table: 4 Estimated Production functions of the LLL and CT for Wheat in north-west IGP of India

Sr.No	Particular	LLL		CT		Pooled		Pooled D	
		Coeff	t - stat	Coeff	t - stat	Coeff	t - stat	Coeff	t - stat
1	Intercept	-5.548	-1.69	2.589	5.37	2.60***	5.52	1.96***	4.14
2	Human Labour	0.540*	1.96	0.583*	1.75	-0.081	-0.60	0.531**	2.61
3	Machine Labour	0.368***	2.78	0.029	0.39	0.28**	2.63	0.228**	2.29
4	Seed	1.012**	2.07	-0.47***	-2.92	0.051	0.23	0.045	0.22
5	Fertilizer	0.413	1.33	0.137**	2.22	0.045	0.33	-0.036	-0.27
6	PPC	-0.461**	-2.01	0.019	0.14	0.26**	2.30	-0.037	-0.28
7	Irrigation	0.625*	1.73	0.039	0.99	-0.29***	-5.70	-0.12*	-1.90
8	Dummy							0.14***	3.83
9	Adjusted R ²	0.767		0.670		0.762		0.777	
10	F- stat	41.07***		12.51***		54.32***		54.91***	

Note: ***, ** and * indicate significance at 1, 5 and 10 per cent level, respectively.

Table: 5 Estimated Production functions of the LLL and CT for Paddy in north-west IGP of India

Sr.No.	Particular	LLL		CT		Pooled		Pooled D	
		Coeff	t - stat	Coeff	t - stat	Coeff	t - stat	Coeff	t - stat
1	Intercept	-0.018	-0.01	0.473	0.66	2.69***	6.913	4.566***	3.81
2	Human Labour	0.67**	2.29	0.61**	2.08	0.80***	4.435	0.643**	2.59
3	Machine Labour	0.006	0.02	0.075	1.14	-0.175	-0.881	-0.107	-0.57
4	Seed	0.19***	3.25	-0.095***	-4	0.070*	1.901	0.089*	1.93
5	Fertilizer	0.237	0.84	0.111**	2.55	-0.158	-1.418	-0.131	-1.49
6	PPC	-0.176	-0.69	-0.020	-0.15	0.094	0.639	0.063	0.37
7	Irrigation	0.082	0.17	0.115	1.04	-0.289***	-6.897	-0.573***	-3.59
8	Dummy							-0.141**	2.07
9	Adjusted R ²		0.767		0.726		0.766		0.746
10	F- stat		41.08***		15.98***		59.83***		52.04***

Note: ***, ** and * indicate significance at 1, 5 and 10 per cent level, respectively.

For the pooled data, machine labour and PPC were found positively significant in wheat crop while for paddy human labour and seed were found positively significant. But, the irrigation was observed negatively significant in both the crops.

The estimates of production function for wheat (LLL) in north-east IGP of India reveals that only two variables namely, machine labour and irrigation were significant factors which influenced

the crop yield positively. In case of wheat (CT) only the machine labour was found positively significant while PPC was observed negatively significant. The estimated production function for Paddy under LLL was a “good-fit” as indicated by a high (0.82) value of adjusted R^2 with human labour and irrigation emerging as positively significant and PPC as negatively significant variable.

Table: 6 Estimated Production functions of the LLL and CT for Wheat in north-east IGP of India

Sr.No.	Particular	LLL		CT		Pooled		Pooled D	
		Coeff	t - stat	Coeff	t - stat	Coeff	t - stat	Coeff	t - stat
1	Intercept	2.348	1.27	-0.144	-0.07	0.051	0.04	-0.358	-0.36
2	Human Labour	0.047	0.12	-0.498	-0.88	-1.39***	-4	-0.491	-1.58
3	Machine Labour	0.14*	1.92	0.86**	2.44	0.55***	6.46	0.152	1.62
4	Seed	0.188	0.92	0.201	1.48	0.05	0.34	0.169	1.47
5	Fertilizer	-0.293	-0.8	1.016	1.6	1.10***	3.21	0.55*	1.93
6	PPC	0.060	0.38	-0.82**	-2.03	0.126	0.89	-0.049	-0.42
7	Irrigation	0.41***	3.73	0.475	1.2	0.091	0.64	0.55***	4.08
8	Dummy							0.19***	6.21
9	Adjusted R^2		0.798		0.730		0.628		0.767
10	F- stat		20.09***		18.59***		20.42***		33.46***

Note: ***, ** and * indicate significance at 1, 5 and 10 per cent level, respectively.

Table: 7 Estimated Production functions of the LLL and CT for Paddy in north-east IGP of India

Sr.No.	Particular	LLL		CT		Pooled		Pooled D	
		Coeff	t - stat	Coeff	t - stat	Coeff	t - stat	Coeff	t - stat
1	Intercept	0.436	0.37	2.541	1.05	0.714	1.59	0.612	0.55
2	Human Labour	0.83*	1.97	-0.949	-1.02	-0.88***	-4.90	-0.85**	-2.33
3	Machine Labour	0.102	1.64	0.61**	2.31	0.120*	1.82	0.117	1.53
4	Seed	-0.034	-1.02	0.031	1.38	0.026	1.31	0.025	1.29
5	Fertilizer	-0.480	-1.64	0.676*	1.85	0.40***	3.18	0.39**	2.24
6	PPC	-0.127*	-1.81	-0.65*	-1.85	-0.023	-0.48	-0.023	-0.48
7	Irrigation	0.78***	3.5	1.003	1.12	1.11***	3.92	1.12***	3.77
8	Dummy							0.31**	2.56
9	Adjusted R^2		0.82		0.72		0.75		0.75
10	F- stat		23.50***		18.10***		36.22***		30.57***

Note: ***, ** and * indicate significance at 1, 5 and 10 per cent level, respectively.

In case of estimated production function for paddy under CT, machine labour and fertilizer were found positively significant while the PPC was negatively significant. For pooled data, machine labour and fertilizers were found positively significant in wheat crop, while in case of paddy

machine labour, fertilizer and irrigation were found significant. The human labour was observed negatively significant in both the crops.

The dummy representing technology type was significant and positively related to output on all sample farms in both the states. This result implies

that technology adopters obtained higher output than the non-adopters. This is as a result of gains from use of laser land leveling technology.

The structural break (shift in production function) was examined by testing the homogeneity between the parameters of estimated production function pertaining to Laser Land Levelling and Conventional Tillage for wheat and paddy production with the help of Chow's test (Chow,1960). The calculated chow's F statistic for production effect was found significant. The result confirms that there is significant difference between the production functions of the adopters and non-adopters of Laser Land Levelling. In other words, the technology adopters are associated with structural modifications of their production parameters, implying that the production functions of the sample farms differ. The calculated chow's F statistic for the test for differences in intercept is significant. This result confirmed heterogeneity of intercepts for the technology adopters and non-adopters. This confirms the result of the pooled data with dummy variable representing technology type which revealed that

technology adopting sample farms obtained higher output relative to the non-adopter.

Decomposition of Productivity Difference

The productivity difference among adopters and non-adopters of laser land leveling for wheat and paddy production was segregated into its constituent sources i.e. technological change and input use differential with the help of decomposition model as suggested by Bisaliah (1977). The per hectare log-linear function as presented in Tables 4, 5, 6 and 7 and geometric mean levels of input use for the two technologies were used for decomposition analysis. The results of decomposition analysis are presented in Table 8 and Table 9 for wheat and paddy crops in north-west and north-east IGP of India, respectively.

A perusal of these tables reveals that there was a difference between the observed and the estimated productivity of crops between LLL and CT technology. This discrepancy was attributed to the random error term, which among others, accounts for management aspects, which could not be included in the model.

Table: 8 Decomposition of Total Productivity Differences between LLL and CT Technology of Wheat

Sources of productivity Difference	(Percent Contribution)	
	North-west IGP of India	North-east IGP of India
Total observed difference in productivity	6.21	7.84
A. Due to difference in technology	54.82	17.48
B. Due to difference in input use level		
a) Human Labour	-10.30	-0.75
b) Machine Labour	-2.22	0.32
c) Seed	-13.43	-1.36
d) Fertilizer	-6.93	3.19
e) Plant Protection Chemicals	1.55	-1.31
f) Irrigation	-17.41	-9.75
C. Total Estimated difference in productivity due to all resources (A+B)	6.07	7.81

Wheat

The estimated improvement in productivity (per cent) with adoption of LLL technology was partly attributed to technological change and partly to input use, however, the two together contributed to 6.07 per cent and 7.81 per cent of change in yield of wheat crop in north-west and north-east IGP of India, respectively. However, the contribution of technology in yield increase was around 55 and 17 per cent in north-west and north-east IGP of India, respectively.

It indicates that the farmer could increase returns from wheat by 55 and 17 per cent just by shifting from conventional tillage to laser land levelling in north-west and north-east IGP of India, respectively. As the laser land levelling technology has resource conserving potential, the impact of majority of inputs was observed to be negative in both the states. The effectiveness of technology in terms of change in the input use under LLL method was timely control of weeds and disease, which contributed to the increase

in wheat output in north-west IGP of India. While in case of north-east IGP of India the change in machine labour and fertilizers contributed to around 0.32 and 3.19 per cent of the increased output. Since, LLL is a resource conserving technology and gives more yield than CT it is recommended to increase the existing productivity of wheat by increasing the level of adoption of LLL technology.

Paddy

In case of paddy cultivation, the estimated improvement in productivity with LLL technology are due to technological change and due to input use and the two together technologies together contributed 5.08 per cent and 6.28 per cent of total increase in yield in north-west and north-east IGP of India, respectively.

Table: 9 Decomposition of productivity increase due to adoption of LLL Technology for Paddy

Sources of productivity Difference	(Percent Contribution)	
	North-west IGP of India	North-east IGP of India
Total observed difference in productivity	5.18	6.19
A. Due to difference in technology	12.06	46.63
B. Due to difference in input use level		
a) Human Labour	-4.77	-28.20
b) Machine Labour	0.03	0.94
c) Seed	0.13	0.24
d) Fertilizer	0.03	2.17
e) Plant Protection Chemicals	1.14	0.53
f) Irrigation	-3.55	-16.02
C. Total Estimated difference in productivity due to all resources (A+B)	5.08	6.28

The estimated contribution of technology in increase in yield of north-west and north-east IGP of India was 12 and 46 per cent, respectively. It indicates that the farmer could increase the yield of paddy crop by 12 and 46 per cent just by shifting from conventional tillage to laser land levelling in north-west and north-east IGP of India, respectively.

As the laser land levelling technology has resource conserving potential, the impact of input use levels was observed to be negative in both the states. In north-west IGP of India the change in machine labour, seed, fertilizers and PPC contributed around 0.03, 0.13, 0.03 and 1.14 per cent of the increased output. While in case of north-east IGP of India it was around 0.94, 0.24, 2.17 and 0.53 per cent, respectively. Hence in order to increase the existing productivity of paddy, there is need to increase in level of LLL adoption.

Groundwater extraction in the Rice-Wheat system

Laser land leveling (LLL) is an alternative land leveling technology that has the primary benefit of a reduction in the loss of irrigation water occurring

due to highly undulating land. Therefore, applying LLL rather than CT can help reduce the use of irrigation water and save energy through reduced duration of irrigation (Jat *et al.* 2011). In this view, the extent of water saved with the adoption of LLL over CT was estimated.

The extraction of groundwater, which determines the accessibility to water, depends on depth of water level, engine capacity and size of outlet. In view of different geographical conditions in the study area, water extraction also differs. It was observed that in north-east IGP of India water level was much lower than that in north-west IGP of India. The farmers of north-west IGP of India, therefore resorted to use of higher capacity pumps (Table 10).

On an average, a tube well motor used in north-west IGP of India is about 10 BHP (Break Horse Power), while in north-east IGP of India it is 5 BHP. In north-west IGP of India around 17048 liters of water is extracted per hour while it was about 14393 lit per hr in north-east IGP of India through irrigation pumps.

Table: 10 Ground water extraction

Particulars	North-west IGP of India	North-east IGP of India
Average depth of water level (meters)	76	45
Average size of outlet (inch)	5	4
Engine capacity (HP)	10	5
Water extracted (liters/ hr. of irrigation)	17048	14393

The difference between the water extractions between the two states is about 2655 liters per hour. The total water consumed depends upon the number

of irrigations and time required for irrigation. The estimated results are presented in Table 11.

Table: 11 Water Extraction and productivity of Paddy and Wheat crops

Particulars	North-West IGP of India				North-east IGP of India			
	Wheat		Paddy		Wheat		Paddy	
	LLL	CT	LLL	CT	LLL	CT	LLL	CT
Time of Irrigation (hrs/season)	35.6	45.1	96.98	149.5	18.97	25.92	52.56	64.96
Water applied (000' litres/crop)	607	769	1653	2549	273	373	757	935
Water productivity (gm/lit)	8.93	6.65	3.42	2.09	14.65	10.08	5.96	4.53
Potential to produce additional yield through saved water (qtl)	14		31		15		11	
Additional area can be brought under cultivation through saved water (ha)	0.27		0.54		0.37		0.24	

In both the states the higher amount of water was applied on conventional tilled farms. From the estimation it was observed that paddy under CT in north-west IGP of India is the largest consumer of water. It requires around 2549 thousand liters of water per hectare, which is about 8.96 lakh liters more than the paddy cultivated under laser land leveling technology. LLL on average reduces duration of irrigation by 52.52 hrs for rice and 9.5 hrs for wheat, the total reduction is 62.02 hrs for rice-wheat rotation. In case of water productivity it was observed more under LLL farms and is about 8.93 gm/lit and 3.42 gm/lit in wheat and paddy, respectively. The per hectare saved water under laser land levelled wheat and paddy has potential to produce additional 14 quintals of wheat and 31 quintals of paddy. It is able to irrigate additional 0.27 and 0.54 hectare, respectively.

In case of north-east IGP of India, paddy under CT is the largest consumer of water. It requires around 935 thousand liters of water per hectare, which was about 178 thousand liters more than the paddy cultivated under laser land leveling technology. LLL on average reduces duration of irrigation by 12.4 hrs for paddy and 6.95 hrs for wheat, the total reduction is 19.35 hrs for rice-wheat rotation. In case of water productivity it was observed more under LLL farms and is about 14.65 gm per lit

and 5.96 gm per lit in wheat and paddy, respectively. The per hectare saved water under laser land levelled wheat and paddy has potential to produce additional 15 quintals of wheat and 11 quintals of paddy and it is able to irrigate additional 0.37 and 0.24 hectare, respectively. In all, the water productivity was observed maximum in north-east IGP of India mainly because less water per hour is extracted and also due to prevalence of lower water table depth as compared to that of north-west IGP of India.

Socio-economic benefits of using laser land leveling

Economic benefits of laser land leveling

When a farmer levels 1 ha of land using laser land leveller, the effect typically lasts for at least 4 years and 3 years in north-west and north-east IGP of India, respectively. Thus, it is assumed that the life of one leveling to be 4 years in north-west IGP of India and 3 years in north-east IGP of India. Secondly it is also assuming that the farmer practices the dominant cropping pattern of rice-wheat during the entire period; planting rice in *kharif* and wheat in *rabiseason*. Finally it is assumed that the increase in price of wheat and rice and the discount rate over time will balance each other so that prices stay constant at the current minimum support prices (MSPs) as fixed by the government of India. Based

on above mentioned assumptions the benefit derived from LLL operation is compiled and presented in Table 12. The incremental benefit to the farm due to

$$\text{For North-west IGP of India, } 4 \\ \text{Incremental Benefit (Rs/LLL)} \quad \Sigma_{i=1} [P_{W_i}\Delta Y_{W_i} + P_{R_i}\Delta Y_{R_i}] - C_L H_L$$

$$\text{For North-east IGP of India, } 3 \\ \text{Incremental Benefit (Rs/LLL)} \quad \Sigma_{i=1} [P_{W_i}\Delta Y_{W_i} + P_{R_i}\Delta Y_{R_i}] - C_L H_L$$

use of LLL technology is calculated by using the equation as given below:

Table:12 Incremental benefits of using LLL

Particulars	North-west IGP of India	North-east IGP of India	Overall
Price of Wheat (Rs/kg)	16.25	16.25	16.25
Price of paddy (Rs/kg)	15.5	15.5	15.5
Incremental yield of Wheat(kg/ha)	310	240	550
Incremental yield of paddy(kg/ha)	312	270	582
Benefit per year from wheat(Rs/ha)	5037.5	3900	8937.5
Benefit per year from paddy (Rs/ha)	4836	4185	9021
Number of years LLL applicable	4	3	3.5
Benefit per LLL operation	39494	24255	63749
Cost of LLL (Rs/ha)	4250	4200	8450
Net Benefit per year (Rs)	8811	6685	15496
Net Benefit per LLL operation	35244	20055	55299

The benefit stream is calculated by using minimum support price (2017-18) for respective crop which is Rs.16.25 per kg for wheat and Rs.15.50 per kg for rice. The study considers the yield differential in laser levelled land and conventional tilled land to be 310 kg/ha for wheat and 312 kg per ha for in rice in north-west IGP of India while the same for north-east IGP of India it is 240 kg per ha for wheat and 270 kg per ha for in rice. Based on farmers response, in north-west and north-east IGP of India the cost of hiring laser land leveling service was Rs. 850/ hr and Rs. 700/ hr and on an average around 5 hours and 6 hours time was required to level a hectare of land by LLL technology, respectively. Therefore, the total cost of leveling 1 ha is Rs.4250 and Rs.4200, in north-west and north-east IGP of India, respectively. In all, about Rs.35244 and Rs.20055 of net incremental benefit was derived from the adoption of LLL in north-west and north-east IGP of India, respectively and at overall level it is about Rs.55299 per LLL operation.

Social benefits of laser land leveling

The entire water ecosystem is a complicated system thus savings in one sector may not translate to real savings overall. However given the increasing water scarcity and competing and increasing demands for water by domestic and industrial users, lesser water use by the agricultural sector makes more water available for the other sectors. In this context, the reduction in use of irrigation water due to adoption of LLL technology over CT farming is considered as "water saving" and same is computed. Major benefits of using LLL in RW system in north-western and north-eastern Indo-Gangetic plains of India are summarized in Table 13.

According to research estimates, a shift from conventional tillage to laser land leveling would on an average increase the yields of wheat and paddy by 275 kg per ha and 291 kg per ha, respectively. This shift would also reduce the total irrigation time per season by 8.2 hr/ha in wheat and 32.5 hr/ha in paddy.

Table: 13 Major benefits of adopting laser land leveling in rice-wheat systems

Area under RW system and benefits of LLL	Haryana	Bihar	Total
Tangible Benefits			
Area under wheat (million ha) in 2015-16	2.58	2.16	4.74
Area under rice (million ha) in 2015-16	1.35	3.21	4.56
Average increase in yield due to LLL			
Wheat (kg/ha)	310	240	275
Paddy (kg/ha)	312	270	291
Additional output benefit if LLL is adopted in 50% of the area under RW system			
Wheat (million kg/year)	399.9	259.2	659.1
Paddy (million kg/year)	210.6	433.35	643.95
Total value of additional output (Million Rs/year)*	9763	10929	18572
Non-Tangible Benefits			
Irrigation time saving			
Wheat (hours/ha/season)	9.5	6.95	8.2
Paddy (hours/ha/season)	52.52	12.4	32.5
Water Saving (Litres)			
Wheat (Million Litres)	208923	108035	316958
Paddy (Million Litres)	604369	286453	890822
Potential to produce additional yield with saved water under LLL			
Wheat (kg/ha)	1400	1500	
Paddy (kg/ha)	3100	1100	
Additional output benefit if LLL is adopted in 50% of the area under RW system			
Wheat (million kg/year)	1806	1620	3426
Paddy (million kg/year)	2093	1766	3858
Total value of additional output (Million Rs/year)*	61781	53690	115472
Actual Electricity saved including T&D loss [@]			
Wheat (Million Kwh)	128	44	173
Paddy (Million Kwh)	550	192	742
Monetary benefit of saved electricity			
Wheat (Million Rs/year)	13	40	53
Paddy (Million Rs/year)	55	172	227
Carbon emission coefficients for Electricity/Kwh [§]			
Carbon Emission(Million kg CE/year)	0.0725	0.0725	0.0725
Carbon Emission(Million kg CE/year)			
Wheat(Million kg CE/year)	9	3	13
Paddy (Million kg CE/ year)	40	14	54
Benefit from reduction in carbonemission			
Wheat(Million Rupees)	19	6	25
Paddy (Million Rupees)	80	28	108
Total Benefit in Million Rupees (Tangible + Non-Tangible)	71711	64866	136577

*Calculated using the minimum support prices (MSPs) of wheat (Rs.1625) and rice (Rs.1550) in 2017-18.

Source: [@] GOI (2011), [§] R. Lal (2004)

In north-west IGP of India, 2.58 million ha were under wheat and 1.35 million ha were under paddy cultivate on in 2015-16. Similarly in north-east IGP of India, 2.16 million ha of wheat and 3.21 million ha of paddy were cultivated in 2015-16. Even if 50 per cent of that area can be brought under LLL, this would lead to realization of a number of tangible and non-tangible benefits. An additional yield of approximately 659.10 million kg of wheat and 643.95 million kg of paddy will be obtained. LLL helps to create additional tangible benefit of Rs.18572 million and non-tangible benefit of Rs.118005 million. Therefore, it is observed that adoption of a laser land levelling technology in RW systems of the north-western and north-eastern Indo-Gangetic plains has large potential impact. It will also help to save approximately 12 lakh million liters of water per year if 50 per cent of RW system area of Haryana and Bihar will be brought under LLL.

The 10 BHP tube well motor requires about 8 Kwh of energy per operational hour (DHBVN, 2014). In addition, the distribution loss is almost 31 % in India (GOI, 2011). This means that to supply 1 Kwh of electricity, India needs to generate 1.31 Kwh. Therefore, the adoption of LLL will save electricity used for irrigation in RW system by around 915 million Kwh. It will also help to reduce the carbon emission by 77 million kg CE per year. Therefore, in all total tangible and intangible benefit derived from adoption of LLL on 50 per cent of area under rice-wheat system in Haryana and Bihar will be about Rs.136577 million in which intangible benefit has more contribution than tangible benefit. Along with these benefits, use of LLL also reduces emission of GHGs and is about 208.6 kg Carbon Equivalent per hectare per LLL.

CONCLUSION

A shift from traditional land levelling to laser land levelling would reduce on an average total irrigation time per season by around 8.2 hr/ha in wheat and around 32.5 hr/ha in paddy. Thus LLL minimizes the water use for agriculture and also reduces the energy required to operate the water pumps. If the current economic growth and increase in population continue, future water demand in India will grow substantially. Though the exact figures are contested, all projections indicate a sharp increase in water demand from all sectors - domestic, agricultural and industrial. Amarasingheet *al.* (2007) projected that average domestic water demand would increase from 85 liter per capita per day (lpcd) in 2000 to 170

lpcd by 2050. On account of this situation, scaling up of LLL technology is crucial as it has the potential to save approximately 5065 thousands litres of water per hectare per LLL operation in the rice-wheat system of north-west and north-east IGP of India. The previous study on impact of LLL in the north-western IGP also revealed that there is saving of water under LLL is about 2,70,000 cubic meters per year in the rice-wheat system (Jat, 2012). Given the competing and increasing demands for water by domestic and industrial users, less water used by the agricultural sector makes more water availability for other sectors. In this context, water saved in irrigation due to laser levelling of the farmer's field has a broad policy implication for the sustainability of agriculture and water resource management. As total duration of irrigation in laser levelled field is significantly lower, this reduces the electricity use for irrigation by 2200 Kwh per ha in the rice-wheat system in the study area. Such a decline in electricity use in agriculture would reduce fiscal burden to the government of India through reduced subsidy requirement for electricity used for irrigation. In a situation when the governments of these states are in quest of measures to conserve water and energy resources, LLL can be one of the most appropriate technologies to be promoted at national level. Along with these benefits, LLL also helps to reduce about 209 Kg CE per ha per LLL operation. Similar kinds of results were reported under study conducted by Gill (2014). Therefore, a reduction in the duration of irrigation avoids the GHG emission that would otherwise have incurred while generating the electricity required for operating tube-well motors for pumping water for irrigation. Average time required to laser level the field for the first time is 5-6 hr/ha. However, this can vary depending on the level of undulation of farm land. In the study area, an improved crop yield with reduced amounts of irrigation water use is a crucial finding of this study. Our estimates exhibit that a shift from traditional to laser land levelling would on average reduce operational cost for wheat and paddy cultivation by Rs.4996 per hectare in north-west IGP of India, and Rs.2816 per hectare in north-east IGP of India. The incremental return over per hectare operational cost was about Rs.14772 and Rs.9815 in north-west and north-east IGP of India, respectively mainly due increased yields and reduction in operational cost under LLL. The yield of wheat and paddy at overall level increased by 275 kg per ha and 291 kg per ha, respectively. In Haryana, 2.35 million ha area was under wheat and 1.38 million ha area was

under paddy in 2015-16. Even if 50 per cent of this area is brought under laser levelling technology, this would lead to an additional yield of approximately 399.9 million kg of wheat and 210.6 million kg of paddy in Haryana. Similarly in Bihar, 2.16 million ha of wheat and 3.21 million ha of paddy were cultivated in 2015-16. If 50 per cent of that area could be laser levelled, this would lead to an additional yield of 259.2 million kg of wheat and 433.35 million kg of paddy. The total value of additional outputs from adopting LLL in 50 per cent of the land under a rice wheat system in Haryana and Bihar is equivalent to 18572 Million Rs. peryear. Though increased yield is only associated with the food availability aspect of food security, it is a very crucial aspect. The production function of technology adopters and non-

adopters was found different mainly because of the structural modifications of adopter's production parameters. The analysis of productivity difference between laser land levelling adopters and non-adopters of wheat and paddy production by Bisalialah decomposition model revealed that the technology is responsible for around 54.85 per cent difference in productivity of wheat in north-west IGP of India and about 46.63 per cent difference in productivity of paddy in north-east IGP of India. Therefore, it can be stated that the adoption of laser land leveling has direct implications for food security through increased food production, water resource conservation through reduced duration of irrigation, and also reduced energy use due to fewer hours of irrigation required in RW systems.

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Export Potentiality of Millets Grown in India

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ABSTRACT

India emerges as a key player, being the largest producer and exporter of millets in the world. The domestic landscape reveals the dominance of states like Rajasthan, Maharashtra, and Uttar Pradesh in millet cultivation, especially focusing on major varieties such as Pearl Millet, Sorghum, and Finger Millet. The study was entirely based on secondary data. The growth rate of production of millets was negative, as the area under millets reduced the production was also parallelly reduced. Despite facing challenges such as decreasing cultivation areas, the country showcases a historic surge in millet exports, experiencing substantial growth in both quantity and value. There is huge demand for millets along the globe. The top export destinations include UAE, Saudi Arabia, and Nepal, signifying a growing global demand for Indian millets. While Gujarat takes the lead among exporting states, Maharashtra closely follows, underlining the pivotal role played by these regions in India's millet export landscape. India had enjoyed a comparative advantage in millets exports as RCA values were found to be more than one throughout the years. Efforts should be taken to promote export of selected millet products from India to explore and exploit potential of other markets and to avoid overdependency on few countries.

Key Words: Comparative advantage, export, Millets, UAE

INTRODUCTION

India is the world leader in the production of millets with share of around 41% of total world production in 2020. India produces around 18 million MT of millets annually, according to Ministry of Agriculture and Farmers Welfare data. In India, Rajasthan is the leading producer of pearl millet and Maharashtra is the leading producer of sorghum crop. Other producing states are Uttar Pradesh, Gujarat, Haryana and Karnataka. Despite, their nutritional superiority, utilization of millets is restricted due to non-availability of refined and processed millets in ready to eat form.

With demand for nutria-cereals rising steadily globally, the Department of Commerce expects millets exports to increase exponentially in

the coming years as Indian exporters find new markets abroad. Currently, India is the fifth largest exporter of millets in the world, according to 2020 data, with exports continuously increasing at around 3% CAGR in the last five years ending with 2020. The top three importers of millets from India in 2021-22 are UAE, Saudi Arab & Nepal. APEDA has been aggressively working towards facilitating shipments of millets by Indian exporters and helping them make inroads into new markets. To give impetus to the export of potential products as well as to remove the bottlenecks in the supply chain of nutria-cereals, APEDA has created Nutri Cereals Export Promotion Forum which also included millets exports. APEDA has signed an MOU with Indian Institute of Millets Research

(IIMR) for making a strategy for promotion of millets and millet value added products. It has initiated a study on ‘Refinement of Millet Value Chain for Export Markets: Preparation of export strategy in wake of International Year of Millets, 2023’ through IMMR.

Getting popularities of millets and their products among higher middle class and rich class society, this study was designed with these objectives-

Objectives

1. To study the compound growth rate and instability in area, production and exports of millets
2. To study the revealed comparative advantage of millets

METHODOLOGY

Location of Study

The study was conducted in all India perspective for a period of 20 years.

Collection of data: The present study was majorly based on the secondary data. The yearly time series data of area, production and yield of millets at India level was collected from indiatat.com, and export quantity, export value, export destinations of India and World was collected from various websites like www.apeda.gov.in and fao.org/faostat/en/#data/TCL respectively.

Analytical Tools and Techniques

1. Exponential growth model
2. Instability Index
3. Revealed Comparative Advantage

1. Exponential growth model

Growth rate of exports of millets for the study period was computed using the exponential growth model. The model is specified as follows:

$$Y = ab^t e \text{ ----- (1)}$$

Where,

Y= Export (quantity and value) for the year t

a = Intercept

b = Regression coefficient

t = Time variable

e = Residual term

By converting the equation (1) into its natural logarithmic form in order to obtain the compound growth rate is given below.

$$\ln Y = \ln a + t \ln b + \ln e$$

The percentage of compound annual growth rate was derived by using the following formula.

$$CAGR = [(anti \ln b) - 1] * 100$$

2. Study of instability

One of the simplest ways of measuring variability present in the data is by using coefficient of variance (CV). The variability in quantity and value of exports during the study period was measured using the formula for CV as given below:

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} * 100$$

Though CV is one of the simplest measure of the instability it does not completely explain the variability present in the time series data because of the presence of the trend component. In order to overcome this problem, formula suggested by Cuddy and Della (1978) was used. Cuddy-Della instability index was calculated as follows.

$$II (\%) = CV \sqrt{(1 - \bar{R}^2)}$$

Where, II = Instability Index

CV = Coefficient of variation

\bar{R} = Adjusted Coefficient of Determination of time trend regression of the original data of exports quantity or value

3. Revealed Comparative Advantage (RCA)

The comparative advantage of India’s export of selected millets was measured on the basis of the observed pattern of trade termed as the Revealed Comparative Advantage (RCA) or the Export Performance Ratio (EPR), one of the most widely used methods (Balassa, 1965) was applied to measure the comparative advantage.

$$RCA = \frac{\frac{X_{ij}}{X_{wj}}}{\frac{X_i}{X_w}}$$

Where, X_{ij} = ith country’s export of commodity j

X_{wj} = world exports of commodity j

X_i = total agricultural exports of country i

X_w = world’s agricultural exports

If the RCA takes the value greater than unity *i.e.*, $RCA > 1$, then India has a revealed comparative advantage in exports of millets. If the value is less than one *i.e.*, $RCA < 1$ then exports of millets do not have revealed comparative advantage for India.

However the RCA can take any value and hence it cannot be used to compare the RCA of two or more commodities. Therefore, in order to make it comparable, the Revealed Symmetric Comparative Advantage (Laursen, 1998) worked out as follows:

$$RSCA = \frac{RCA - 1}{RCA + 1}$$

RSCA ranges from -1 to +1. The positive value of RSCA indicated the comparative advantage in exporting the millets whereas its negative value indicated that India has no comparative advantage in exporting the millets.

RESULTS AND DISCUSSION

World Scenario: Developing countries produce and consume 97% of the world’s millets and a small fraction comes from the rest of the world. The average data of the millet production of the different continents indicated that Asia is the largest producer of millets followed by Africa, Europe and America. In Asia, millet production concentrates mainly in India and China. In India, millet production concentrated mainly in dry arid regions where rainfall is low and erratic. India is the largest producer of

millets in the world followed by USA, Nigeria, China and Ethiopia. The most widely produced millet is pearl millet, which is mainly grown in the states of Rajasthan, Uttar Pradesh and Gujarat. In terms of millet exports, the United States took the lead in 2021, with Argentina and Australia also notable contributors from the Americas. China, in the same year, claimed the top spot as the world’s largest millet importer, accounting for 65% of the total global imports, trailed by Germany and Japan.

Table 1: Top five millets exporting and importing countries in the world (2021)

Producer	Quantity (‘000 Metric tonnes)	Exporters	Value (USD million)	Importers	Value (USD million)
India	17260.57 (17.68)	USA	2126.32 (47.50)	China	3054.17 (64.87)
USA	9772.91 (10.01)	Argentina	554.73 (12.39)	Germany	138.27 (2.94)
Nigeria	8495.00 (8.70)	Australia	510.98 (11.41)	Japan	129.29 (2.75)
China	6283.50 (6.44)	Poland	223.49 (4.99)	Spain	108.19(2.30)
Ethiopia	6276.62 (6.43)	Canada	138.80 (3.10)	USA	107.09 (2.27)
World	97614.00 (100.00)	World	4476.68 (100.00)	World	4708.43 (100.00)

Source: USDA

Note: Data in parentheses indicates percentage to the total respective categories

Indian Scenario:

The analysis of the growth in both area and production of total millets in India spanning from 1991-92 to 2020-21 is segmented into distinct decadal periods: 1991-92 to 2000-01 (Decadal Period I), 2001-02 to 2010-11 (Decadal Period II), and 2011-12 to 2020-21 (Decadal Period III). Furthermore, an overarching analysis for the entire period from 1991-92 to 2020-21 is conducted using the growth rate analysis method, and the outcomes are presented in the table. Negative growth in the area dedicated to millet cultivation is primarily attributed to a shift in

farmers' cropping patterns, possibly influenced by the declining significance of millets in consumption practices. Additionally, the inherently low productivity of these millets could be another significant factor contributing to the decrease in cropping area. The negative growth rate in millet production aligns with the reduction in cultivation area, indicating a parallel decline in production. The Instability Index results revealed variable fluctuations in both millet cultivation area and production over the analyzed periods, highlighting the dynamic and uncertain nature of millet agriculture in India.

Table 2: Decadal change in area and production of total millets in India

(1991-92 to 2020-21)

Particulars	Area			Production		
	CAGR	II (Instability Index)	R ²	CAGR	II (Instability Index)	R ²
Period-I (1991-92 to 2000-01)	-2.85	0.02	0.93	-2.10	0.10	0.30
Period-II (2001-02 to 2010-11)	-2.05	0.04	0.69	0.17	0.12	0.00
Period- III (2011-12 to 2020-21)	-2.98	0.05	0.80	-1.31	0.04	0.17
Overall period (1991-92 to 2020-21)	-2.51	0.05	0.96	-0.83	0.11	0.32

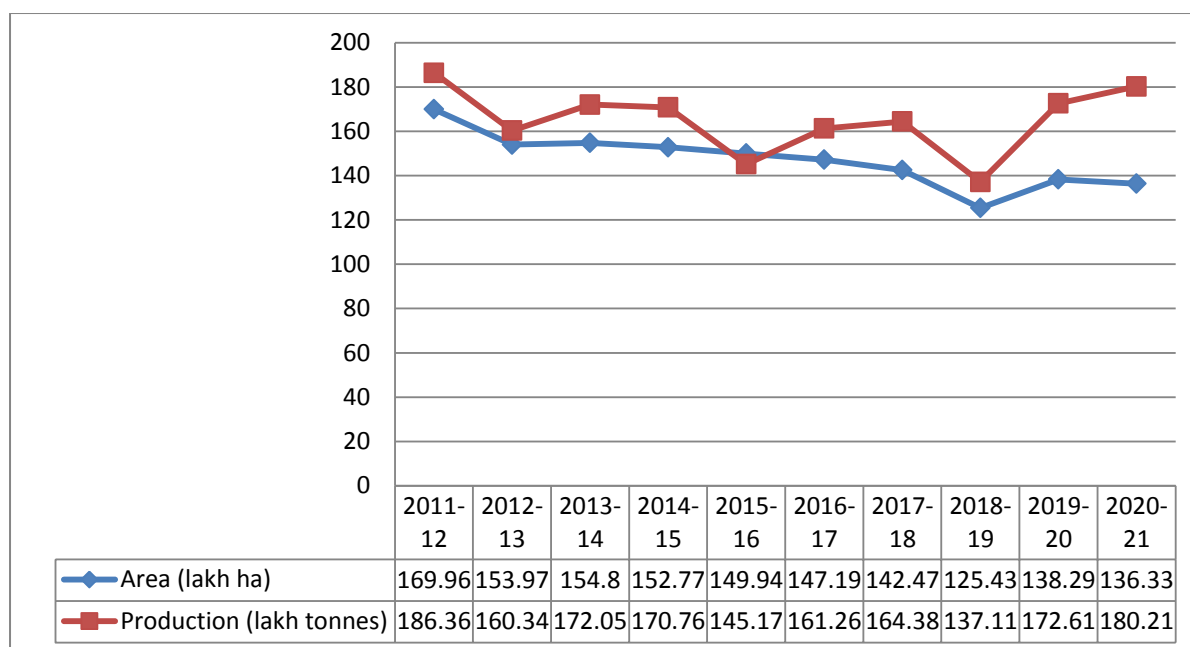


Figure 1: Area and Production of Millets during 2011-12 to 2020-21

India's Pearl Millet production accounts for 40.51 per cent followed by Sorghum 8.09 per cent in the world production of Millets in 2020. Multiple varieties of millets are produced in India such as Pearl Millets, Sorghum, Finger Millet, Foxtail, Kodo, Barnyard, Proso, Little Millet and Pseudo Millets like Buckwheat and Amaranths. Pearl millet (Bajra), Sorghum (Jowar) and Finger Millet (Ragi) constitutes the largest share in India's total production of millets.

During the year 2020-21, major millets namely Bajra, Jowar, Ragi and small millets cultivated in India on 136.33 lakh ha area produced 180.21 lakh tonnes millets. Bajra alone contributed 60.28 per cent share to total millets production from 56.13 per cent area. Jowar and Ragi are second and third most grown millet in the country with 32.11 and 8.50 per cent area and 26.70 and 11.09 per cent production share to total millets respectively.

Table 3: Commodity-wise area and production of major millets in India (2020-21)

Sr. No.	Major Millets	Area (lakh ha)	Per cent share to total area	Production (lakh tonnes)	Per cent share to total production	Yield (kg/ha)
1	Bajra	76.52	56.13	108.63	60.28	1420
2	Jowar	3.78	32.11	48.12	26.70	1099
3	Ragi	11.59	8.50	19.98	11.09	1724
4	Small millets	4.44	3.26	3.47	1.93	781
	Total Millets	136.33	100.00	180.21	100.00	1322

Source: <https://apeda.gov.in/milletportal/Production.html>

The major millets producing states in India are Rajasthan, Maharashtra, Uttar Pradesh, Karnataka, Madhya Pradesh, Gujarat, Haryana, Tamil Nadu, Andhra Pradesh and Uttarakhand. Currently, together these ten states accounts for around 98 per cent in Millets production in India during the period

2021-22. Six states namely Rajasthan, Maharashtra, Uttar Pradesh, Karnataka, Madhya Pradesh and Gujarat accounts for more than 84 per cent share in total millet production. Rajasthan contributes 27 per cent of the total millet production in India.

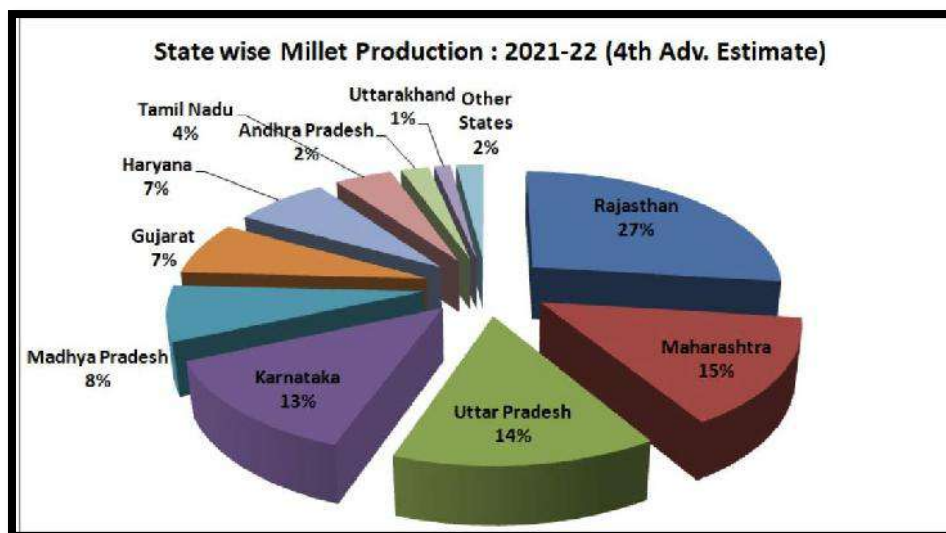


Figure 2: State-wise Millets production in India during the year 2021-22

Export Scenario:

A cursory glance at the data in table shows the growth of India’s agricultural export in terms of Rs crore. During the year 2010-11 to 2022-23, India’s agricultural export continuously increasing with a growth rate of 7.53%. India total agricultural export

went up from Rs 262778.96 crore to Rs 426454 crore while India millets export grew from Rs 448.21 crore to Rs 608.11 crore during last decade. The proportionate share of millets export to India’s agricultural export is still nominal or very less *i.e.* 0.14%.

Table 4: Growth and instability in total millets export from India (2010-11 to 2022-23)

Sr. No.	Year	Agricultural export (Rs crore)	Millets		Per cent share of Millets Export Value to Agri. Export
			Export Quantity (tonnes)	Export Value (Rs crores)	
	2003-04		2309.81	2.85	
1	2010-11	111018.99	3,543.55	8.55	0.01
2	2011-12	180528.60	5,805.15	18.23	0.01
3	2012-13	223618.24	16,322.64	39.6	0.02
4	2013-14	262778.96	216,418.78	448.21	0.17
5	2014-15	239681.04	257,386.98	540.53	0.23
6	2015-16	215396.55	188,985.05	418.83	0.19
7	2016-17	226661.91	166,942.30	390.89	0.17
8	2017-18	251563.94	156,274.02	370.07	0.15
9	2018-19	274571.28	219,402.50	542.5	0.20
10	2019-20	252976.06	129,012.88	425.69	0.17
11	2020-21	305279.97	146,993.61	435.8	0.14
12	2021-22	369980.21	158,509.98	469.36	0.13
13	2022-23	426454.03	169,049.21	608.11	0.14
Period -I (2003-04 to 2012-13)		CGR(%)	15.98*	32.17**	
		II	73.24 (0.34)	82.35 (0.60)	
Period-II (2013-14 to 2022-23)		CGR (%)	-4.33*	1.58	
		II	17.79 (0.41)	16.45 (0.09)	
Overall period (2003-04 to 2022-23)		CGR (%)	31.01**	38.58**	
		II	50.11 (0.75)	41.27 (0.83)	

Source: DGCIS

**Significant at 1% level, *Significant at 5% level

Note: Figures in parentheses shows R-Square values

India's millet exports have achieved a historic high growth, experiencing a remarkable increase of 31.01% in quantity and 38.58% in value. As of the current year (2022-23), India exports 169.05 thousand tonnes of millets valued at Rs 608 crores, indicating a robust demand for Indian millets in the global market. Analyzing the data, it is evident that there was a positive compound annual growth rate (CAGR) of approximately 16% in millet export quantity during Decadal Period I (2003-04 to 2012-13). This surge could be attributed to the heightened demand for Indian millets in international markets. However, the Coefficient of Variation of Dispersion Index (CDVI) during this period was 73.24%,

signifying a certain degree of export instability, likely due to irregular export activities. In contrast, Decadal Period II (2013-14 to 2022-23) witnessed a negative CAGR of -4.3%. This decline may be attributed to lower millet production in India and an increased awareness among Indians about the importance of millet consumption. Interestingly, the CDVI for this period was 17.79%, indicating relative stability in exports, possibly due to reduced exports to other countries. The cumulative CAGR and CDVI over the entire period recorded 31.01% and 50.11%, respectively. This signifies a substantial overall growth in millet exports, coupled with a moderate level of stability in export activities.

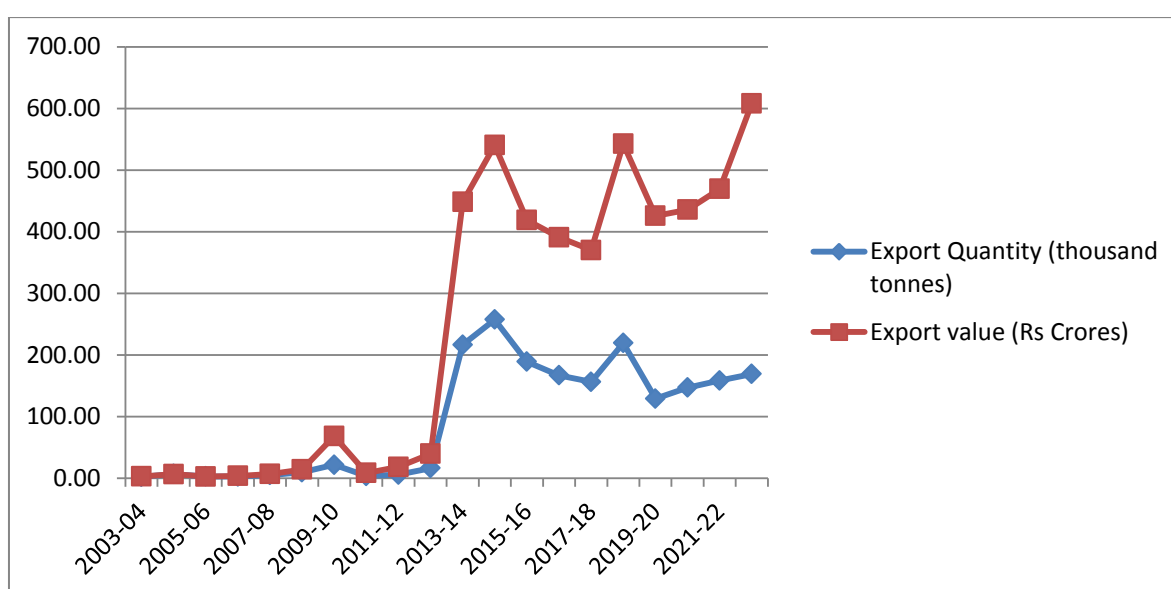


Figure 3: Export of millets from India (2003-04 to 2022-23)

Export Destinations:

Table 5: Top 10 Export Destinations for Indian Millets (2022-23)

Rank	Country	Quantity (tonnes)	Value (Rs Crores)	Unit Value (Rs/q)
1	UAE	34017.21 (20.12)	108 (17.76)	3174.86
2	Saudi Arab	24518.69 (14.50)	83.14 (13.67)	3390.88
3	Nepal	20020.01 (11.84)	44.70 (7.35)	2232.77
4	Bangladesh	12629.45 (7.47)	29.94 (4.92)	2370.65
5	Japan	6588.15 (3.90)	26.95 (4.43)	4090.68
6	USA	2105.97 (1.25)	24.83 (4.08)	11790.29
7	Germany	2009.52 (1.19)	22.96 (3.78)	11425.61
8	Libya	6811.77 (4.03)	21.97 (3.61)	3225.30
9	Egypt	1461.65 (0.86)	17.71 (2.91)	12116.44
10	Oman	5850.53 (3.46)	17.18 (2.83)	2936.49
11	Others	53036.3 (31.37)	210.65 (34.64)	3971.81
Total (Incl. others)		169049.25 (100.00)	608.03 (100.00)	3596.76

Note: Figures in parentheses denotes percentage to the total export of millets from India

The table provides insights into the millet exports from India to key destinations during the year 2022-23. The primary recipients of Indian millets include UAE, Saudi Arabia, Nepal, Bangladesh, Japan, USA, Germany, and Libya. Notably, UAE stands out as the largest importer, acquiring 34.02 thousand metric tons valued at Rs 108 crores, constituting 20.12% and 17.76% of the total quantity and value, respectively. The second-highest share in both quantity (14.50%) and value (13.67%) of millet

exports was attributed to Saudi Arabia, which imported millets worth Rs 83.14 crores in the same year. Egypt and the USA had the highest unit values for imported millets, standing at Rs 12,116 and Rs 11,790 per quintal, respectively, surpassing other major importers like Germany. Conversely, the lowest unit value for millet exports among these destinations was observed in Nepal, at Rs 2,232.77 per quintal.



India's Top 6 Millet Export Destinations

Commodity-wise export:

The primary millets exported include Bajra, Sorghum, and Ragi, collectively representing 88.96% and 89.95% in terms of quantity and value, respectively. Bajra, contributing 40.57% in value and exporting 81,709 tonnes, stands out as a significant

player in total millets exports. Following closely, Sorghum and Ragi hold the second and third-highest shares in both quantity and value. Given their substantial contributions to total millets exports, a detailed study was initiated for Bajra, Sorghum, and Ragi.

Table 6: Quantity and value of commodity-wise millets export from India (2022-23)

Product	Quantity (tonnes)	% share in total quantity	Value (Rs crores)	% share in total value
Bajra (Pearl Millet)	81709	48.33	246.68	40.57
Sorghum (Jowar)	47249	27.95	184.51	30.34
Ragi	21439	12.68	115.76	19.04
Others	18652.21	11.03	61.16	10.06
Total Millets	169049.21	100.00	608.11	100.00

Source: APEDA, 2023

State-wise Export Scenario: Millets export is predominantly concentrated in five key states: Gujarat, Maharashtra, Bihar, West Bengal, and Telangana, collectively contributing to nearly 95% of the total millets export in the country. Gujarat emerges as the primary exporter, shipping 78.11 thousand metric tons valued at Rs 34.2 USD million,

accounting for a substantial share of 46.20% in quantity and 45.30% in value. Following closely, Maharashtra holds the second-highest share, representing 29.86% in quantity and 31.79% in value, with millet exports totaling Rs 24 USD million in the same period.

Table 7: Top five exporting states of Millets (2022-23)

Major Producing States	Export Quantity (tonnes)	Export Value (USD millions)
Gujarat	78106 (46.20)	34.2 (45.30)
Maharashtra	50486 (29.86)	24 (31.79)
Bihar	19917 (11.78)	5.5 (7.28)
West Bengal	12587 (7.45)	3.5 (4.64)
Telangana	1680 (0.99)	3.3 (4.37)
India	169049 (100.00)	75.5 (100.00)

Note: Data in parentheses denotes percentage to the India's total export of millets

Export Competitiveness: Competitiveness is the ability of a nation to grow successfully and to maintain its share in world trade.

RCA (Revealed Comparative Advantage) & RSCA (Revealed Symmetric Comparative Advantage): Though India is the leader, competition from other major producing countries can't be ruled out. It is important to have proper understanding on the competitiveness of India's millets export over time so as to take proper policy measures. The export

performance ratio also known as the revealed comparative advantage was estimated for millets. Since the world trade data was not available in financial year wise, the calendar year wise data was used to measure the RCA. Revealed symmetric advantage (RSCA) was calculated based on RCA for millets. Positive value of RSCA shows the presence of comparative advantage, whereas negative value shows the absence of comparative advantage/comparative dis-advantage.

Table 8: RCA & RSCA of India's Millets export

Year	Millets	
	RCA	RSCA
2003	8.86	0.80
2004	12.73	0.85
2005	25.00	0.92
2006	14.81	0.87
2007	13.90	0.87
2008	23.00	0.92
2009	21.14	0.91
2010	22.28	0.91
2011	11.54	0.84
2012	9.17	0.80
2013	8.17	0.78
2014	6.89	0.75
2015	9.19	0.80
2016	10.22	0.82
2017	7.54	0.77
2018	8.57	0.79
2019	7.71	0.77
2020	6.21	0.72
2021	5.94	0.71
2022	7.81	0.77

RCA values were found to be more than one throughout the years, which indicates that the share of millet export to total agricultural export in India is more than that of Asia's combined data. This clearly shows India was found to have comparative advantage throughout the study period. The RSCA values were also found to be in increasing trend from 0.80 during 2003 to 0.91 during 2010 indicating that,

over the years India is having less and less comparative disadvantage. Even though there was comparative advantage, decreasing trend was seen in RCA and RSCA values from the year 2011 to 2022. This decreasing trend shows that, over the recent years India is having less and less comparative advantage in millets exports.

CONCLUSION

Developing countries contribute significantly to millet production and consumption, India emerges as a key player, being the largest producer and exporter of millets in the world. The domestic landscape reveals the dominance of states like Rajasthan, Maharashtra, and Uttar Pradesh in millet cultivation, especially focusing on major varieties such as Pearl Millet, Sorghum, and Finger Millet. The study was entirely based on secondary data. The growth rate of production of millets was negative, as the area under millets reduced the production was also parallelly reduced. Despite facing challenges such as decreasing cultivation areas, the country showcases a historic surge in millet exports, experiencing substantial growth in both quantity and value. There is huge demand for millets along the globe. The top export destinations include UAE, Saudi Arabia, and Nepal, signifying a growing global demand for Indian millets. While Gujarat takes the lead among exporting states, Maharashtra closely follows, underlining the pivotal role played by these regions in India's millet export landscape. India had enjoyed a comparative advantage in millets exports as RCA values were found to be more than one throughout the years. Efforts should be taken to promote export of selected millet products from India to explore and exploit potential of other markets and to avoid overdependency on few countries.

Message:

The increasing demand for Indian millets in global markets, as evidenced by the diverse export destinations, highlights the potential for sustained growth and economic opportunities in the millet sector, emphasizing the need for strategic policies to enhance both domestic cultivation and international trade.

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Export of Marine Fish Products of India: Analysing the Composition.

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Abstract

This study examines the structure, performance, and global competitiveness of India's marine fish product exports over a 26-year period (1995–96 to 2020–21). Drawing upon India's extensive Exclusive Economic Zone (EEZ) and significant marine resource potential, the analysis is based on secondary data and employs trend analysis along with compound growth rate estimation. The findings reveal sustained growth in export value, both in nominal and real terms, with frozen shrimp emerging as the predominant contributor to overall performance, followed by notable expansion in dried item exports. In contrast, chilled items recorded relatively slower growth in the later years, suggesting potential market saturation or supply-side constraints. The results underscore the sector's resilience and evolving composition, offering insights for policy formulation aimed at enhancing competitiveness and market diversification.

Keywords: Global competitiveness, Significant marine resource, Frozen shrimp, export value, Trend analysis,

INTRODUCTION

The fisheries sector occupies a pivotal position in India's economy, contributing to national income, employment generation, nutritional security, and foreign exchange earnings. Comprising inland and marine fisheries, the sector benefits from extensive natural endowments, including an 8,000 km coastline, a 2 million km² Exclusive Economic Zone (EEZ), and rich freshwater resources. In 2020–21, the gross value added (GVA) from fisheries was ₹2,32,620 crore, representing 1.1% of national GVA and 6.72% of agricultural GVA. India ranked third in global fish production and second in aquaculture output, contributing 7.7% to global supply. Marine fishing potential is estimated at 4.41 million metric tonnes, with significant demersal, pelagic, and oceanic resources. In 2020–21, India exported 1.15 million tonnes of fish and fishery products valued at ₹34,717.26 crore (USD 5.96 billion), despite a pandemic-induced 10.88% decline in volume. The sector directly employed approximately 28 million people and provided affordable, high-quality animal protein, particularly benefiting vulnerable populations. These indicators highlight the sector's resilience, socio-economic relevance, and strategic role in India's post-pandemic recovery.

METHODOLOGY

The present study was based on secondary data. The detail information required for the study was collected from secondary sources in order to accomplish the various objectives related to export of marine fish products. The country wise time series data on export of marine fish products in terms of value and quantity from 1995-96 to 2020-21 was collected for the study. Further, destination wise time series data on export of marine fish products, international prices, wholesale prices were collected from annual publication of MPEDA (Marine Product Export Development Authority, India) and its website www.mpeda.com, FAO year book, WTO website.

Analytical tools

Estimation of Growth Rates The compound growth rates were worked out to estimate the trends in export of marine fish product. The growth in quantity exported and export values realized from exports was analysed using the following exponential growth function of the form

$$Y = ab^x e^u$$

Where,

Y = Dependent variables

a = intercept

b = regression coefficient

x = Number of years

e^u = Error term

The compound growth rate will be estimated by using the semi-logarithmic form of the equation as below:

RESULTS AND DISCUSSION

Composition and Trends in Exports of Marine Fish Products (1995–2020)

Table 1: Item-wise Export of Indian Marine Fish products-(quantity in tones):

Year	Fr. Shrimp	Fr.Fin Fish	Fr. Cuttlefish	Fr. Squid	Dried items	Live items	Chilled items	Others	Total
Period I (1995-2007)	1440056	2035995	465096	489032	121155	24548	43727	417044	5036650
Period II (2008-2020)	4851970	3985952	876772	1081957	904095	76847	317731	1655608	13750934
Overall (1995-2020)	6292026	6021947	1341868	1570989	1025250	101395	361458	2072652	18787584
Per cent share	33.49	32.05	7.14	8.36	5.45	0.53	1.92	11.03	100.00

Table 1.presents the item-wise export quantities of Indian marine fish products for the period 1995–2020. The total export quantity over the 26-year period was 18.79 million tonnes, with Frozen Shrimp and Frozen Fin Fish emerging as the dominant items, contributing 33.49% and 32.05% respectively to total exports. Together, these two categories accounted for more than 65% of the total export volume, indicating a highly concentrated export structure.

A substantial increase in export volumes was observed in Period II (2008–2020) compared to Period I (1995–2007). Frozen Shrimp exports rose markedly from 1.44 million tonnes in Period I to 4.85

$$\text{Log Y} = \text{Log a} + \text{Log b}$$

Then, the per cent compound growth rate (g) was computed using:

$$g = [\text{Antilog of (Log b) - 1}] \times 100$$

million tonnes in Period II—more than a threefold increase. Similar growth was recorded for Frozen Squid, while moderate increases were observed in Dried Items, Live Items, Chilled Items, and the Others category. The latter, comprising a mix of miscellaneous products, contributed 11.03% to overall exports. The observed pattern reflects both the increasing global demand for high-value products such as Frozen Shrimp and the diversification of India’s export portfolio over time. This diversification is indicative of the sector’s adaptability and its ability to cater to a broader spectrum of international markets.

Item-wise Value of Marine Fish Product Exports (1995–2020)

Table2: Item-wise Export of Indian Marine Fish Products (Value in Rs. Crore)

Year	Fr. Shrimp	Fr.Fin Fish	Fr. Cuttlefish	Fr. Squid	Dried items	Live items	Chilled items	Others	Total
Period I (1995-2007)	49371.95	10332.7	5402.15	4887.56	1271.03	600.49	806.85	4641.37	77314.12
Period II (2008-2020)	247496.1	45098.5	20259.8	21223.9	11840.5	3267.65	6750.44	25097.4	381034.4
Overall (1995-2020)	296868.09	55431.25	25661.96	26111.45	13111.56	3868.14	7557.29	29738.8	458348.6
Per cent share	64.76	12.09	5.59	5.69	2.86	0.84	1.64	6.48	100.00

Table 2. presents the item-wise value of Indian marine fish product exports for the period 1995–2020. Over the 26-year span, total export earnings amounted to ₹4.58 lakh crore, with Frozen Shrimp emerging as the most valuable export commodity, accounting for 64.76% of total earnings. This dominance reflects the strong global demand for high-value shrimp products and India’s competitive position in this segment. A sharp rise in export value was recorded in Period II (2008–2020), where Frozen Shrimp earnings increased from ₹49,372 crore in Period I (1995–2007) to ₹2.47 lakh crore—a fivefold growth. Frozen Fin Fish, Frozen Cuttlefish,

and Frozen Squid followed with respective shares of 12.09%, 5.59%, and 5.69%, indicating their continued relevance in India’s export portfolio, albeit at a smaller scale compared to shrimp. Other categories, including Dried Items, Live Items, Chilled Items, and Others, made marginal contributions in value terms, collectively accounting for less than 12% of earnings. Overall, the data underscores the pivotal role of Frozen Shrimp as the economic backbone of India’s marine fish exports, while also indicating the need for diversification to reduce market concentration risks.

Market-wise Export of Marine Fish Products (Quantity, 1995–2020)

Table 3: Market-wise Export of Indian Marine Fish products (Based on Quantity)

year	Japan	USA	European Union	China	South East Asia	Middle East	Others	Total
Period I (1995-2007)	812918	551707	1207354	1810013	627708	223609	345038	5578351
Period II (2008-2020)	982813	1990895	2216829	1676869	4265644	643612	1432570	13209232
Overall (1995-2020)	1795731	2542602	3424183	3486882	4893352	867221	1777608	18787583
Per cent share	9.56	13.53	18.23	18.56	26.04	4.62	9.46	100

Table 3: presents the market-wise distribution of Indian marine fish product exports based on quantity for the period 1995–2020. During the study period, total exports amounted to 18.79 million tonnes, with South East Asia (26.04%) and China (18.56%) emerging as the largest markets. The European Union (18.23%) and the USA (13.53%) also represented significant destinations, together accounting for nearly one-third of total exports.

A notable structural change occurred in Period II (2008–2020). Exports to the USA and the European Union increased sharply, reaching 1.99 million tonnes and 2.22 million tonnes respectively, reflecting enhanced market penetration and compliance with

quality standards in developed economies. While Japan and the Middle East maintained relatively stable shares over time, the “Others” category—comprising emerging and non-traditional markets—expanded considerably, highlighting India’s growing outreach to diverse destinations.

Overall, the data indicates a progressive diversification of export destinations, with an increasing dominance of Asian markets alongside sustained engagement with traditional Western markets. This diversification potentially reduces market concentration risks and enhances India’s resilience to demand fluctuations in any single region.

Market-wise Export of Marine Fish Products (Value, 1995–2020)

Table 4: Market-wise Export of Indian Marine Fish products (Based on Value):

Year	Japan	USA	European Union	China	South East Asia	Middle East	Others	Total
Period I (1995-2007)	22,376.00	14,657.76	18,094.78	9,193.02	6,105.22	2,625.67	4,261.66	77,314.12
Period II (2008-2020)	30802.52	114603.29	68894.27	37305.95	83263.11	18702.77	27462.49	381034.4
Overall (1995-2020)	53,178.52	1,29,261.05	86,989.05	46,498.97	89,368.33	21,328.44	31,724.15	4,58,348.52

Table 4 presents the market-wise value of Indian marine fish product exports during the period 1995–2020. Over the 26-year span, total export earnings amounted to ₹4.58 lakh crore, with the USA emerging as the leading market, contributing ₹1.29 lakh crore (28.2% of total export value). South East Asia and the European Union followed, with earnings of ₹89,368 crore (19.5%) and ₹86,989 crore (19.0%) respectively.

A significant transformation was observed in Period II (2008–2020), marked by a substantial increase in export earnings from the USA and South East Asia. The USA's share in export value grew more than sevenfold compared to Period I (1995–2007), reflecting strong demand for high-value commodities such as frozen shrimp. Conversely, Japan, a major market in Period I with earnings of ₹22,376 crore, experienced relatively modest growth in subsequent years, indicating a gradual shift in trade patterns. Overall, the results highlight reorientation of India's marine export earnings toward high-value Western and South East Asian markets, with the USA emerging as the dominant destination in value terms. This trend underscores the strategic importance of diversifying market engagement while strengthening India's foothold in premium global seafood markets.

Conclusion :

Between 1995 and 2020, India's marine fish product exports were dominated by Frozen Shrimp and Frozen Fin Fish, together accounting for over 65% of export quantity, with Frozen Shrimp contributing nearly two-thirds of total earnings. Significant growth was recorded in Period II (2008–2020), particularly in Frozen Shrimp and Frozen Squid, reflecting strong global demand and product

diversification. Market analysis shows South East Asia and China leading in quantity, while high-value markets such as the USA and the European Union drove earnings, with the USA emerging as the top value destination. The results indicate a resilient and adaptive sector, increasingly oriented toward premium markets and broader export destinations. Continued diversification in both products and markets will be essential to sustain growth and mitigate risks from global demand fluctuations.

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Analysis of Cost and Returns in Broiler Production in Palghar District of Maharashtra State

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ABSTRACT

This study was conducted in order to determine profitability in broiler production in Palghar district of Maharashtra State. A multi stage and purposive sample techniques were employed for the selection of the study area and respondents. Data for this study were collected with the aids of structured questionnaire. About 80 broiler farmers were randomly selected to form the sample size for the study. The analytical techniques used for the study were frequency, percentage, ratios and budgeting techniques. The study shows that total cost incurred by contract poultry units was 3.86 lakh out of which maximum 43.48 per cent (Rs. 1.67 lakh) were paid as wages to labour, followed by imputed value of fixed cost 40.73 per cent (Rs.1.57 lakh). The variable cost contributed about 59.27 per cent in total cost (Rs. 2.28 lakh) which was found to be lower as compared to non-contract units. In case of non-contract broiler units the average per bird cost of production and gross returns were Rs.167.55 and Rs.173.31, respectively resulting into net returns of Rs. 5.76 per bird. Among the total cost of production majority (65.25%) and (16.72%) of the cost accounts to feed cost and cost of day-old chicks respectively. Out of the total gross returns derived 98.59 per cent from broiler poultry birds, 0.93 per cent from sale of poultry manure and 0.52 per cent from sale of empty gunny bags. As regards to contract broiler units the average per bird cost of production and gross returns were Rs.15.41 and Rs.17.16, respectively with net returns of Rs.1.75 per bird. Among the total cost of production majority (43.50%) and (4.69%) of the cost accounts to wages of labour and cost of litter material respectively. Out of the total gross returns derived 78.85 per cent were from rearing charges of broiler poultry birds, 17.36 per cent from sale of poultry manure and 5.25 per cent from sale of empty gunny bags.

Keywords: Analysis, broiler, cost and return and production.

INTRODUCTION

Indian Poultry Industry is 5,000 years old and has undergone a remarkable shift in assembly and operation. Journey of poultry industry started from a mere backyard activity and destined to a major commercial activity in just about four decades with comprehensive efforts and large sum of investment in breeding, hatching, rearing and processing. The Indian poultry sector is valued at Rs. 1 lakh cr. (\$ 15.38 bn). In coming years, poultry production and consumption is predicted to grow due to various factors. Nearly 70 per cent of the total output of poultry industry is contributed by organized sector and remaining 30 per cent by unorganized sector. Out

of total broiler production of poultry, two third of the output (about 66.70%) is contributed by the meat and the other one third (about 33.30%) by egg production. There are about 1000 hatcheries operating in the country.

Poultry farming in the wider intellect includes rearing of domesticated birds such as Chickens, Ducks, Turkeys and Geese commercially for the purpose of meat, eggs and feather production. The most common and extensively raised poultry bird in the world is chicken. Among the two major types of chicken, the broilers are raised for meat purpose while layers are raised for egg purpose. Chickens are fast growing birds. Earlier, it required about 4 months

to produce a two kilogram of Chicken. But now, a two-kilogram chicken can be produced in 42 days. A better understanding of husbandry practices, and use of new technologies, poultry farms can be profitable enterprises.

Livestock population of India is highest in the world; it contributes approximately 4 per cent to Gross Domestic Product (GDP) and 27 per cent to agricultural GDP. Poultry Industry is providing nutritional security to the poor and also offering employment to millions of people in rural and urban areas. The future for Indian Poultry Industry appears to be very favourable and is driven by rising purchasing power, changing food habits, contract poultry farming and rapid urbanization are certain key reasons for this persistent pick-up in poultry sector.

METHODOLOGY

For present study four stage sampling method was followed such as 1) selection of region, 2) selection of district, 3) selection of tahsil and 4) selection of broiler unit. Maharashtra is divided in to nine agro-climatic zones taking in to consideration the rainfall pattern, quantum and distribution, the North Konkan zone was purposively selected for the present study where there is more potential for poultry business.

Konkan zone comprises of 5 districts namely Palghar, Raigad, Ratnagiri, Sindhudurg and Thane. Out of which Palghar district was selected purposively as new broiler units are increasing in this district.

Four tahsils were selected randomly. A detailed list of broiler poultry units was obtained from Agricultural officers of selected tahsils. From each tahsil four villages and from each village twenty broiler units will be selected randomly, Thus the total sample consists of 80 broiler units which were analysed to obtain appropriate results as per proposed objectives.

Data collection

The data were collected by survey method, with the help of specially designed schedule by personal interview with owner of broiler production unit owners. The information regarding fixed assets and variable assets, returns, profitability, disposal

pattern and constraints of selected broiler poultry units was obtained.

Sampling procedure and sample size

To study the effect of broiler poultry size on productivity and profitability of broiler production, the selected sample broiler poultry growers were classified into different size groups based on type of broiler poultry unit. The grouping was done with following procedure. The broiler poultry owners were classified in to two categories viz. I) Contract broiler units II) Non contract broiler units, because as management, cost and other aspects differ distinctly in these groups.

The stratification was carried out purposively in such a way that total sample size is distributed among each category and each tahsil. Such that 59 sample from contract broiler unit and 21 sample from non contract broiler unit, thus total 80 sample were selected for study.

Data analysis

For the purpose of achieving specific objectives of the study, the collected data were analysed to draw the conclusions.

The data were arranged in suitable tables and simple statistical tools such as average, percentage, ratios and budgeting techniques.

RESULTS AND DISCUSSIONS

Cost and returns in broiler poultry production

In Study area the cost and returns pattern was influenced by the method of operation. The cost and returns pattern was found to be dissimilar in non-contract and contract units, therefore the cost and returns were presented separately for non-contract and contract owners. The cost of broiler production was represented as per year, per batch and per bird as follows:

Per unit per year cost incurred in broiler production

The information regarding per unit per year cost incurred in broiler production is presented in Table 1.

Contract units:

It was observed from table 1 that, the total cost incurred by contract poultry units was 3.86 lakh

out of which maximum 43.48 per cent (Rs. 1.67 lakh) were paid as wages to labour, followed by imputed value of fixed cost 40.73 per cent (Rs.1.57 lakh). The proportion of fixed cost in total cost was higher in contract units because of cost on purchase of one day old chicks and cost of feed do not exist as these items were supplied by the buy-back contracting company. The variable cost contributed about 59.27 per cent in total cost (Rs. 2.28 lakh) which was found to be lower as compared to non-contract units.

Non-Contract units:

It could be observed from table, the per unit total cost incurred by non-contract farms was Rs.

113.44 lakhs. Out of which major share 95.33 per cent was variable cost (Rs. 108.15 lakh) followed by Rs. 5.29 lakh (4.67%) a fixed cost. Amongst the items of variable cost share of cost of feed was highest 65.25 per cent (Rs.72.65 lakh) followed by cost incurred on purchase of one day old chicks Rs. 18.63 lakh (16.72%). It was revealed that cost incurred on non-contract type units was quite high than contract units which was attributed to higher size of poultry unit in non-contract units and no any expenditure was incurred on purchase of one day old chicks and feed etc.

Table 1: Per unit per year cost incurred in broiler production

(Figures in Rs.)

Sr. No	Particular	Contract (N=59)	Non-Contract (N=21)
A)	Variable cost		
1	Wages of Labour		
	Male	133118 (34.47)	221142 (1.98)
	Female	34758 (9.00)	147428 (1.30)
	Total	167878 (43.48)	368572 (3.25)
2	Cost of one day old chicks	-	1863666 (16.72)
3	Cost of feed	-	7265742 (65.25)
4	Cost of litter material	18127 (4.69)	60095 (0.53)
5	Electricity charges	16166 (4.19)	38333 (0.34)
6	Medical/ Vaccine expenses	-	54171 (0.48)
	Miscellaneous item charges		
7	Expenses on sanitation	2088 (0.54)	5642 (0.05)
	Total Working capital	204259 (52.90)	9656223 (86.64)
8	Interest on working capital (12% to total working capital)	24511 (6.35)	1158746 (10.40)
	Total variable cost (A)	228829 (59.27)	10815068 (95.33)
B)	Fixed cost		
1	Depreciation on building and implements	33256 (0.77)	108706 (0.66)
2	Interest on fixed capital(10% to fixed investment)	123985 (32.11)	421161 (2.34)
	Total fixed cost (B)	157275 (40.73)	529867 (4.67)
	Total cost (A+B)	386105 (100.00)	11344936 (100.00)

(Figures in parentheses indicate percentage to total)

Per unit per batch cost incurred in broiler production

The average cost of production per batch is presented in Table 2 The average number of birds reared per batch in contract and non-contract units

were 4177 and 11285 respectively. For non-contract unit total cost of broiler production per batch was found to be Rs. 1.89 lakh and for contract unit total cost of broiler production per batch was found to be Rs.64357 which is obviously lower than non-contract.

Table 2: Per unit per batch cost incurred in broiler production

(Figures in Rs.)

Sr. No	Particular	Contract (N=59)	Non-Contract(N=21)
A) Variable cost			
1	Wages of Labour	Male	36857
			(1.95)
		Female	24571
			(1.30)
	Total	27980	61429
		(43.50)	(3.20)
2	Cost of one day old chicks	-	217976
			(11.50)
3	Cost of feed	-	1210957
			(64.04)
4	Cost of litter material	3021	10015
		(4.69)	(0.53)
5	Electricity charges	2694	6388
		(4.19)	(0.34)
6	Medical/ Vaccine expenses	-	9028
			(0.48)
Miscellaneous item charges			
7	a) Expenses on sanitation	348	940
		(0.54)	(0.05)
	Total Working capital	34043	1609370
		(52.90)	(85.11)
8	Interest on working capital (12% to total working capital)	4085	193124
		(6.35)	(10.21)
Total variable cost (A)		38144	1802511
		(59.27)	(95.33)
B) Fixed cost			
1	Depreciation on building and implements	5542	18117
		(8.61)	(0.96)
2	Interest on fixed capital (10% to fixed investment)	20664	70193
		(32.11)	(3.71)
Total fixed cost (B)		26212	88311
		(40.73)	(4.67)
Total cost (A+B)		64357	1890822
		(100.00)	(100.00)

(Figures in parentheses indicate percentage to total)

Per unit per bird cost incurred in broiler production

The average cost of production per bird in non-contract units is presented in Table 3. It is seen

from the table that, in non-contract the total cost of broiler production per bird was found to be Rs167.55 which is higher than contract and for contract unit total cost of bird was Rs.15.41. There was huge difference in contract units and non-contract units

because of dissimilar operations and conditions of pay any charges for one day old chicks, feed, contracting company as contract farms do not have vaccines etc.

Table 5.8: Per unit per bird cost incurred in broiler production

(Figures in Rs.)

Sr. No	Particular	Contract (N=59)	Non-Contract (N=21)
A)	Variable cost		
1	Wages of Labour	Male	5.31
			(34.50)
		Female	1.39
			(9.00)
	Total	6.7	5.4
		(43.50)	(3.20)
2	Cost of one day old chicks	-	19.3
			(11.50)
3	Cost of feed	-	107.31
			(64.04)
4	Cost of litter material	0.72	0.89
		(4.69)	(0.53)
5	Electricity charges	0.65	0.57
		(4.19)	(0.34)
6	Medical/ Vaccine expenses	-	0.80
			(0.48)
	Miscellaneous item charges		
7	a) Expenses on sanitation	0.08	0.08
		(0.54)	(0.05)
	Total Working capital	8.15	142.6
		(52.90)	(85.11)
8	Interest on working capital (12% to total working capital)	0.98	17.1
		(6.35)	(10.21)
	Total variable cost (A)	9.13	159.73
		(59.27)	(95.33)
B)	Fixed cost		
1	Depreciation on building and implements	1.33	1.60
		(8.61)	(0.96)
2	Interest on fixed capital (10% to fixed investment)	4.9	6.22
		(32.10)	(3.70)
	Total fixed cost (B)	6.28	7.82
		(40.73)	(4.67)
	Total cost (A+B)	15.41	167.55
		(100.00)	(100.00)

(Figures in parentheses indicate percentage to total)

Cost of production per kg of live weight in units

In broiler production sizeable amount of income was received from the selling of birds and from other by-products like manure and gunny bags. Therefore, the cost of production per kg of live weight in non-contract units was calculated (net of by-products value) and presented in Table 4. It is observed from the table that, after deducting the

returns value of by-product from the total cost of production. The cost of production per kg of live weight in non-contract farms was Rs.74.78. The cost of feed, chicks and medicines do not exist in contract units therefore cost of production per kg in contract farms was low Rs. 5.45. However, it gives valuable information to new entrants in the contract type poultry business, because buy back company pay to poultry owner on the basis of weight or birds.

Table 4: Cost of production per kg of live weight in units

Sr. No	Particular	Contract (N=59)	Non-Contract (N=21)
1	Average live weight per bird (kg)	2.3	2.2
2	Per bird total cost of rearing (Rs.)	15.41	167.55
3	Per bird returns from by product (Rs.)	2.87	3.03
4	Cost of production per kg of live weight (Rs.)	5.45	74.78

Production from broiler sample units

The items of produce obtained from different size group of broiler poultry unit were sale of broiler poultry birds, sale of poultry manure and sale of gunny bags and carton boxes. The information on this per year per batch basis is given in Table 5.

broiler poultry birds was 72096 kg, poultry manure was 25417 kg, empty gunny bags was 2175. While per batch it was 10523 kg broiler birds, 4236 kg poultry manure and 362 gunny bags. The Table revealed that, per unit and per batch quantity produced from contract and non-contract units increased as the size of broiler farm increased.

It is seen from the Table 5. that, per unit quantity produced annually at overall level from

Table 5: Production from broiler sample units

Sr. No	Particular	Contract (N=59)	Non-Contract(N=21)	Overall (N=80)
A	Per unit annual production			
	Broiler Poultry birds(kg)	55851	117736	72096
	Poultry manure (kg)	17065	48880	25417
	Gunny bags (No.)	1504	4062	2175
B	Production per unit per batch			
	Broiler Poultry birds(kg)	7285	19623	10523
	Poultry manure (kg)	2844	8146	4236
	Gunny bags (No.)	250	677	362

Gross returns recovered from broiler production

The gross returns per farm per year, per batch and per bird realized from various source of contract and non-contract broiler poultry units were presented in Table 6. It is revealed from the Table 6. that, In contract and non-contract units annual gross returns obtained per unit was Rs.42.99 lakh and Rs. 117.35 lakh respectively. In non-contract unit out of

total gross returns, 98.59 per cent was received from sale of broiler birds, whereas only 0.93 per cent was accrued from sale of poultry manure and 0.52 per cent from sale of empty gunny bags. In contract farms, out of total gross returns, 78.85 per cent were from sale of broiler birds, 17.36 per cent were from sale of poultry manure and 5.25 per cent from sale of empty gunny bags.

Table 6: Gross returns recovered from broiler production

(Figures in Rs.)

Sr. No	Particular	Contract (N=59)	Non-Contract (N=21)
A)	Annual gross returns per unit		
1	Sale of broiler poultry birds	339051 (78.85)	11556669 (98.59)
2	Sale of poultry manure	68263 (17.36)	117314 (0.93)
3	Sale of empty bags	22575 (5.25)	60945 (0.52)
	Gross income	429985 (100.00)	11734929 (100.00)
B)	Gross return per batch		
1	Sale of broiler poultry birds	56508	1926111
2	Sale of poultry manure	11377	19552
3	Sale of empty bags	3575	10157
	Gross income	71460	1955821
C)	Gross return per bird		
1	Sale of broiler poultry birds	13.53	170.68
2	Sale of poultry manure	2.72	1.73
3	Sale of empty bags	0.86	0.90
	Gross income	17.11	173.31

(Figures in parentheses indicate percentage to total)

Per unit cost and returns in broiler poultry production

The information regarding per unit cost incurred and returns received in broiler poultry production is presented in table 7 revealed that, per unit annual net returns of broiler poultry production in contract and non-contract owners was Rs.42.99 lakh and Rs.117.35 lakh respectively, per batch it was

Rs.71,663 and Rs.19.55 lakh respectively and per bird net returns obtained was Rs.1.75 and Rs.5.76 respectively.

It was concluded that the net returns obtained from contract broiler poultry units were found to be lower than non-contract broiler poultry units.

Table 7: Per unit cost and returns in broiler poultry production

(Figures in Rs.)

Sr. No	Particular	Contract (N=59)	Non-Contract (N=21)
A)	Per unit (Annual)		
	Gross returns	429983	11734929
	Total cost	386105	11344936
	Net returns	43878	389993
B)	Per batch		
	Gross returns	71663	1955822
	Total cost	64350	1890823
	Net returns	7313	64998
C)	Per bird		
	Gross returns	17.16	173.31
	Total cost	15.41	167.55
	Net returns	1.75	5.76

It may be due to major share of total income is taken away by contracting company and on the basis of stringent performance indicators imposed by contract company, terms and conditions of contract. This may be the reason due to which many contract farmers break the contract and then they found to be continue the business as a non-contract type poultry unit, which was opined by non-contract owners.

CONCLUSIONS

Based on the findings of the study, it was concluded that In case of non-contract units per bird gross returns and total cost of production were Rs.173.31 and Rs.167.55 respectively resulting in to net income per bird to the tune of Rs.5.76 per bird. In contract units, net returns (Rs.1.75) were less than non-contract due to dissimilar operational pattern.

In line with the findings of the study, the following recommendations were made.

- Government should frame some kind of mechanism to streamline the procedure of terms and conditions of agreement between poultry owner and contracting company.
- To make poultry enterprise more profitable and stable cost of feed and cost of one day old chicks should be reduced and proper electricity facilities should be provided to poultry units.

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Market Participation of Smallholder Vegetable Growers in Northern Hills of Chhattisgarh: A Logistic Regression Approach

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ABSTRACT

Market participation is pivotal for the economic viability and sustainability of smallholder vegetable growers, particularly in regions with diverse agricultural challenges. This study investigates the determinants of market participation among smallholder vegetable growers in the northern hills of Chhattisgarh, a region with unique topographical, climatic, and socio-economic conditions. The research analyzes various categorical and continuous variables, including land ownership, gender, education, family size, income, farm size, area under vegetable cultivation, and distance from the market. Using a Binomial Logit model, the study identifies significant factors influencing farmers' decisions to engage with markets. The study employs a multistage sampling procedure, selecting 150 households across Korea and Surajpur districts. The findings reveal that age, farm size, distance from the market, and access to market information significantly impact market participation. Older farmers and those with larger farms are less likely to participate in markets, while increased vegetable cultivation and access to market information enhance participation. The study underscores the need for targeted interventions to support these groups, improve infrastructure, and provide accurate market information. The logistic regression model demonstrates a strong fit, explaining a substantial proportion of the variance in market participation (Cox & Snell R Square: 55.5 Per cent, Nagelkerke R Square: 82.5 Per cent). These insights inform policymakers, development practitioners, and researchers working towards the sustainable development of agriculture in Chhattisgarh and similar regions. The study concludes that a multi-pronged approach, focusing on infrastructure improvement, market information dissemination, and support for specific farmer demographics, is essential for enhancing market participation and fostering a resilient agricultural sector in the region.

Keywords: Market Participation, Vegetable growers, logistic regression model

INTRODUCTION

Market participation is a critical factor influencing the economic viability and sustainability of smallholder vegetable growers, particularly in regions with diverse agricultural challenges and opportunities. In the northern hills of Chhattisgarh, a region characterized by its unique topography, climate, and socio-economic conditions, the dynamics of market participation among smallholder vegetable growers warrant detailed investigation. Understanding these dynamics is essential for formulating effective policies and interventions aimed at improving agricultural productivity and livelihoods.

Smallholder farmers in this region face numerous barriers to market participation, including limited access to transportation, inadequate market information, and poor infrastructure. These

challenges are compounded by factors such as land ownership patterns, gender roles, and varying levels of education and income. Despite these obstacles, many smallholders manage to participate in local markets, driven by the potential for higher income and improved food security.

This research paper aims to explore the determinants of market participation among smallholder vegetable growers in the northern hills of Chhattisgarh. By analyzing both categorical and continuous variables, such as land ownership, gender, education, family size, income, farm size, area under vegetable cultivation, and distance from the market, this study seeks to identify key factors that influence farmers' decisions to engage with markets.

Using logistic regression analysis, the study provides insights into the relative importance of these determinants, highlighting areas where targeted

interventions could enhance market participation rates. The findings are expected to contribute to the existing body of knowledge on smallholder agriculture and inform policymakers, development practitioners, and researchers working towards the sustainable development of agriculture in Chhattisgarh and similar regions.

In summary, this paper presents a comprehensive analysis of market participation among smallholder vegetable growers in the northern hills of Chhattisgarh, shedding light on the multifaceted factors that drive or hinder their market engagement. By addressing these factors, stakeholders can develop more effective strategies to support smallholders, thereby enhancing their economic resilience and contributing to broader rural development goals.

METHODOLOGY

The study has adopted a multistage sampling procedure for the selection of the district, talukas, blocks, villages, and vegetable growers. Korea and Surajpur district from North Hill of Chhattisgarh were selected purposively for study. Two blocks Baikunthpur and Khadgawan from Korea district and Ramanujnagar and Bhaiyathan from Surajpur district were randomly selected for the research work. Seventy-five households from both the districts were randomly selected. Thus, a total of 150 households were selected for collecting the required data for the study. Thereafter group of villages from each block was selected randomly. After the complete enumeration of villages, 150 households [marginal, small, and medium farmers] were selected randomly using the snowball sampling technique method. Our study mainly focuses on smallholder vegetable growers, so we have taken only three categories of farmers i.e. marginal (below 1 ha.), small (1 to 2 ha.), and medium (2 to 4 ha.). The interviews using the Recall Approach have been used in the collection of primary data for the study.

Determinants of market participation

The determinants of market participation of vegetable growers were estimated using the Binomial Logit model. The expression of the model is given below.

The Logit model is $\text{Ln}\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon$

The Odd ratio is given by

$$\frac{P_i}{1-P_i} = e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon}$$

The probability that the i^{th} household sells vegetables is given by

$$P_i = \frac{e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon}}{1 + e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon}}$$

where,

P_i takes the value 1 if i^{th} household sell vegetables

P_i takes the value 0 if i^{th} household do not sell vegetables

Ln is the natural log

β_0 is the intercept

X_i 's is the prediction variable

$\beta_1, \beta_2, \dots, \beta_n$ are the slope coefficients to be estimated

ε is the random error term

The marginal effect for a unit change in dependent variable is given by

$$\frac{\partial P_i}{\partial x_i} = P_i (\beta_j - \sum P_i \beta_j)$$

RESULTS AND DISCUSSION

General characteristics of sample households

The general characteristics of the sample households are presented in Table 1. It can be seen from the table that the total number of sample households was 150. Total family members were 572 out of which 342 were found to be working. The average family size was 3.81. Average family member in medium farm households was considerably large (4.24) as compared to marginal farm households (3.61). The literacy rate in the selected households was 62.23 per cent. Average size of holding was 1.11 hectares. The sample households comprised predominantly of scheduled tribe (49.33 per cent) followed by other backward caste (34.67 per cent), scheduled caste (7.33 per cent) and general (2.67 per cent).

Cropping pattern:

Table 2 shows that the area under crops and cropping intensity. It can be seen from table that Paddy covered highest cropped area 68.11 per cent per farm in kharif season and vegetables covered highest cropped area 5.05 per cent per farm in Rabi season. On an average the total operated area was 84.53 per cent per farm compare to total cropped area 100.00 per cent per farm. Cropping intensity was found 118.02 per cent. It was also observed that as the farm increase the cropping intensity was also increased.

Variables Information

The table 3 summarizes the categorical variables from a dataset involving 150 observations. Each variable is associated with specific categories and shows the number of observations (N) and the percentage of total observations (Percent) for each category. The table provides a clear distribution of individuals across different categorical variables related to market participation, land ownership, gender, access to transportation facilities, road conditions, and market information.

The table 4 summarizes the descriptive statistics for several continuous variables from a dataset involving 150 observations. Each variable is listed with the number of observations (N), minimum value, maximum value, mean (average), and standard deviation (Std. Deviation). The table provides key statistical measures for continuous variables related to age, education, family size, income, farm size, area under vegetable cultivation, and distance from the market, giving a comprehensive overview of the data's central tendency and variability.

Table 5 presents the results of a logistic regression model analyzing the determinants of market participation among smallholder vegetable growers. Each variable's coefficient (Coef.), standard error (Std. Error), and p-value (P-value) are listed, indicating the strength, direction, and statistical significance of their relationship with market participation.

Interpretation of Logistic Regression Results

1. AGE: Age has a negative and significant impact on market participation. As age increases by one year, the log odds of market participation decrease by 0.038 percent. Age did not determine the likelihood of market participation, but negatively affected the intensity of market participation (Ayodele et al., 2020). This may be because as age increases productivity of leafy vegetable farmers decreases, as does the intensity of participation in the market (Oduro et al., 2004).

2. EDUCATION: Education also has a negative impact, though less significant. Each additional year of schooling decreases the log odds of market participation by 0.040 percent. Household heads with higher levels of education are more likely to not participate in markets because, with an increased level of education, they prefer to do skilled jobs.

3. FAMILY SIZE: Family size does not have a statistically significant effect on market participation.

4. INCOME: Income is not significantly associated with market participation.

5. FARM SIZE: Farm size negatively affects market participation significantly. Larger farm sizes decrease the log odds of market participation by 1.333 percent. Amao et al., 2018 also found that increasing farm size reduces market participation of leafy vegetable farmers.

6. AREA UNDER VEGETABLE: The area under vegetable cultivation positively impacts market participation. An increase in vegetable cultivation area increases the log odds of market participation by 3.718 percent. This finding is contrary to the finding of Hurakadli et al., 2023.

7. LAND OWNERSHIP: Land ownership is not significantly associated with market participation.

8. GENDER: Gender does not have a significant effect on market participation.

9. DISTANCE FROM MARKET: Distance from the market has a significant negative impact on market participation. For each kilometer increase in distance, the log odds of market participation decrease by 0.499 percent. Barwalet al., 2023 also found that the longer the distance from the farmer's production area to the market, the less likely the farmer is to participate in that particular marketing channel.

10. ACCESS TO TRANSPORTATION FACILITY: Access to transportation facilities is not significantly associated with market participation.

11. ROAD CONDITION: Road condition does not have a significant effect on market participation.

12. MARKET INFORMATION: Access to market information has a strong positive impact on market participation. Having market information increases the log odds of market participation by 4.944 percent. Bindu et al., 2013, Mukarumbwa et al., 2018 & Barwalet al., 2023 also found a similar finding that the existence of market information improves the market participation

The logistic regression model reveals that age, farm size, distance from the market, and market information are significant determinants of market participation among smallholder vegetable growers. Specifically:

- **Age and distance from the market** have significant negative impacts on market participation.
- **Farm size** also negatively affects participation, suggesting larger farms might be more self-sufficient or less reliant on market sales.
- **Area under vegetable cultivation and market information** positively influence market participation, highlighting the

importance of specialized vegetable production and information access in promoting market engagement.

The logistic regression model fitness attributes provide information on the overall fit and explanatory power of the model.

Logistic Regression Model Fitness Attributes

1. -2 Log Likelihood: The -2 Log Likelihood (-2LL) is a measure of the model's goodness-of-fit. It is used to compare different models; a lower value indicates a better fit to the data. In this case, the value is 46.082. This value on its own does not provide much information but can be compared to the -2LL of other models to assess relative fit.

2. Cox & Snell R Square: The Cox & Snell R Square is a pseudo-R-squared measure, which indicates the proportion of variance in the dependent variable (market participation) explained by the independent variables in the model. Its value ranges from 0 to 1, where higher values indicate a better fit. In this model, 55.5Per cent of the variance in market participation is explained by the predictors.

3. Nagelkerke R Square: The Nagelkerke R Square is another pseudo-R-squared measure that adjusts the Cox & Snell R Square to make its maximum value equal to 1. This measure also indicates the proportion of variance explained by the model, with higher values suggesting a better fit. In this model, 82.5Per cent of the variance in market participation is explained by the independent variables, which indicates a very strong fit.

Overall, these statistics suggest that the logistic regression model is a good fit for the data, with a high proportion of the variance in market participation being explained by the included independent variables.

CONCLUSIONS

The market participation of smallholder vegetable growers in the northern hills of Chhattisgarh is a multifaceted issue influenced by a range of socio-economic, demographic, and infrastructural factors. This study has provided a comprehensive analysis of these determinants, highlighting key areas where policy interventions can significantly enhance market engagement and, consequently, the economic well-being of smallholder farmers.

The findings indicate that age, farm size, distance from the market, and access to market information are significant determinants of market participation. Older farmers and those with larger farms are less likely to participate in markets, suggesting a need for targeted support to these groups. Conversely,

increased vegetable cultivation and access to market information positively influence market participation, underscoring the importance of providing farmers with accurate and timely information to improve their market engagement.

The negative impact of distance from the market on participation points to the critical role of infrastructure development. Improving road conditions and transportation facilities can reduce the physical barriers to market access, thereby enabling more farmers to participate in markets.

Interestingly, variables such as land ownership, gender, family size, income, and road conditions did not show significant effects on market participation. This suggests that while these factors are important, their impact may be context-specific or intertwined with other underlying issues that were not captured in this study.

The logistic regression model used in this research demonstrates a strong fit, explaining a substantial proportion of the variance in market participation (Cox & Snell R Square: 55.5Per cent, Nagelkerke R Square: 82.5Per cent). This indicates the robustness of the model and the reliability of the identified determinants.

In conclusion, enhancing market participation among smallholder vegetable growers in the northern hills of Chhattisgarh requires a multi-pronged approach. Policymakers and development practitioners should focus on providing market information, improving infrastructure, and supporting older and larger-scale farmers to overcome barriers to market participation. By addressing these critical factors, stakeholders can foster a more inclusive and resilient agricultural sector, ultimately contributing to the sustainable development of the region. This study adds valuable insights to the existing body of knowledge and provides a solid foundation for future research and policy formulation in similar agricultural contexts.

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Table No. 1: General characteristics of sample households

S. No.	Particulars	Marginal	Small	Medium	Overall
1.	Total no. of Households	88 (100.00)	45 (100.00)	17 (100.00)	150 (100.00)
2.	Caste wise no. of Households				
	a. General	4 (4.55)	0 (0.00)	0 (0.00)	4 (2.67)
	Other backward caste	30 (34.09)	15 (33.33)	7 (41.18)	52 (34.67)
	c. Schedule tribe	44 (50.00)	20 (44.44)	10 (58.82)	74 (49.33)
	d. Schedule caste	10 (11.36)	10 (22.22)	0 (0.00)	11 (7.33)
3.	Total family member	318 (100)	182 (100)	72 (100)	572 (100)
4.	Average size of family	3.61	4.04	4.24	3.81
5.	Average size of holding (ha.)	0.57	1.47	2.91	1.11
6.	Working members	190 (59.75)	114 (62.64)	38 (52.78)	342 (59.79)
7.	Age group				
	a. below 18 years	93 (29.25)	52 (28.57)	26 (36.11)	171 (29.90)
	b. 18-60 years	201 (63.21)	119 (65.38)	41 (56.94)	361 (63.11)
	c. above 60 years	24 (7.55)	11 (6.04)	5 (6.94)	40 (6.99)
8.	Education				
	a. Illiterate	123 (38.68)	72 (39.56)	21 (29.17)	216 (37.76)
	b. I – V Std.	143 (44.97)	89 (48.90)	32 (44.44)	264 (46.15)
	c. VI – X Std.	46 (14.47)	13 (7.14)	13 (18.06)	72 (12.59)

	d. X – XII Std.	5 (1.57)	6 (3.30)	3 (4.17)	14 (2.45)
	e. Graduate	1 (0.31)	2 (1.10)	3 (4.17)	6 (1.05)
9.	Literacy (per cent)	61.32	60.44	70.83	62.23

Table No. 2: Cropping pattern of sample households

S. No.	Particulars	Marginal Per Farm (in Per cent)	Small Per Farm (in Per cent)	Medium Per Farm (in Per cent)	Overall Per Farm (in Per cent)
(A)	Kharif Season				
	a. Paddy	69.88	69.40	64.75	68.11
	b. Jowar	1.99	2.79	2.51	2.54
	c. Maize	3.48	4.27	2.39	3.40
	d. Pigon pea	1.74	2.21	1.87	2.06
	e. Urd	1.74	2.35	1.88	2.06
	f. Kulthi	1.25	0.88	1.46	1.37
	g. Groundnut	0.00	0.59	0.97	0.76
	h. Niger	1.41	1.03	1.46	1.37
	i. Vegetable	3.98	2.94	3.03	3.25
	Total	86.23	86.47	80.17	84.53
(B)	Rabi Season				
	a. Wheat	2.83	2.50	4.55	3.30
	b. Gram	1.58	1.47	2.21	1.78
	c. Pea	0.33	0.88	2.02	0.99
	d. Tiwra	0.49	0.74	1.10	0.69
	e. Mustard	1.58	2.35	2.59	2.16
	f. Linseed	0.82	1.47	2.83	1.89
	g. Vegetable	5.39	4.41	4.66	5.05
	Total	13.77	13.53	19.83	15.47
	Total Operated Area	86.23	86.47	80.17	84.53
	Total Cropped Area (A+B)	0.66 (100)	1.70 (100)	3.63 (100)	1.31 (100)
	Cropping intensity (per cent)	115.79	115.65	124.74	118.02

Table 3: Categorical Variable Information

		N	Percent
Dependent Variable	MARKET PARTICIPATION (1 for Yes, 0 for No)	0	37 24.7Per cent
		1	113 75.3Per cent
		Total	150 100.0Per cent
Factor	LAND OWNERSHIP (1 for Own Land, 0 for Leased)	0	20 13.3Per cent
		1	130 86.7Per cent
		Total	150 100.0Per cent
	GENDER (1 for Male, 0 for Female)	0	30 20.0Per cent
		1	120 80.0Per cent
		Total	150 100.0Per cent
	ACCESS TO TRANSPORTATION FACILITY (1 for Yes, 0 for No)	0	90 60.0Per cent
		1	60 40.0Per cent
		Total	150 100.0Per cent
	ROAD CONDITION (1 for Good, 0 for Poor)	0	48 32.0Per cent
		1	102 68.0Per cent
		Total	150 100.0Per cent
	MARKET INFORMATION (1 for Yes, 0 for No)	0	87 58.0Per cent
		1	63 42.0Per cent
		Total	150 100.0Per cent

Table 4: Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Covariate	AGE (No. of Years)	150	30	72	52.55	10.206
	EDUCATION (No. of Years of Schooling)	150	0	15	3.90	3.110
	FAMILY SIZE (In Number)	150	2	15	5.47	1.871
	INCOME(In Rupees)	150	23100	593730	109222.87	91672.528
	FARM SIZE (In Hectares)	150	.0000	4.0000	1.100200	.8518598
	AREA UNDER VEGETABLE (In Hectares)	150	.0252	1.0100	.339773	.2583933
	DISTANCE FROM MARKET (In KM)	150	1	32	5.42	4.398

Table 5: Results of Logistic Regression Model on Market Participation

Variable	Coef.	Std. Error	P- value
AGE	-.038	.0271	.004***
EDUCATION	-.040	.0614	.080*
FAMILY SIZE	-.323	.325	.320
INCOME	-.612	.3813	.136
FARM SIZE	-1.333	.442	.003***
AREA UNDER VEGETABLE	3.718	1.965	.059*
LAND OWNERSHIP	.986	1.485	.507
GENDER	1.323	1.283	.302
DISTANCE FROM MARKET	-.499	.114	.000***
ACCESS TO TRANSPORTATION FACILITY	1.635	2.038	.423
ROAD CONDITION	.863	.927	.352
MARKET INFORMATION	4.944	1.356	.000***
CONSTANT	-1.563	4.004	.696

***, ** and * denote significance at 1 per cent, 5 per cent and 10 per cent levels

Table 6: Logistic Regression Model Fitness Attributes

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
46.082 ^a	.555	.825

Economic Analysis of Krushiraj Agro-tourism as Agribusiness in Maharashtra State: A Case Study

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ABSTRACT

Agro-tourism has potential to boost up the economic condition of agrarian economy. The keeping in view of importance of Agro-tourism in Maharashtra state the study was under taken in Ahmednagar district as a case study i.e., Economic Analysis of Krushiraj Agro-tourism centre in Maharashtra State. The objective of study was to estimate cost and returns of study and to study economic viability of the agro tourism in Maharashtra. The standard cost concepts was used for estimation of economic analysis of the study.

The present study revealed that, the initial capital investment for establishment of Krushiraj Agro-tourism centre (KATC) was Rs 66,56,500. Major items of cost were land, infrastructure, irrigation facility and machinery. Out of total capital the land has highest costing of Rs 38,50,000. Variable cost of agro-tourism centre (ATC) was Rs 26,21,910. Benefit cost ratio was worked out and it was 1.18, which shows that ATC was economical viable. The payback period of ATC was 7.7 years. By considering the fixed cost, per head variable cost and per head charges, the breakeven point (BEP) was calculated, in monetary term it was Rs 98,94,797 and in physical (No. of Visitors) 9,635.

The internal rate of return (IRR) of KATC was worked out to be 16.70 per cent which indicates that investment in Agro tourism entrepreneur gets more returns than bank rate on make investment in Agro tourism business. All economic parameters shows that selected KATC was economical viable and profitable business.

Keywords: ATC, KATC, IRR, B:C ratio, BEP.

INTRODUCTION

Agrotourism is not new for the farmers, from point of economics this concept has more importance as many farmers of India have different resources which are not used fully in some season especially in summer and in some parts in rainy season, which includes unused rooms, man power etc. Such resources if utilized in managed manner can give additional income to farming family. Some farmers move toward Agro-tourism as professional business, which give them year around income plus their regular cropping income. India is one of the major tourists' centres in the world and there is large scope and great potential to farmers in developing agro-tourism in country and improve their economic status.

Agro-tourism have potential to boost up the economic condition of agrarian economy. The keeping in view of importance of Agro tourism in Maharashtra state the study was under taken in Ahmednagar district as a case study i.e., Economic Analysis of Krushiraj Agro-tourism as Agribusiness in Maharashtra State: A Case Study. The objective of

study was to estimate cost and returns of study and to study economic viability of the agro tourism in Maharashtra.

METHODOLOGY

Ahmednagar district of Western Maharashtra was purposively selected. A list of active Agro-tourism centres with the names and address of each were taken from the official website of MART (Maharashtra State Agriculture and Rural Tourism Co-Operative Federation Ltd.) Saiban Agro-tourism Centre was selected from Ahmednagar district.

For estimation of the economic viability of the KATC

1. B:C Ratio

Total returns (₹)

B: C ratio = -----

Total costs (₹)

2) Net Present Value (NPV)

n Rt

NPV= $\sum_{t=0}^n \frac{R_t}{(1+i)^t}$ -----

t=0 (1+i) t

Where,

Rt= net cash inflow

i= discount rate

t= Time period in years

3. Payback period

$$P = \frac{I}{E}$$

Where,

P = Payback period in years

I = Investment in rupees

E = Annual net cash revenue in rupees.

4) Break-even point analysis (BEP) of ATCs

i) BEP in physical unit

$$BEP = \frac{F}{P}$$

5) Internal Rate of Return (IRR)

$$IRR = \frac{\text{Lower Discount Rate} + \left(\frac{\text{Difference between NPW at two discount rates}}{\text{Difference between NPW at two discount rates}} \right) \times (\text{Higher Discount Rate} - \text{Lower Discount Rate})}{1}$$

RESULTS AND DISCUSSION

Table 1 Total capital assets of KATC

Particulars	Land	Construction	Irrigation	Implements	Livestock	A) Total	B	C	Total imputed cost (A+B+C)
Value in ₹	38,50,000 (57.83)	7,28,500 (10.95)	2,92,000 (4.39)	14,91,000 (22.40)	2,95,000 (4.43)	66,56,500 (100)	2,80,650	3,85,000	73,22,150

(*Figures in parentheses indicate percentage to the total)

A) Interest on fixed capital @ 10% of value (excluding land value)

B) Rental value of land @ 10% of value

Share of each item in total capital investment was having very difference. Land have maximum 57.83 % share in total fixed asset. followed by construction and irrigation.

Table 2 Total Variable Cost of KATC

Particulars	Total operating cost (T)	Total Employment expenditure (E)	Sub-total (T+E)	Interest on working capital @ (6%)	Total variable cost
Value in ₹	3,73,500	21,00,000	24,73,500	148410	26,21,910

(*Figures in parentheses indicate percentage to the total)

Variable costs vary with the level of Production and extent of use. These costs included variable resources such as, electricity charges, transportation facilities charges, machineries maintenance charges, drinking water, advertisement

ii) BEP at Monetary terms

$$BEP = \frac{F}{1 - V/P}$$

Where,

F = fixed cost of ATC

P = Charges paid by per Visitor

V = Variable cost incurred per visitors.
Total variable cost of ATC

$$V = \frac{\text{Total cost of ATC}}{\text{No. of visitors visited to ATC}}$$

$$P = \frac{\text{Total cost of ATC}}{\text{No. of visitors visited to ATC}}$$

$$IRR = \frac{\text{NPW at lower discount rate} - \text{NPW at higher discount rate}}{\text{Difference between NPW at two discount rates}} \times (\text{Higher Discount Rate} - \text{Lower Discount Rate}) + \text{Lower Discount Rate}$$

Table 3 Income from tourists (2019)

Sr. No.	Particulars	Tourists	KATC
I	No. of tourist arrived in one year (1 day visit) (2019)	Adult	3,390
		Children / students	3,850
	Total Tourist		7,240
	Total Income from Tourist (Rs)	Adult	20,34,000
		Children /students	17,32,500
Total Income day (RS)		37,66,500 (33.74)	
II	No. of tourist stayed at night in one year (2019)	Adult	3,098
		Children / students	2,747
	Total tourists		5,845
	Total Income from Tourist (Night) (Rs)	Adult	46,47,000
		Children / students	27,47,000
Total income night (Rs)		73,94,000 (66.26)	
III	Grand Total of Tourists (Day+ Night Stay)		13,085
IV	Grand Total of Income (Day+ Night Stay)		1,11,60,500 (100)

(Figures in parentheses indicate percentage to the total)

The ultimate objective behind establishing the ATC is to increase or supplementing the income of farmers. ATC owners have main income from Agro-tourism. This has been categorized viz. income from one day visit and income from night stayed

tourists. The total income received from tourist in day visit for the year 2019 was Rs 37,66,500 and its share was 33.74 %. Income from night staying was Rs 73,94,000 and shared 66.26 % to total income from tourism.

Table 4 Total net income of KATC (2019)

Sr. No.	Particulars	Total Income (Rs)
1	ATC	1,11,60,500
2	Crop Production	5,00,000
3	Livestock Production	1,45,000
4	Total	1,18,05,500

Out of total income 94.53 % income was from Agro-tourism. from crop and livestock 5.47 % So, for KATC main source of income was Agro- tourism.

Table 5 Benefit: Cost ratio of KATC

Sr. No.	ATC	Costs (Rs)			Total income	B:C Ratio
		Fixed	Variable	Total		
1	KATC	46,36,500	7,80,160	54,16,660	83,78,600	1.18

As the B:C ratio of KATC was above 1, i.e. 1.18 so the KATC was have good returns from investment and it is economical viable.

Table 6 Pay Back period of KATC

Sr. No.	ATC	Payback period (year)
1	KATC	7.7

KATC took 7.7 years to gain its initial investment from Agro-tourism.

Table 7 Break-even point analysis of KATC

Sr. No.	Particulars	KATC
1	Fixed Cost (FC) (Rs)	73,22,150
2	Variable cost (VC)	26,21,910
3	Total cost (TC)	99,44,060
4	Total income (I)	1,18,05,500
5	VC Incurred /visitor	200.3
6	Per head charge	759.95
7	Total No visitors	13,085
8	i) BEP in physical unit (Tourists)	9,635
9	ii)BEP in monetary value	98,94,797

Break-even point analysis indicated that, the level of production at which no profit or loss to owners. In another way it is the quantity which just meets costs allocated to business known as break-

even point (BEP). BEP in physical unit was 9,635 number of tourists and BEP in monetary value Rs 98,94,797

Table 8 Internal rate of return of KATC

Sr. No.	ATCs	Lower discount rate (%)	Upper discount rate (%)	NPV @ 15%	NPV@ 20%	IRR (%)
1	KATC	15	20	172211.5	-1023035.6	15.72

KATC have good returns of 15.72 % on its initial investment. This proves that KATC was in economical viable entrepreneur.

Summary and conclusions

As selected SATC have following economic parameters like

- Total capital asset Rs 73,22,150
- Income from tourism Rs 1,11,60,500
- Net income of owner Rs 1,18,05,500
- B:C ratio 1.18
- payback period 7.7 years
- BEP -Monetary Rs 98,94,797 and physical- 9,635
- IRR 15.72 %

As all statistical tools show that selected Krushiraj Agro-tourism Centre, have positive values. From this it can be conclude that Agro-tourism is economical viable entrepreneur and have potential capacity to support the agricultural economy of the rural India.

From this case study it was suggested that In consideration of all economic parameters. The farmers having all resources to start ATC should go for it, as it will helps to increase the income and standard of life.

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Harvesting Markets: An Analysis of India's Agricultural Trade

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ABSTRACT

India's agricultural trade has experienced significant transformations, driven by globalization, free trade agreements, and evolving market dynamics. This study provides a comprehensive analysis of India's agricultural trade patterns, highlighting the top commodities exported and imported, key trading partners, and the price dynamics influencing trade. The findings reveal that India maintains a trade surplus in key commodities while relying on imports for others, showcasing its dual role as a global exporter and strategic importer. Analysis of trade deficits and surpluses among partner nations identifies critical markets for enhancing trade relations. Furthermore, the study underscores the impact of price volatility on trade volumes, emphasizing the need for robust policy interventions to stabilize markets and enhance competitiveness. This research contributes to understanding India's agricultural trade landscape, offering insights for policymakers to harness opportunities and address challenges in the global market.

Keywords: Agricultural trade, trade surplus, trade deficit, global markets, commodity exports and imports, price dynamics, free trade agreements, market competitiveness.

INTRODUCTION

India's agricultural sector has undergone a remarkable transformation, evolving from a primarily subsistence-based economy to a major global player in agricultural trade. Historically, agriculture has been the backbone of the Indian economy, providing employment to a significant portion of the population and contributing substantially to GDP. However, the sector faced numerous challenges, including low productivity, inadequate infrastructure, and dependence on monsoons. The turning point came with the economic reforms of 1991-92, when India embraced Liberalization, Privatization, and Globalization (LPG). These policy measures dismantled trade barriers, encouraged private sector investment, and facilitated foreign participation in agriculture, fostering modernisation and improving efficiency across the value chain.

A pivotal milestone in India's agricultural evolution was the Green Revolution of the 1960s, which revolutionized food production through high-yield variety (HYV) seeds, advanced irrigation techniques, mechanization, and chemical fertilizers. This shift led to a dramatic increase in the production of wheat and rice, turning India from a food-deficient nation to a food-secure and surplus-producing country. Over the decades, the benefits of this revolution extended to other crops, improving overall agricultural resilience and productivity.

With increased output and policy-driven

incentives, India's share in global agricultural trade has expanded significantly. Today, India is the world's largest producer of spices, milk, pulses, and jute, while also being among the top producers of rice, wheat, sugarcane, cotton, and horticultural products such as fruits and vegetables. The country is also a leading exporter of basmati rice, non-basmati rice, wheat, sugar, tea, coffee, marine products, and processed food items. Indian spices such as turmeric, black pepper, and cardamom are highly valued in international markets, reinforcing India's dominance in global agribusiness.

Government initiatives like the Agricultural Export Policy (AEP) and the promotion of organic farming, food processing, and digital agriculture have further strengthened India's trade capabilities. Investments in cold storage, logistics, and e-market platforms such as e-NAM (National Agriculture Market) have enhanced market access for farmers, ensuring better price realization and reduced post-harvest losses.

As India moves forward, technological advancements, precision farming, and sustainable agricultural practices are shaping the future of the sector. With a growing emphasis on climate resilience, water conservation, and agro-tech innovations, India continues to solidify its position as a global leader in agriculture. The integration of digital technology and policy-driven support is expected to further enhance productivity, making

Indian agriculture more competitive and globally relevant.

Literature Review

India's agricultural trade has been a focal point of extensive research due to its crucial role in economic growth, global market integration, and food security. Studies indicate that India has maintained a competitive edge in exporting rice, spices, and processed agricultural goods (Balassa, 1965; Kumar et al., 2020), while simultaneously experiencing an increasing import dependency on edible oils and pulses (Joshi *et al.*, 2018). The United States, the United Arab Emirates, and China have emerged as major importers of India's high-value agricultural commodities, particularly frozen shrimp, bovine meat, and basmati rice, whereas Malaysia, Indonesia, and Argentina are key exporters of essential imports such as edible oils and pulses (Chand, 2017; Mishra & Banga, 2019). Research further suggests that price competitiveness plays a vital role in determining India's agricultural trade position, with low production costs in rice and seafood providing a comparative advantage but facing competition from emerging exporters like Vietnam and Brazil (Sarker et al., 2015; Mukherjee & Das, 2021). Trade policies, including Free Trade Agreements (FTAs), tariff structures, and subsidies, have had a significant impact on India's trade flows, fostering exports but also introducing competition in domestic markets (Panagariya, 2004; Ramesh, 2022). While India continues to maintain a trade surplus, persistent challenges such as price volatility, policy uncertainties, and climatic factors necessitate strategic interventions to sustain growth and ensure long-term trade resilience (Jain et al., 2021; Verma & Kaushik, 2023).

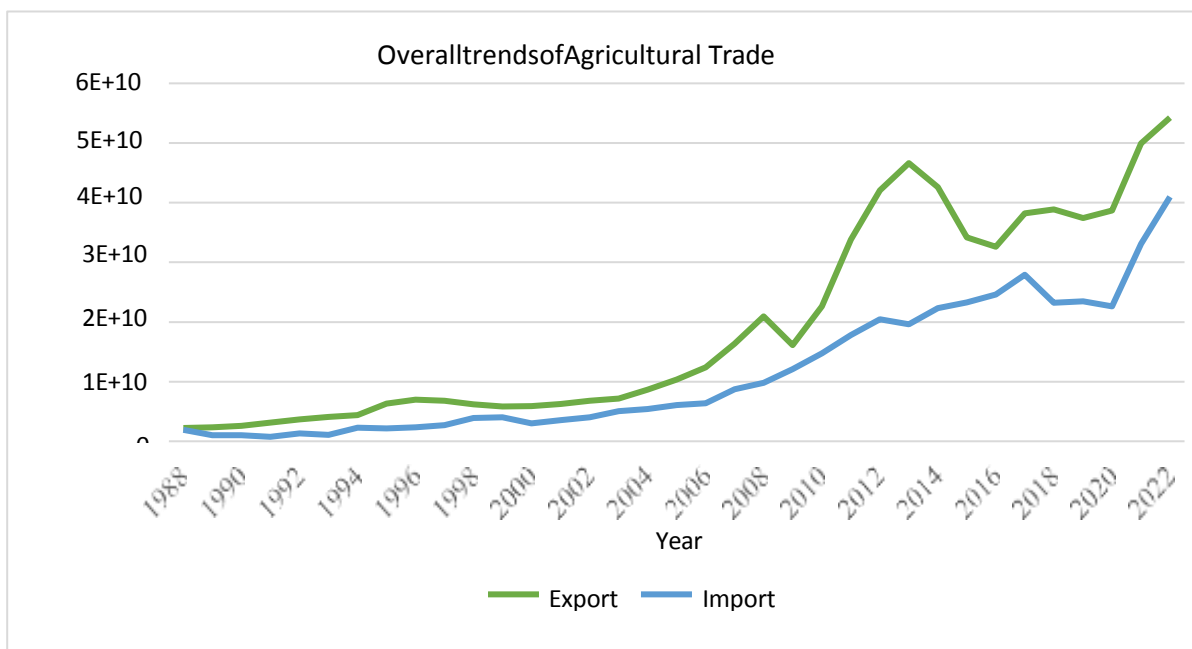
METHODOLOGY

This study adopts a quantitative research approach to examine India's agricultural trade, focusing on trade balance trends, key trading partners, and the composition of agricultural exports and imports. The methodology involves data collection, statistical analysis, and comparative evaluation to provide a comprehensive understanding of India's trade dynamics. The study relies on secondary data obtained from reputable sources, including the Directorate General of Foreign Trade (DGFT), India, which provides detailed records of India's agricultural exports and imports; the Food and

Agriculture Organization (FAO), which offers global trade statistics, production trends, and country-wise trade comparisons; the World Trade Organization (WTO), which supplies information on international trade agreements, tariff structures, and market access policies; the United Nations Comtrade Database, which serves as a comprehensive source of trade data for cross-country analysis; and the Ministry of Commerce & Industry, India, which provides official trade statistics, export-import policies, and market insights. Covering the period from 2000 to 2023, the study systematically collects data from these sources, ensuring accuracy through cross-verification, converting trade values into U.S. dollars for uniformity, and standardizing data for consistency. The analytical approach involves a combination of descriptive statistical methods and trend analysis, including trade balance analysis to assess trends in agricultural trade surplus or deficit, identification of key trading partners based on historical trade balance data, commodity-specific trade analysis focusing on high-value exports and essential imports, price and competitiveness trends using price indices and trade value trends, and an impact assessment of trade policies examining trade agreements, tariff changes, and policy interventions affecting India's agricultural trade.

RESULTS AND DISCUSSION

The study selected a diverse range of commodities to comprehensively evaluate the impact of Free Trade Agreements (FTAs) on agricultural trade. The chosen commodities were categorized under specific HS (Harmonized System) codes and included products from various sectors such as animals (HS 01-05), vegetables (HS 06-15), food products (HS 16-24), and industrial inputs like essential oils and resinoids (HS 3301), casein and derivatives (HS 3501), and albumins (HS 3502). The selection also covered textiles and raw materials, including raw silk, wool, cotton, and their processed forms (HS 5002, 5101, 5201-5203). Additionally, high-value industrial and agricultural products like prepared binders (HS 3823) and peptones (HS 3504) were included, reflecting a broad spectrum of trade-relevant commodities. This diverse selection ensured that the analysis captured the varied implications of FTAs across different segments of agricultural and allied sectors.



Agricultural Trade Patterns of India: The analysis of India's agricultural trade patterns revealed distinct trends in exports and imports, particularly influenced by Free Trade Agreements (FTAs). The overall trends of agricultural trade from 1988 to 2022 demonstrated consistent growth in both exports and imports, with a significant acceleration observed after 2005, the identified FTA breakpoint. The Compound Annual Growth Rate (CAGR) for exports was slightly higher for FTA countries (10.71 per cent) compared to non-FTA countries (10.11 per cent), while imports exhibited a more pronounced growth for FTA

countries (13.15 per cent) relative to non-FTA countries (11.21 per cent).

1.1 Trade Balance Analysis: The analysis indicates that India has maintained a consistent trade surplus in agricultural commodities over the past two decades. However, the magnitude of this surplus has varied due to fluctuations in global demand, domestic production capacities, and trade policies. The data reveal that India's agricultural exports have experienced significant growth, reaching approximately \$5.5 billion in 2023, while imports have also increased, albeit at a slower rate.

Country	Gross Exp.	Gross Imp.	Deficit
Indonesia	1290388	5975756	-4685368
Brazil	147938.7	3275974	-3128035
Argentina	19841.36	2424139	-2404297
Malaysia	1732674	3114770	-1382096
Ukraine	26961.29	1259763	-1232802
Myanmar	276843.8	928022.1	-651178
Australia	439603	1026290	-586687
Afghanistan	103819.1	662561.5	-558742
Russian Federation	837645.7	1367585	-529939
Tanzania	239166	505538.4	-266372

A countrywise examination highlights that the United States, the United Arab Emirates, China, Bangladesh, and Vietnam are India's primary surplus trading partners, with India exporting high-value agricultural commodities to these markets.

Conversely, Malaysia, Indonesia, Argentina, Brazil, and Ukraine represent the largest trade deficit contributors, primarily due to India's dependence on imports of edible oils, pulses, and fertilizers.

Country	Gross Exp.	Gross Imp.	Surplus
United States	5527920	1880637	3647283
United Arab Emirates	3094462	185774.4	2908688
Bangladesh	2980618	208717	2771901
China	3485365	922300.2	2563064
Vietnam	2752380	553903	2198477
Saudi Arabia	2178663	492676.1	1685987
Iraq	1440134	202032.9	1238101
Netherlands	1007426	161411.3	846015.1
Japan	790115.3	48811.06	741304.3
Nepal	999267.1	324131.7	675135.4

1.2 Major Trading Partners: The data indicate that Malaysia and Indonesia collectively account for over 80 per cent of India's crude palm oil imports, a key factor contributing to India's agricultural trade deficit.

Additionally, Argentina, Brazil, and Ukraine significantly contribute to the deficit, primarily due to India's reliance on soybean oil, pulses, and fertilizers sourced from these countries.

Products	Trade Value 1000 USD	% total exports
Semi-milled or wholly milled rice	3306980	12.57
Frozen shrimps and prawns	3286774	12.49
Frozen boneless bovine meat	1278989	4.86
Herbicides, anti-sprouting products	964451.4	3.67
Fruits of genus <i>Capiscum</i> or <i>Pimenta</i>	764142.1	2.90
Castor oil and its fractions	759901.2	2.89
Cotton, not carded or combed	730511.4	2.78
Oil-cake and other solid residues,	724647.7	2.75
Maize (excl. seed)	583320.2	2.22
Raw cane sugar, in solid form	521351.7	1.98

India maintains a consistent trade surplus with the United States, the United Arab Emirates, China, Bangladesh, and Vietnam. This surplus is largely driven by the export of processed food products such as frozen shrimp, bovine meat, basmati rice, spices and tea. These findings suggest that India possesses a competitive advantage in high-value

agricultural exports, facilitating a favourable trade balance with these nations.

1.3 Commodity Analysis: India's agricultural trade is characterized by substantial imports of essential commodities and the export of high-value products. Analyzing key imported and exported commodities provides a comprehensive understanding of India's trade patterns and dependencies.

Products	Trade Value 1000 USD	% total imports
Crude palm oil	5552646	26.91
Crude soya-bean oil	3585619	17.38
Crude sunflower-seed and safflower	2892845	14.02
Palm oil (excl. crude) and liquid f	2021220	9.80
Raw cane sugar, in solid form	1308832	6.34
Dried beans, shelled	598848.4	2.90
Dried lentils, shelled	575854.2	2.79
Dried leguminous vegetables, shelle	440643.9	2.14
Industrial monocarboxylic fatty aci	367308.6	1.78
Natural gums, resins, gum-resins an	182158.2	0.88

Key Imported Commodities: India's primary agricultural imports consist of commodities that are essential for domestic consumption and agricultural productivity but face domestic supply constraints.

- **Crude Palm Oil:** Representing approximately 27 per cent of total agricultural imports, crude palm oil remains India's most significant import, primarily sourced from Malaysia and Indonesia. This dependency exposes India to global price fluctuations.
- **Soybean and Sunflower Oil:** Collectively accounting for nearly 30 per cent of agricultural imports, these edible oils are primarily sourced from Argentina and Ukraine.
- **Pulses:** India is the world's largest importer of pulses, particularly chickpeas, lentils, and peas, which are primarily sourced from Canada, Myanmar, and Australia. These imports play a crucial role in meeting domestic demand.
- **Fertilizers:** India imports substantial quantities of potash, urea, and phosphates to support agricultural productivity, with major suppliers including Russia and China.
- **Fruits and Nuts:** Products such as almonds, apples, and cashews are among the top imported agricultural goods, with significant imports from the United States, Iran, and Afghanistan.

Key Exported Commodities: India is a leading exporter of several high-value agricultural products, significantly contributing to its trade surplus.

- **Milled Rice:** India remains the world's largest exporter of rice, particularly basmati and non-basmati varieties, with key markets in the Middle East and Africa.
- **Frozen Shrimp:** A major export commodity, with strong demand from the United States, China, and the European Union, making it a key contributor to India's trade surplus.
- **Bovine Meat:** India is among the top global exporters of bovine meat, with Southeast Asia and the Middle East serving as primary destinations.
- **Spices:** India dominates global spice exports, particularly black pepper, cardamom, and turmeric, benefiting from its traditional expertise and diverse climatic conditions.
- **Tea and Coffee:** India ranks among the leading global exporters of tea and coffee, with major importers including Russia, the United Kingdom, and Germany.

These findings indicate that while India's agricultural trade remains robust, its dependence on

essential commodity imports, particularly edible oils and fertilizers, presents economic and policy challenges. Enhancing domestic production and implementing strategic trade policies can play a crucial role in ensuring sustainable agricultural trade growth.

1.4 Price and Competitiveness Trends

An analysis of price trends suggests that India's competitive advantage in commodities such as rice, shrimp, spices, and tea is driven by lower production costs and sustained global demand. However, India's reliance on imported edible oils, particularly from Malaysia and Indonesia, renders it vulnerable to price volatility. Additionally, fluctuations in international fertilizer prices have a direct impact on India's agricultural input costs. The results indicate that trade balance trends are highly influenced by global market dynamics, particularly for key imported commodities such as crude palm oil, pulses, and fertilizers. Addressing these vulnerabilities through trade diversification and domestic production expansion remains a critical policy priority for sustaining India's agricultural trade balance.

1.5 Policy Implications

The results underscore several key policy considerations for India's agricultural trade:

- **Edible Oil Dependency:** Given the heavy reliance on imported edible oils, policies should focus on boosting domestic oilseed production to reduce external dependence.
- **Impact of Free Trade Agreements (FTAs):** FTAs have contributed to both increased export opportunities and heightened import competition. Future agreements should prioritize protecting domestic agricultural industries.
- **Export Promotion Strategies:** Strengthening policies to enhance the competitiveness of rice, shrimp, spices, tea, and processed food exports can further bolster India's trade surplus.
- **Market Diversification:** Reducing reliance on a limited number of trading partners by expanding into new export markets can improve trade resilience.
- **Agricultural Infrastructure Development:** Investments in cold storage, transportation, and processing facilities can enhance trade efficiency and minimize post-harvest losses.

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Retail Marketing of Selected Cashew Processed Products in Ratnagiri District

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ABSTRACT

The present study was conducted in Ratnagiri district of Konkan region purposively. Six tahsils viz., Ratnagiri, Chiplun, Khed, Dapoli, Sangmeshwar and Guhagar were selected randomly from Ratnagiri district. 5 supermarkets, 10 retailers and 100 consumer samples were selected randomly from each market area of selected tahsils. Thus, total sample size was 190 respondents. The data for present study pertained to the year 2023. Standard cost concept was used to study the cost of marketing. The results showed that, total gross margin received by retailer in a year by selling cashew processed products was Rs.68,490. The total gross margin received by supermarket owner in a year by selling cashew processed products was Rs.99,492. The major constraints faced by retailers and supermarket owner was season wise demand fluctuations, changing consumer preference, inadequate supply chain, limited consumer.

Keywords: Cashew, cost concept, price spread, gross margin, constraints.

INTRODUCTION

One of the greatest economic sectors in the world, retail (food and grocery retail business), is going through a transition phase in India. From 2022 to 2030, it is anticipated to expand at a Compound Annual Growth Rate (CAGR) of 3 per cent. India produces roughly 12 per cent of the world's fresh fruit in 2021, ranking behind China as the second-largest producer in the world (Source: FAO). The food processing sector in India is mostly focused on exports. One of the most valuable processed nuts sold on the world's commodity markets is the cashew (*Anacardium occidentale L.*), which is also a significant cash crop. Cashew is grown on 9,23,000 hectares of land in India, producing 613,000 MT and yielding 0.7 MT/ha (Indian Horticulture Database, 2010) with a 32.3 per cent market share. Given that it employs more over 10 lakh people on farms and factories in rural regions, the cashew sector is quite significant economically. Maharashtra stands first in annual cashew nut production during 2021-22 at 0.20 million tonnes (MT), growing from 0.19 million tonnes cashew nut produced in 2020-21 according to data released by the National Horticulture Board

(NHB). In addition to its extensive cashew output, India is renowned for developing cashew processing techniques and exporting cashew kernels around the world. Previously centred in Kollam (Kerala), Mangalore (Karnataka), Goa, and Vettapalam (Andhra Pradesh), the cashew processing sector is now found in several Indian states. India has become the world's centre for cashew processing throughout the years. The Indian cashew processing industry began as small-scale, family-run workshops and over time transformed into a highly organized, labor-intensive sector. The cashew processing business has developed into a highly profitable sector as a result of the consistent rise in global demand for cashew nuts. Generally speaking, rural and underdeveloped areas are where the cashew nut processing enterprises are found. With more than 15 per cent of global exports, India is the top exporter of cashews. The expansion of India's exports of cashews to more than 60 nations across various continents is mostly due to the importation of raw cashew nuts. UAE, Japan, Netherlands, Saudi Arabia, USA, UK, Canada, France, Israel, and Italy are India's top export markets. India mostly exports cashew nuts and very little juice from the shells of cashew nuts. The value

of cashew exports increased by 7 per cent between 2021 and 2022, from US\$ 420 million in 2020–21 to US\$ 453.1 million in 2021–22. The value of cashew exports between April 2022 and January 2023 was US\$ 290.94 million. India saw a 9 per cent growth in its cashew export volume from 70.5 million kg in 2020–21 to 76.8 million kg in 2021–22. The nation exported cashews worth \$41.8 million in January 2023, up from \$36.47 million in December 2022. Since the agricultural sector makes up a large portion of the Indian economy, all connected industries, such as the food processing business, support job creation while also boosting the national economy. According to the Food Processing Minister for 2020–21, India's GDP is 12.8% derived from the food processing sector. Understanding consumer interests, preferences, brand loyalty and constraints faced by shopkeeper in marketing with regard to cashew processed products is crucial because they determine the future of the market for cashew processed products. Therefore, the present study entitled, "Retail Marketing of Selected Cashew Processed Products in Ratnagiri District" was undertaken.

METHODOLOGY

As Ratnagiri district is one of the major cashew and mango producing region, a multitude of processed fruit products are manufactured. Hence the Ratnagiri district of Konkan region is selected purposively.

The six tahsils namely Ratnagiri, Chiplun, Khed, Dapoli, Sangmeshwar and Guhagar were selected from Ratnagiri district. The sample for the present study is 190 respondents. The 5 supermarket and 10 retailers in from each market area of tahsils selected randomly and from market area 100 consumer samples were selected randomly thus final sample size is 190. The data were collected by survey method from the selected retailers and supermarkets, the respondents were interviewed personally with the help of comprehensive pretested schedule designed for purpose. The collected data were analyzed for arriving at useful conclusion by tabular method. Simple and arithmetical tools such as averages, frequency distribution and percentage were used. The data analyzed for each group separately. The results of the analysis are presented in simple tabular form following analytical techniques were used.

Cost concept used in analysis:

Standard cost concept used in study viz., cost of marketing.

i) Cost of marketing: Cost of marketing included cost incurred by retailers and supermarket owner on processed products of mango and cashew trading.

ii) Price spread: Price spread included difference between cost incurred and profit by the producer (here retailers and super market owner)

Price spread = Price paid by consumer – (price paid by retailer + Cost and margin Incurred by agencies involved)

RESULT AND DISCUSSION

Per year intermediary wise per annum average quantity of cashew nut product trade by retailers and supermarket

The per annum average quantity of cashew nut processed products sold by retailers and supermarket owner in the study area are presented in the Table 1.

It is depicted from the Table 1 that, only the plain roasted cashew nut and cashew *barfi* sold by both retailers and supermarket owner. However, other product like salted cashew nuts, *masala* cashew nut, barbeque flavour cashew nuts and *Kaju sarbat* (cashew juice) were marketed by retailer owner. It was also observed that average 221.60 kg of plain roasted cashew nut was sold by retailers in a year as against it was 454.64 kg quantity per year sold by supermarket owner, similarly the quantity of cashew *barfi* sold by supermarket owner (56.47 kg/year) was higher than the retailer (42.89 kg/year).

In case of other processed cashew product, 98.51 kg/year, 60.34 kg/year, 14.72 kg/year and 34.42 kg/year quantity of salted cashew nut, *masala* cashew nut, barbeque flavour cashew nut and *Kaju sarbat* sold by retailers in a year respectively.

Table 1 Per year average quantity of cashew nut processed product sold by retailers and supermarket

Sr. No	Particulars	Average quantity sold/ year (Kg)	
		Retailers	Supermarkets
1	Plain roasted cashew nuts	221.6	454.64
2	Salted cashew nuts	98.51	-
3	<i>Masala</i> cashew nuts	60.34	-
4	Barbeque flavour nuts	14.72	-
5	Cashew <i>barfi</i>	42.89	56.47
6	<i>Kaju sarbat</i>	34.42	-

Price spread of various cashew processed products and gross margin received by retailers

The product and unit wise price spread of cashew processed product marketed by retailers is analyzed and presented in Table 2.

Table 2 provides a detailed breakdown of the price spread for various cashew processed products and total margin received during the year at retailer's level. In the context of plain roasted cashew nuts, retailers purchased 1 kg and 500 gm packages at a cost of Rs. 650.34 and Rs.322 from producer and marketing cost incurred by the retailer for respective packages were Rs.0.33 and Rs.0.42. However, the total unit sale of plain roasted cashew nut was found to be 77 packets and 72 packets of 1 kg and 500 gm unit and thus, from the both products total gross income gained by retailer was Rs. 17,266 which accounted to 25.06 per cent of total margin received by retailer in a year from sale of cashew processed products.

Whereas, for salted cashew nut, retailers purchased 1 kg, 500 gm, 100 gm and 50 gm packet at a cost of Rs.800, Rs.420, Rs.90 and Rs.50 from producer and marketing cost incurred by the retailer for respective packages were Rs.0.39, Rs.0.41, Rs.37 and Rs.0.33. Thus, for the all four packets total gross margin was estimated Rs. 17,072 which accounted to 24.92 per cent of total margin received by retailers in a year from sale of cashew processed products.

In case of *masala* flavour cashew nuts, retailers purchased 1 kg, 200 gm, 100 gm, 50 gm packages at

a cost of Rs.801, Rs.180, Rs.90 and Rs.30 from producer and marketing cost incurred by the retailer for respective packages were Rs.0.43, Rs.0.41, Rs.0.33 and Rs.0.42. The net margin received by the retailers for respective package was accounted to Rs.203.57, Rs.24.59, Rs.19.67 and Rs.24.58. However, total gross margin received from the sale of *masala* flavour cashew nuts was Rs. 17,015 which accounted to 24.84 per cent of total margin received by retailer in a year from sale of cashew processed products.

Whereas, in barbeque flavour cashew nuts, retailers purchased 1 kg, 100 grams, 50 grams of packages at cost of Rs.806, Rs.90 and Rs.40 from producer and marketing cost incurred by the retailer for respective packages were Rs.0.66, Rs.0.33 and Rs.0.42. It was also observed from table that, the total unit of barbeque flavour cashew nuts sold by retailers in a year was worked out to 1,400 and 237 packets of 1 kg, 50 gm and 100 gm unit respectively. Thus, total gross margin from all three size packets sale was Rs. 8299 which was 12.11 per cent of total margin received by retailer in a year from sale of cashew processed products.

While in case of cashew *barfi* and *kaju sarbat* (cashew juice) only 200 gm and 500 ml package size were available in retailers shop in which price paid by retailers to producer for purchase of same were Rs.131 and Rs.79 per packets. The marketing cost incurred by retailer was observed to be Rs.0.47 and Rs.0.73 for per unit of respective packet. Therefore, per unit net margin received by the retailers was accounted to Rs.40.53 and Rs.21.27. Consequently,

the total unit sale of cashew *barfi* and *kaju sarbat* / cashew juice was found to be 214 packets and 18 packets of 200 grams and 500 ml unit respectively. Thus, for the same total gross margin was estimated

to Rs.8560 and Rs.382 respectively which was 12.5 and 0.57 per cent of total margin received by retailer in a year from sale of cashew processed products.

Table 2. Unit wise price spread of various cashew processed products and gross margin received by retailers

Sr. No.	Cashew processed Products	Quantity in kg	price paid by retailers to producer (per unit) (Rs.)	Marketing cost (Per unit) (Rs.)	Price Paid by Consumers to retailers (Rs.)	Net Margin received by retailers (Per unit) (Rs.)	Total unit sale in a year (No.)	Gross margin in year received by retailer (Rs.)	Percentage (%)
1	Plain roasted cashew nuts	1	650.34	0.33	801	150.33	77	11,550	-
		0.5	322	0.42	400	77.58	72	5,616	-
Total								17,166	25.06
2	Salted cashew nuts	1	800	0.39	1000	199.61	2	398	-
		0.5	420	0.41	510	89.59	6	534	-
		0.1	90	0.37	110	19.9	420	8,400	-
		0.05	50	0.33	55	9.45	860	7740	-
Total								17,072	24.92
3	Masala flavour Cashew nuts	1	801	0.43	1004	203.57	1	203	-
		0.2	180	0.41	205	24.59	37	888	-
		0.1	90	0.33	110	19.67	333	6,660	-
		0.05	30	0.32	55	24.38	386	9,264	-
Total								17,015	24.84
4	Barbeque flavour cashew nuts	1	806	0.66	1003	196.34	1	196	-
		0.1	90	0.42	110	19.58	237	4,503	-
		0.05	40	0.33	55	9.67	400	3,600	-
Total								8,299	12.11
5	Cashew Barfi	0.2	131	0.47	172	40.53	214	8,560	12.5
6	Kaju sarbat /cashew juice	0.5	79	0.73	101	21.27	18	382	0.57
Total								68,490	100

It is concluded from the Table 2 that out of total cashew processed products plain roasted cashew nut had highest (25.06 %) gross income in total gross income received by the retailer per year which is followed by salted cashew nuts (24.92%), masala flavor cashew nuts (12.11%), barbeque flavour cashew nut (12.11%) and cashew *barfi* (12.5%). However, cashew *sarbat* had less than 1 per cent share in total income indicates the demand for cashew *sarbat* was very negligible in the study area.

Price spread of various cashew processed products and gross margin received supermarket owner

The product and unit wise price spread of cashew processed product marketed by supermarket owner is analyzed and presented in Table 3.

Table 3. Unit wise price spread of cashew processed products for supermarket owner

Sr. No	Particulars	Qty in kg	Cost paid by supermarket owner (per unit)(Rs.)	Marketing cost (per unit) (Rs.)	Price Paid by Consumer (Rs.) (per unit)	Net Margin received by supermarket owner (Rs.)	Total unit sale in year	Gross margin in year
1	Plain roasted cashew nuts	1	610	1.66	798	186.34	454	84,444 (84.88)
2	Cashew <i>barfi</i>	0.25	191	1.09	259	66.1	228	15,048 (15.12)
Total							682	99,492 (100)

(Figures in parentheses indicates percentage total)

It is seen from the Table 3 that only two products were available at supermarkets with 1 kg and 250 gm size of packets that were plain roasted cashew nut and cashew *barfi*. The per unit cost paid by supermarket owner to producer for purchase of respective products was Rs.610 and Rs.191 and then marketing cost incurred by them for each packet was Rs.1.66 and Rs.1.09. Consequently, the price paid by consumers to purchase these products was Rs.798 and Rs.259 and the net margin received by retailer for 1 kg and 250 grams packet of plain roasted cashew nut and cashew *barfi* was accounted to Rs.186.34 and Rs.66.1. The total unit sale of plain roasted cashew nut and cashew *barfi* was found to be 454 and 228 packets of 1 kg and 250 gm unit respectively. Thus, gross margin received by supermarket owner was Rs.84,444 and Rs.15,048 which accounted to 84.88 per cent and 15.12 per cent

of total margin received by supermarket owner in a year from sale of cashew processed products.

Constraints in marketing of processed products of cashew

Constraints in various aspects of life, including business and retail, are inherent challenges that can impede smooth operations and necessitate strategic solutions. In the realm of retail, particularly in the sale of processed products, several constraints can pose hurdles for businesses. These constraints encompass a spectrum of challenges, from supply chain intricacies to evolving consumer dynamics.

The major constraints faced by the market intermediaries for market of processed products of cashew were analyzed and presented in the Table 4

Table 4. Constraints faced by the retailer and supermarket owner for sale of processed products

Sr. No.	Constraints	Frequency (N=90)	Percentage
1	Season wise demand fluctuations	88	97.77
2	Changing consumer preference	86	95.55
3	Inadequate supply chain	72	80
4	Limited consumer awareness	57	63.33

There were four major constraints identified that are as follow

1. Season wise demand fluctuations:

Demand for these processed products may also fluctuate seasonally. Balancing to meet varying demand may be challenging sometime. About 97.77 per cent of the retailers and supermarket owner were found to have this constraint.

2. Changing consumer preference:

Staying abreast of changing consumer preference and dietary trends is essential to meet evolving demands. Out of total supermarket owner and retailers in the study area 86 per cent were found this as a constraint

3. Inadequate supply chain:

Out of total retailers and supermarket owner in the study area 80 per cent of the retailers and supermarket owner found challenging to depend on suppliers for consistent product supply as delays or issue from supplier can disrupt operation. The irregular supply chain can affect marketing efforts by creating uncertainties in product availability and quality, leading to potential dissatisfaction among customers seeking these specific processed items.

4. Limited Consumer awareness:

Consumer awareness of the products may be limited, as consumer may not be familiar with new processed products especially if

the consumers were tourist one. Creating awareness about new processed product may require significant marketing efforts. About 63.33 per cent of retailers and supermarket owner faced this constraint in study area.

Suggestions of retailers and supermarket owner for marketing of processed products.

The suggestion of retailers and supermarket owner for marketing of processed products are given in table 5.

The following major suggestion were given by the retailers and supermarket owners

1. Producer should consider consumer perception:

Understand consumer preferences, expectations, and values through market research. This insight helps in designing products that align with consumer needs. About 97.77 per cent of retailers and supermarket owner thought that this could be helpful for them.

2. Producer should study market trends:

Regularly analyze market trends, changing consumer behaviors. Stay informed about competitors and market dynamics to adapt strategies. 93.33 Per cent of retailers and supermarket owner found this helpful for overcome the constraints.

Table 5 Suggestions for retailers and supermarkets owner for constraints in marketing of processed fruit products

Sr. No	Suggestion	Frequency	Percentage (%)
1	Producer should consider consumer perception	88	97.77
2	Producer should study market trends	84	93.33
3	Planning for maintaining supply chain	71	78.88
4	Advertisement for consumer awareness	67	74.44

3. Planning for Maintaining Supply Chain:

Efficiently managing inventory levels is crucial. This involved forecasting demand, optimizing reorder points, and employing just-in-time strategies to minimize excess inventory also, cultivating strong relationships with suppliers helps ensure a reliable supply of raw materials. Regular communication and collaboration can lead to better pricing, flexibility, and responsiveness. About 78.88 per cent of retailers

and supermarket owner found this suggestion for the constraint of inadequate supply chain.

4. Advertisement for Consumer Awareness:

Social media, search engine optimization, and email marketing are effective tools for reaching and engaging consumers. Also retailers and supermarket owner should communicate openly about product features, sourcing, and production processes.

Consumers appreciate transparency, and it builds trust as thought by 74.44 per cent retailers and supermarket owner

CONCLUSIONS

The results showed that total gross margin received by retailer in a year by selling cashew processed products was Rs.68,490. The total gross margin received by supermarket owner in a year by selling cashew processed products was Rs.99,492. The taste is most significant factor for purchase of products followed by price, availability, income level in cashew processed products. Nearly all consumers in sample respondents of consumer consider quality as the foremost important factor while purchasing for specific brand. The major constraints faced by retailers and supermarket owner was season wise demand fluctuations, changing consumer preference, inadequate supply chain, limited consumer.

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Acreage Response of Soybean Crop in Buldhana district of Maharashtra

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ABSTRACTS

The present study was undertaken to know growth rate and instability of area, production and productivity, and effect of price and non-price factor on acreage response of soybean crop. The results revealed that, the compound growth rate for area, production and yield in soybean crop was positive. Area and production was statistically significant in Buldhana district during the entire period under study, the highest instability index for area and production was observed for soybean among selected crops.

The lagged area of soybean significantly attributed to the deciding factors for the acreage under soybean crop in Buldhana district. The lagged prices of green gram significantly attributed to the deciding factors for the acreage under soybean crop in Buldhana district. Among all selected crop soybean had most stable crop in case of area and also stable in production and productivity compare to other selected crops. On the other hand there was higher magnitudes of instability were observed among the selected crops.

The study was concluded that the effect of area expansion was found to be a contributing element in boosting the production of soybean and to intensify the efforts in stabilizing productivity of soybean crop in the Buldhana district, introduction of high yielding and pest resistant varieties for soybean crop performing better on larger area in the district.

Keywords : Acreage Response, Seasonal Indices & Variability

INTRODUCTION

Soybean (*Glycine max.*) is an important oilseed crop in India. *Glycine* is derived from Greek word “*glykus*” and probably refers as “sweet tuber”. Soybean is originated from China. It also known as “Golden bean” and “Miracle crop” due to its several uses. It is a self-pollinated crop belong to family leguminaceae. Subfamily papilionadieae having chromosome number $2n=40$. It is grown in India as a dual-purpose crops i.e oilseed and pulse crop. It is a good source of proteins as well as amino acids which is important for good health. They are two stem growth habit and floral initiation in soybean. These are determinant and in determinant type. Soybean consists of tap root system. It consists of primary and trifoliolate leaves. Soybean has a typical papilionaceous flower. Soybean is moderately salt tolerant crop, the reported salinity threshold is 5 dSm^{-1} .

Soybeans play a vital role in crop rotation and soil health management in agricultural systems. It plays important role in following aspects such as nitrogen fixation, nitrogen contribution, crop

rotation, enhanced soil organic matter, improved soil health, improved soil health, weed management, diverse rotations, sustainability, resilience. In summary, soybeans are valuable in crop rotation systems due to their ability to fix nitrogen, improve soil health, and contribute to sustainable and environmentally friendly agricultural practices. Their inclusion in crop rotations can lead to improved soil fertility, reduced pest and disease pressures, and more resilient and economically viable farming systems. In view, of the objectives of the study are to examine the effect of price and non-price factors on acreage response of soybean crop, to estimate growth rates of area, production and productivity of soybean crop.

METHODOLOGY

The present study was based on the secondary data for the period of 2001-02 to 2020-21. The soybean crop was selected on the basis of maximum average area under crops during last twenty years in Buldhana district. The period of data is divided into three period Period I (2001-02) , Period II (2011-12 to 2020-21) and Period I (2001-

02 to 2020-21). Twenty years data were collected from various government published sources. Simple statistical tools like sums, averages and percentages were employed to estimate the acreage under crops.

i) Compound Annual Growth Rate

The compound growth rate of area, production and yield of crops was estimated for last twenty years were estimated by using following exponential model.

$$Y=ab^t e$$

$$CAGR=[\text{Antilog}(b-1)] \times 100$$

Where,

CAGR = Compound annual compound growth rate

t=time period in year

Y=Area/ production/yield of crops in the district

a&b=Regression parameters

ii. Instability Analysis

The coefficient of variation (CV) was calculated by using the formula,

$$C.V.= \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

Even though Coefficient of Variation (C.V) is the simplest measure of instability, it over-estimates the level of instability in timeseries data which are characterized by long-term trends. The Cuddy Della Valle Index de-trends the annual price and shows the exact direction of the instability (Cuddy and Della Valle, 1978). Hence, it is a better measure to capture instability in area, production and productivity agricultural crops. A low value of this index indicates low instability and vice-versa. The Cuddy-DellaValle index corrects the CV as,

Cuddy– DellaInstability Index (%)

$$= C.V.X\sqrt{(1 - R)^2}$$

Where,

C.V is the Coefficient of Variation in per cent ,and R is the coefficient of determination from a time trend regression adjusted for its degrees of freedom.

Estimation of Nerlovian Adjustment Model

The following modified version of Nerlovian adjustment model was used in its simplest form for

the purpose of the study.

$$A_t = a + b_1 P_{t-1} + b_2 A_{t-1} + b_3 Y_{t-1} + b_4 R_t + b_5 A_{c1t} + b_6 A_{c2t} + b_7 P_{c1t-1} + b_8 P_{c2t-1} + b_9 Y_{c1t-1} + b_{10} Y_{c2t-1} + u_t$$

Where,

A_t =Acreage of selected crop in '00' hectares during the current year

P_{t-1} =Price(Rs./ha)of selected crop during the preceding year

A_{t-1} =Acreage of selected crop in hectares during the preceding year

Y_{t-1} =Productivity(Kg/ha)of selected crop during the preceding year

R_t =Rain fall during crop season(mm)

A_{c1t} =Area under first competing crop during the current year

A_{c2t} =Area under second competing crop during the current year

P_{c1t-1} =Price of first competing crop during the preceding year

P_{c2t-1} =Price of second competing crop during the preceding year

Y_{c1t-1} =Productivity of first competing crop during the preceding year

Y_{c2t-1} =Productivity of second competing crop during the preceding year

U_t =Error term

Afgd a Intercept term

=

b_i's =Regression co-efficient

The rule applied to visualize the magnitude of multicollinarity was the correlation coefficient between a pair of independent variables. The multicollinarity was considered 'high' if it is greater than 0.80 (Heady, E. O. and Dillon, 1961). The data was tested for the presence of autocorrelation in the model by using Durbin-Watson statistic. The level of significance of regression was tested by applying 'f' test.

RESULTS AND DISCUSSION

I. Compound Annual Growth Rates of Area, production and productivity of major crops in Buldhana district

Table.1 Compound growth rates of area, production and productivity of selected crops in Buldhana district

Sr. No.	Study Period	Particulars	Soybean	Sorghum	Green gram
1	Period I (2001-02 to 2010-11)	Area	15.25***	11.59***	-8.34***
2		Production	10.45	-10.78***	-10.44
3		Productivity	-4.17	3.81	-2.29
4	Period II (2011-12 to 2020-21)	Area	4.98***	-15.67***	-10.27**
5		Production	6.76	-24.30***	-9.63
6		Productivity	1.7	-10.23	0.71
7	Entire Period (2001-02 to 2020-21)	Area	9.34***	-12.16***	-10.54***
8		Production	9.96***	-16.28***	-8.09***
9		Productivity	0.58	-4.69***	2.32

(Note-*,** and ***Significantat10,5 and 1percentlevel,respectively)

It was observed from the Table. 1, in Period I (2001-02 to 2010-11) the area under soybean crop was increased positive and significantly by 15.25 per cent at 1 per cent level significance. The production was positive at 10.45 per cent, but the productivity was declined by -4.17 per cent.

In Period II (2011-12 to 2020-21) the area expansion under soybean crop was increased positive and significantly by 4.98 per cent at 1 per cent level significance, the production and productivity were non significant but positive at 6.76 and 1.7 per cent, respectively.

During the Entire Period (2001-02 to 2020-21) the CAGR in respect of soybean, the area expansion was significant and positive at 9.34 per cent at 1 per cent significance level. The production expansion was also positive and significant at 9.96 per cent at 1 per cent level of significance. The productivity was increased by 0.58 per cent.

In Period I (2001-02 to 2010-11) the area under sorghum crop was increased positive and significantly by 15.25 per cent at 1 per cent level significance. The production was significant but negative at -10.78 per cent, at 1 per cent significance. The productivity of sorghum was increased positively by 3.81 per cent.

In Period II (2011-12 to 2020-21) the area, production and productivity of sorghum was negatively significant during the study period. During the Entire Period (2001-02 to 2020-21) the area, production and productivity of sorghum crop was negatively significant. The area expansion of sorghum crop was increasing but does not affect on productivity due to unavailability of resources use in production.

It was observed from the table that, in Period

I (2001-02 to 2010-11) the area under green gram crop was significant but negative by -8.34 per cent at 1 per cent level significance. The production was negative at -10.44 per cent and the productivity was also declined by -2.29 per cent.

In Period II (2011-12 to 2020-21) the area expansion under green gram crop was significant but negative by -10.27 per cent at 5 per cent level significance, the production was recorded negative at -9.63 per cent and the productivity was increased at 0.71 per cent.

In the Entire Period (2001-02 to 2020-21) the Compound Annual Growth Rate (CAGR) in respect of green gram, the area expansion was significant but negative at -10.54 per cent at 1 per cent significance level. The production expansion was also significant but negative at -8.09 per cent at 1 per cent level of significance. The productivity was increased by 2.32 per cent.

All the decline in area production and productivity of selected field crop in the study area like soybean, sorghum and green gram may primarily be caused by climatic condition, traditional farming, inappropriate fertilizer use, either excess or absolutely no use of plant protection measures. While in case of sugarcane availability of irrigation source, weather condition may have their impact but the other fact associate with decline in area, production and productivity might be mono cropping unhealthy soil conditions, excess application of irrigation as well as fertilizers.

It could be concluded from the discussion that significant variation in area, production and productivity among the selected crops in Buldhana district with drastic increases and decline

during the period under study. Thus the hypothesis stated that the null hypothesis was rejected and alternate hypothesis stated as "The growth of area production and productivity of crops was varying has been proved and accepted."

II. Instability in area, production and productivity of major crops in Buldhana district

Table.2 Instability in area, production and productivity of selected crops in Buldhana District during different period (Cuddy-Della Value Index %)

Sr. No.	Study Period	Particulars	Soybean	Sorghum	Green gram
1	Period I (2001-02 to 2010-11)	Area	12.82	7.82	14.85
2		Production	59.42	13.11	50.05
3		Productivity	46.46	18.65	46.21
4	Period II (2011-12 to 2020-21)	Area	4.88	19.59	42.61
5		Production	36.9	45.36	61.60
6		Productivity	36.76	29.46	30.12
7	Entire Period (2001-02 to 2020-21)	Area	14.13	15.25	25.00
8		Production	42.14	35.69	56.59
9		Productivity	41.17	30.54	37.26

During the Entire Period (2001-02 to 2020-21) for soybean crop the instability in area, production and productivity was recorded to the tune of 14.13, 42.14 and 41.17 per cent respectively. This indicated that the instability in area, production and productivity of soybean in the Period II was lower than the Period I due to area of soybean crop shifted to other crops during study period

In the Period I (2001-02 to 2010-11) for sorghum crop the instability in area, production and productivity was recorded to the tune of 7.82, 13.11 and 18.65 per cent, respectively. In the Period II (2011-12 to 2020-21) for sorghum crop the instability in area, production and productivity was recorded to the tune of 19.59, 45.36 and 29.46 per cent, respectively. In the Entire Period (2001-02 to 2020-21) for sorghum crop the instability in area, production and productivity was recorded to the tune of 15.25, 35.69 and 30.54 per cent, respectively. This indicated that the instability in area, production and productivity of sorghum in the Period I was lower than the Period II to the tune 7.82, 13.11 and 18.65 per cent, respectively.

It was observed from the Table.2, in the Period I (2001-02 to 2010-11) for soybean crop the instability in area, production and productivity was recorded to the tune of 12.82, 59.42 and 46.46 per cent, respectively. In the Period II (2011-12 to 2020-21) for soybean crop the instability in area, production and productivity was recorded to the tune of 4.88, 36.9 and 36.76 per cent, respectively.

In the Period I (2001-02 to 2010-11) in case of green gram crop the instability in area, production and productivity was recorded to the tune of 14.85, 50.05 and 46.21 per cent, respectively. In the Period II (2011-12 to 2020-21) for green gram crop the instability in area, production and productivity was recorded to the tune of 42.61, 61.60 and 30.12 per cent, respectively. In the Entire Period (2001-02 to 2020-21) for green gram crop the instability in area, production and productivity was recorded to the tune of 25.00, 56.59 and 37.26 per cent, respectively. This indicated that the instability in area and production of green gram in the Period I was lower than the Period II due to increase area of green gram crop.

III. Selection of Competitive Crops for Selected Major Crops in Buldhana District

On the basis of correlation matrix results, two competitive crops for soybean were selected crop viz., sorghum and green gram presented in Table 3. In view, for sorghum and green gram were the 1st and 2nd competitive crops, respectively.

Table.3 Competing crop included in acreage response function

Sr.No.	Selected Major Crops	1 st Competitive Crop	2 nd Competitive Crop
1	Soybean	Sorghum	Green gram

The current chapter examines the acreage response of soybean in Buldhana district over a 20-year period from 2001-02 to 2020-21 and two sub-periods, namely Period I 2001-02 to 2010-11 and Period II 2011-12 to 2020-21. The Nerlovian Adjustment Model was used in this study.

IV. Acreage Response Function for soybean in Buldhana District

The variation in the acreages of soybean can be attributed to a large number of factors *viz*: social, economical, political, technological and natural as well. Therefore, it became imperative to empirically find out the influence of the individual factors on crop acreages, so that appropriate policy measures could be suggested to overcome the problem of wide fluctuation in acreages under soybean in the Buldhana district.

Recognizing the need of such analysis, an attempt has made to analyze the acreage response of soybean in Buldhana district of Maharashtra with the help of multivariate analysis of time series data. This type of analysis enables us to study empirically the factors influencing acreage under soybean crop. The analysis of acreage response of soybean to price and non-price variables had been attempted for the period of 20 years i.e. from 2001-02 to 2020-21. For this analysis, the modified version of Nerlovian lag model was used. The results obtained from the estimated acreage response model in respect of soybean have been discussed for Buldhana district.

The current acreage of soybean as a dependent variable was regressed on the factors which hypothesized to influence, the area under soybean in Buldhana district. In all the variables were identified which were supposed to influence the area under soybean. Finally, using the usual criteria of consistency in signs and statistical significance of regression coefficients, the variables with wrong signs and non-significant levels were dropped and the equations were re-run to estimate the acreage response models.

Table 4. shows the results of the estimated

linear acreage response function for soybean crop in Buldhana district for entire period (2001-02 to 2020-20). An attempt has been made to study the *soybean* growers responsiveness to price and non-price variables in Buldhana district during period 2001-02 to 2020-21. The function was estimated in the framework of linear multiple regression for entire periods with a set of 9 independent variables. The results of the estimated acreage response functions for the entire time period (2001-02 to 2020-21) are presented in table 4.16. In addition to the coefficients, their standard errors, R^2 and F value are also given in the table.

The explanatory variables included in this model were lagged price of soybean (P_{t-1}), lagged productivity of soybean (Y_{t-1}), lagged area under soybean (A_{t-1}), pre-sowing rainfall (PSR), current area under first competing crop-sorghum (A_{c1t}), lagged price of sorghum (P_{c1t-1}), lagged price of second competing crop-green gram (P_{c2t-1}), lagged productivity of sorghum (Y_{c1t-1}) and lagged productivity of green gram (Y_{c2t-1}).

The value of R^2 obtained for this function was 0.9933 in the entire period i.e. 2001-02 to 2020-21, indicating that the function has very high explanatory power with the inclusion of the mentioned independent variables.

The area under soybean crop in preceding year has shown a negative relationship with of soybean crop in hectares during the preceding year, productivity (kg/ha) of soybean crop during the preceding year, rainfall during the crop season (mm), area under first competing crop i.e. sorghum, area under second competing crop i.e. green gram, price of first competing crop during the preceding year i.e. sorghum. The rainfall was negatively significant at 10 per cent. The regression coefficients of competing crops are negative might be due to higher values of standard errors because of large variability in the data or by other reasons. This indicate that the farmer's acreage allocation decision are not much more determined by the lagged acreage of the crop.

Table. 4 Results of estimated acreage response function for soybean in Buldhana district (2001-02 to 2020-21)

Sr. No.	Factor	Regression coefficient (2001-02 to 2020-21)
1	Intercept	1974.2525 (875.0344)
2	P _{t-1}	0.1169 (0.1348)
3	A _{t-1}	-0.3032 (0.3896)
4	Y _{t-1}	-0.0465 (0.2034)
5	R _t	-0.5673* (0.2535)
6	AC _{1t}	-0.8392 (0.4730)
7	AC _{2t}	-0.4547 (0.5662)
8	PC _{1t-1}	-0.1464 (0.2024)
9	PC _{2t-1}	0.7001* (0.3192)
10	YC _{1t-1}	0.1182 (0.1290)
11	YC _{2t-1}	0.0322 (0.4460)
	R ²	0.9933
	Fvalue	133.61

(Figures in parentheses are standard errors of respective regression coefficients)

(Note: *, ** and *** Significant at 10, 5 and 1 percent level, respectively)

The current acreage of soybean was influenced by price of selected crop (Rs./q.) during preceding year i.e. soybean, productivity of second competing crop during preceding year i.e. green gram, productivity of second competing crop during preceding year i.e. green gram shows positive influence on acreage of soybean crop area under competitive crop sorghum, relative price of sorghum and relative yield of green gram positively. This indicates that the farmer's acreage allocation decision are not much more determined by the lagged acreage of the crop. The productivity of second competing crop during preceding year i.e. green gram crop was positively significant at 10 per cent significance. In case of entire period the value of R² obtained was 0.9933.

It could be concluded from the above discussion that, majority of the selected independent variable for acreage response analysis of soybean, had positive and significant impact on the acreage response of the soybean crop.

CONCLUSIONS

1. The results revealed that, the area under soybean was almost increased doubled from 1582.20 hectares (Period I 2001-02 to 2010-11) to 3518.00 hectares (Period II 2011-12 to 2020-21) in Buldhana district. The share of area under soybean has steadily moved up in the district.

2. For the study period, the compound growth rate for area, production and yield in soybean crop was positive. Area and production was statistically significant in Buldhana district. In Buldhana district, the acreage, production and yield of major crops were anticipated to be unstable. It was discovered that the area and productivity of most of the crops fluctuate; this could be due to the fact that the crops were heavily reliant on natural occurrences, which result in significant losses.

3. The lagged area of soybean significantly attributed to the deciding factors for the acreage under soybean crop in Buldhana district. The lagged prices of green

gram significantly attributed to the deciding factors for the acreage under soybean crop in Buldhana district.

4. Among all selected crop soybean had most stable crop in case of area and also stable in production and productivity compare to other selected crops. On the other hand there was higher magnitudes of instability were observed among the selected crops.

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Diversification Analysis an Innovative Practice under Climate Smart Technology of Major Crops in Gujarat

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ABSTRACT

The growth rates of area of mostly major crops is positive during entire study period except crops viz., crops groundnut in overall Gujarat. The growth rates of production of mostly major crops is positive during entire study period except crops viz., pearl millet in overall Gujarat. The growth rates of productivity of mostly major crops is positive during entire study period except crops viz., crops green gram in overall Gujarat.

The variability in area, production and productivity is observed to be least in case of pearl millet maize and groundnut crops while, wheat, gram, black gram, sugarcane and cotton indicated medium variability and the highest variability is recorded by castor, cumin and fennel. Thus, the hypothesis stating that the variation in area and productivity has been answerable for variability of production over the time period of the state had been recognized.

At Gujarat state level the major gainer among the major crops is pearl millet which is having a transfer probability of 0.062 black gram and 0.060 from groundnut and showed highest probability of retention i.e. 0.856. On the contrary rice, maize, wheat, gram, green gram, castor, cotton, sugarcane, cumin and fennel is having the probability of retention of zero indicating that share of these crops is unstable which means it could not retained its share during the current year. The pearl millet is likely to lose its previous years share to groundnut 0.144.

INTRODUCTION

Gujarat is the state which has medium amount of fertile land, in India. It is doing well in industrial as well as agricultural sectors. About 60 per cent of the population is engaged in agriculture, directly or indirectly. Gujarat has achieved a remarkable growth in its agricultural sector, which not only has made it self- sufficient in foodgrains production but also has elevated it to the largest contributor in spices and oilseeds to India's central pool of foodgrains and oilseeds. On the question the relationship between growth and instability. The state of Gujarat as a variety of soils, rainfall pattern, temperature regimes and irrigation facilities. This diverse agro-climatic situation across the state holds potential for development of the horticulture sector in a bigway. However, the wide annual variations in rainfall affects the productivity of crops.

The investment in foodgrains, fruit and oilseed and spices processing units has increased in the state which shows a bright future for horticulture and

processing sector in Gujarat. Considering the importance of foodgrains, horticulture, oilseed and spices sector in the Gujarat state, the present study was undertaken with the following specific objectives:

- Compute Overall Gujarat compound growth rates and instability indices of area, production and productivity of major Crops in Gujarat.
- Compute Overall Gujarat transition probability matrix of major Crops in Gujarat.

METHODOLOGY

The overall state time series data on area, production and yield of major vegetable crops of the state were collected from the Directorate of Agriculture, Government of Gujarat, Gandhinagar, for the period 1982-83 to 2017-18. The overall state compound growth rates (CGRs) of area, production and productivity of major vegetable crops were computed using the following formula:

$$CGR(\%) = (\text{Antilog log } b - 1) \times 100$$

where,

b is the regression coefficient

The level of instability was computed with the help of following formula. This formula was referred from Text book of agriculture Statistics, Rangaswami (2016):

$$\text{Instability Index(CV)} = \frac{\sigma}{X} * 100$$

The Markov probability model

A stochastic process is one which can analyze a set of trials or experiments probabilistically. For stochastic process, if N assumed that the movements (transitions) of objects from one state (possible outcome) to another are governed by a probability mechanism or system. A finite Markov process is a stochastic process whereby the outcome of a given trial t (t = 1, 2, T) depends only on the outcome of the preceding trial (t-1) and this dependence is the same at all stages in the sequence of trials. Consistence with this definition, let S_i represent the r states or possible outcomes;

$$I = 1, 2, \dots, r.$$

W_{it} represent the probability that state S occurs on trial t or the proportion observed in trial t in alternative outcome state *i.e.* of a multinomial population based on a sample of size n, *i.e.* P_r (S_{it}).

P_{it} represent the transitional probability that which denotes the probability that if for any time t the process is in state S_i it moves on the next trial to state S_j *i.e.* Pro (S_{jt} + 1/S_{it}) = P_{ij}.

P = (P_{ij}) represent the transitional probability matrix which denotes the transitional probability for every pair of states (i, j = 1, 2.....r) and has the following properties.

$$0 \leq p_{ij} \leq 1 \dots\dots\dots (1)$$

$$\sum P_{ij} = 1, \dots\dots\dots (2)$$

Given this set of notations and definitions for a first order Markov chain the probability of a particular sequence S_i on trial t and S_t on trial t + 1 may be represented by P_r (S_{it} t S_{jt} + 1) = P_r

$$(S_{it}) P_r (S_{it} t + 1 / S_{it}) = W_{it} P_{jt} \dots\dots\dots (3)$$

and the probability of being in state j at trial t + 1 may be represented by

$$P_r (S_{j, t+1}) = \frac{\sum W_{it} P_{it}}{I} \text{ or}$$

$$W_{it} t + 1 = \sum W_{it} P_{ij} \dots\dots\dots (4)$$

The data for the study were the proportion of area under major crops.

These proportions change from year to year as result of the factors like weather, technology, price and other institutional change. It is reasonable to assume that the combined influence of these individually systematic forces approximate to a stochastic process and the propensity of farmers to move from one crop state to another differ according to the crop state involved. If these assumptions are acceptable, then the process of cropping pattern change may be described in the form of a matrix p of first order transitional probabilities. The element of P_{ij} of the matrix indicates the probability of a farmer in crop state i in one period will more to crop state j during the following period. The diagonal element P_{ij} measures the probability that the proportion share of jth category of crop will be maintained.

[B] Estimation of transition probability matrix

Estimation (4) can be used as a basis for specifying the statistical model for estimating the transition probabilities. If errors were incorporated in equation (4) to account for the difference between the actual and estimated occurrence of (W_j t + 1), the sample observations may be assumed to be generated by the following Linear Statistical Model.

$$W_{jt} = \sum W_{it} t - 1 P_{ij} + U_{jt} \dots\dots\dots (5)$$

Or in Matrix form it can be written as,

$$Y_j = X_j P_j + U_j$$

Where,

Y_j is a (Txi) vectors of observations reflecting the proportion in cropping pattern j in time t, X_j is a (T × R) matrix of realized values of the proportion in cropping I in time t-1, P_j is a (r × 1) vector of unknown transition parameters to be estimated and U_j is a vector of random disturbances.

RESULTS AND DISCUSSION

I. Compound growth rate of major crops in Gujarat

The results of overall Gujarat compound growth rates of area, production and yield of major crops are presented and discussed in Table1.

It is observed from Table 1 that most of the major crops in Gujarat showed significant growth in area, production and productivity. While considering growth in area of major crops cultivated in Gujarat pearl millet and groundnut recorded significant negative growth over the period of 1982-83. However the crops paddy, maize, wheat, gram, castor, cotton, sugarcane, cumin and fennel recorded significant positive growth over the base year 1982-83. Growth in area is observed to be maximum in case of cumin while least significant growth is observed under groundnut crop. While considering growth in production of major crops cultivated in

Gujarat most major crops excluding pearl millet showed significant positive growth over the base year 1982-83. Growth in production is observed to be maximum in case of cumin while least significant growth is observed under black gram crop. While considering growth in productivity of major crops cultivated in Gujarat all major crops excluding green gram showed significant positive growth over the base year 1982-83. Growth in productivity is observed to be maximum in case of sugarcane while least significant growth is observed under fennel crop. Similar results were obtained by Rao (1989).

Table 1: Compound growth rate of major crops in Gujarat (1982-83 to 2017-18)

Crop	Area	Production	Productivity
Paddy	1.57** (0.0023)	3.77** (0.0031)	2.17** (0.0021)
Pearl millet	-2.92** (0.0029)	0.084 (0.163)	3.10** (0.0032)
Maize	1.21** (0.0022)	2.72** (0.0025)	1.49** (0.0021)
Wheat	2.99** (0.0032)	4.29** (0.0037)	1.25** (0.0023)
Gram	2.57** (0.0024)	4.32** (0.0039)	1.70** (0.0025)
Black gram	0.14 (0.168)	2.13** (0.0021)	1.55** (0.0022)
Green gram	0.77 (0.178)	2.45** (0.0027)	1.66** (0.0027)
Groundnut	-0.37* (0.0053)	3.55** (0.0029)	3.95** (0.0037)
Castor	4.07** (0.0038)	5.83** (0.0031)	1.77** (0.0021)
Cotton	2.99** (0.0029)	7.01** (0.0039)	3.92** (0.0035)
Sugarcane	2.44** (0.0021)	6.80** (0.0036)	4.24** (0.0039)
Cumin	5.80** (0.0030)	7.15** (0.0041)	1.27** (0.0020)
Fennel	3.76** (0.0026)	3.92** (0.0033)	0.74* (0.0058)

II. Variability in area, production and productivity of major crops in Gujarat

It is revealed from Table 2.that during study period 1982-83 to 2017-18 in Gujarat, the maximum variability is showed in area under cumin crop, 59.53 per cent, however maximum variability in production and productivity is under sugarcane crop *i.e.* 144.20 and 133.58 per cent, respectively. The maximum variability in area under cumin is observed mainly because area under cumin crop increased as compared to base year and favourable climate

condition, while the maximum variability in production and productivity under sugarcane crop were recorded mainly because area under sugarcane crop declined as compared to base year, adverse climate condition and over maturity condition at time of harvesting that results in weight loss.

However, least variability in case of area and production were showed under pearl millet *i.e.* 0.85 and 27.32 per cent, respectively while considering the productivity least variability is recorded under fennel crop *i.e.* 11.93 per cent. The reason for least

variability in area and production of pearl millet is due to good weather, suitable soil type and use of improved seed and technology like IPM, INM, while in fennel the least variability in productivity is mainly because of favorable climatic condition, use improved seed, use of IPM & INM and soil type. The results were similar to Narwade (2014).

III Behavioral changes in area allocation in Gujarat

It can be observed from the Table 4.20 that in Gujarat all crops have shown stability (except gram and green gram). In case of cereals as well as other crops the maximum stability is acquired by pearl millet crop as reflected in high probability of retention which is 85.60 per cent. In rice probability of retention is 30.80 per cent. In maize probability of retention is 42.60 per cent. In wheat probability of retention is 35.10 per cent. However, in case of pulses in black gram probability of retention is 3.10 per cent.

While considering oilseeds crops, in groundnut and castor probability of retention were 70.10 and 60.70 per cent respectively. In case of commercial crops in cotton probability of retention is 72.80 per cent and in sugarcane probability of retention is 58.90 per cent. In case of spices crops in cumin probability of retention is 41.40 per cent and in fennel probability of retention is 20.10 per cent.

At overall level the major area retainer among the major crops is pearl millet which is having a transfer probability of 0.062 black gram and 0.060 from groundnut and showed highest probability of retention *i.e.* 0.856. On the contrary rice, maize, wheat, gram, green gram, castor, cotton, sugarcane, cumin and fennel were having the probability of retention of zero indicating that share of these crops is unstable which means it could not retain its share during the current year. Pearl millet is likely to lose its previous year share to groundnut which is 0.144. Similar results were obtained by Deshmukh (2007).

Table 2: Variability in area, production and productivity of major crops in Gujarat (Per cent)

Crop	Period 1982-83 to 2017-18		
	Area	Production	Productivity
Paddy	18.66	42.50	26.61
Pearl millet	0.85	27.32	39.66
Maize	16.01	40.14	31.48
Wheat	43.71	58.77	16.17
Gram	46.79	69.96	27.52
Black gram	25.66	39.88	25.43
Green gram	24.67	46.90	39.28
Groundnut	14.65	57.58	58.12
Castor	51.80	59.62	22.49
Cotton	34.65	76.20	129.37
Sugarcane	27.96	144.20	133.58
Cumin	59.53	83.73	25.40
Fennel	51.93	56.55	11.93

Table 4.20: Transition probability matrix for crops in Gujarat (1982-83 to 2017-18)

Crop	Rice	Pearl millet	Maize	Wheat	Gram	Black gram	Green gram	Groundnut	Castor	Cotton	Sugarcane	Cumin	Fennel
Rice	0.308	0	0.064	0	0	0.076	0	0.399	0.122	0	0.029	0	0.002
Pearl millet	0	0.856	0	0	0	0	0	0.144	0	0	0	0	0
Maize	0.086	0	0.426	0.449	0.031	0.006	0.002	0	0	0	0	0	0
Wheat	0	0	0	0.351	0.051	0	0	0	0.096	0.499	0	0	0.003
Gram	0.174	0	0	0.272	0	0	0	0.535	0	0	0.019	0	0
Black gram	0.146	0.062	0.023	0.071	0.021	0.031	0.046	0.480	0.019	0.098	0.002	0	0.001
Green gram	0.323	0	0.411	0	0	0	0	0	0	0	0.266	0	0
Groundnut	0.077	0.060	0.029	0.019	0.014	0.028	0.072	0.701	0	0	0	0	0
Castor	0.087	0	0.091	0	0	0	0	0.045	0.607	0.140	0	0.030	0
Cotton	0.083	0	0.016	0.092	0.021	0	0.013	0	0	0.728	0	0.042	0.005
Sugarcane	0	0	0.019	0	0	0	0	0	0	0.392	0.589	0	0
Cumin	0	0	0	0.586	0	0	0	0	0	0	0	0.414	0
Fennel	0	0	0	0	0.480	0	0	0	0	0	0	0.319	0.201

CONCLUSIONS

The growth rates of area of mostly major crops is positive during entire study period except crops *viz.*, crops groundnut in overall Gujarat. The growth rates of production of mostly major crops is positive during entire study period except crops *viz.*, pearl millet in overall Gujarat. The growth rates of productivity of mostly major crops is positive during entire study period except crops *viz.*, crops green gram in overall Gujarat.

The variability in area, production and productivity is observed to be least in case of pearl millet maize and groundnut crops while, wheat, gram, black gram, sugarcane and cotton indicated medium variability and the highest variability is recorded by castor, cumin and fennel. Thus, the hypothesis stating that the variation in area and productivity has been answerable for variability of production over the time period of the state had been recognized.

At Gujarat state level the major gainer among the major crops is pearl millet which is having a transfer probability of 0.062 black gram and 0.060 from groundnut and showed highest probability of retention *i.e.* 0.856. On the contrary rice, maize, wheat, gram, green gram, castor, cotton, sugarcane,

cumin and fennel is having the probability of retention of zero indicating that share of these crops is unstable which means it could not retained its share during the current year. The pearl millet is likely to lose its previous years share to groundnut 0.144.

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Rising Heat, Shifting Seasons: Farmers' Insights on Climate Change in Vidarbha

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ABSTRACT

Climate change has emerged as a critical challenge affecting the agrarian economy and farmers' welfare in Maharashtra. The state, characterized by diverse agro-climatic zones, experiences instability in crop production and regional disparities, contributing to a rise in farmers' distress, including suicides. This study examines farmers' perceptions of climate change in the Vidarbha region of Maharashtra, focusing on four districts mainly Amravati, Akola, Washim, and Gadchiroli were selected based on their level of development. Primary data were collected for the year 2022-23 using a multistage random sampling technique, covering a total of 240 farmers. Henry Garrett's Ranking Technique was applied to analyze farmers' perceptions. The findings reveal that farmers in Amravati, Akola, and Washim predominantly perceive an increase in temperature, leading to shifts in sowing time and cropping patterns. Conversely, farmers in Gadchiroli reported a rise in flood intensity due to climate change. The study underscores the need for research investments in developing heat-resistant crop varieties to mitigate productivity losses caused by rising temperatures. Additionally, promoting crop diversification, climate-smart agricultural practices, and region-specific cropping patterns is essential for enhancing resilience against climate extremes in the Vidarbha region.

Keywords: Climate Change, Farmers' Perception, Henry Garrett's Ranking, Crop Diversification, Climate-Smart Agriculture, Vidarbha, Maharashtra

INTRODUCTION

Agricultural production is inherently vulnerable to natural forces such as rainfall variability and temperature fluctuations, leading to instability in crop yields. This instability directly impacts the livelihoods of farmers, particularly in regions where agriculture remains the primary source of income. As the global population continues to rise, ensuring stable agricultural growth across different regions is crucial to meeting food security demands. However, climate change has emerged as a significant challenge, adversely affecting the agrarian economy and farmers' welfare, particularly in Maharashtra.

Maharashtra, one of India's largest and most diverse agricultural states, comprises multiple agro-climatic zones, including Konkan, Western Maharashtra, Marathwada, and Vidarbha. These regions exhibit distinct variations in natural, social, and economic conditions, influencing topography, soil characteristics, climatic patterns, and, consequently, cropping and land-use patterns. Among

these, Vidarbha, known for its agrarian distress, has been severely impacted by climate variability, resulting in instability in crop production and widening regional disparities. The increasing frequency of extreme weather events has contributed to economic distress, with growing concerns over rising farmer suicides.

Given these challenges, understanding farmers' perceptions of climate change is critical for shaping effective agricultural policies and adaptation strategies. Farmers' insights on shifting climatic patterns, changing cropping practices, and emerging risks provide valuable input for policymakers to develop region-specific climate adaptation measures. The present study, conducted in the Vidarbha region of Maharashtra, aims to examine farmers' perceptions of climate change and its impact on agriculture. The findings of this study will help in formulating policies that address climate-induced risks while promoting sustainable agricultural practices in the region.

METHODOLOGY

The study is based on primary data collected for the year 2022-23.

1 Selection of study area

The Vidarbha region in Maharashtra includes eleven districts. From Vidarbha region, districts were categorized on the basis of level of development as mentioned in Table 1.

Table 1: Criteria for classification of districts on basis of the composite index

Sr. No.	Level of development	Range of composite index
1.	Most developed	Below (mean - 2 SD)
2.	Developed	(Mean - 2 SD) to (Mean - SD)
3.	Moderately developed	(Mean - SD) to (Mean)
4.	Under developed	(Mean) to (Mean + SD)
5.	Backward	(Mean + SD) to (Mean + 2 SD)
6.	Most backward	Above (Mean + 2 SD)

From each category of development one district was selected. From developed category Amravati district, from moderately developed category Akola district, from under-developed category Washim district and from backward category Gadchiroli district were selected.

2 Collection of data

Primary data were collected with the help of pre-tested schedule through personal interview method.

3 Selection of sample

Multistage random sampling technique was adopted for the study. From each village 15 farmers were selected randomly. Thus, total 240 farmers were selected from Vidarbha region.

Table 2: List of selected districts of Vidarbha on the basis of composite index

Sr. No.	Districts	Tehsils	Villages	Sample size
1.	Amravati (Developed)	Amravati	Pusada Tembha	15 15
		Achalpur	Wasani kh Mukindpur	15 15
2.	Akola (Moderately developed)	Akola	Ghusar Kanchanpur	15 15
		Barshitakli	Kanheri sarap Punoti bk	15 15
3.	Washim (Under developed)	Karanja	Dhanora Tathod Kherda kh	15 15
		Mangrulpir	Ghota Warud kh	15 15
4.	Gadchiroli (Backward)	Dhanora	Metelangada Karwafa	15 15
		Chamorshi	Ashti Chamorshi	15 15
		Total		240

2.4 Analytical Tools

An attempt was made to find out farmers perception on productivity due to climate change. For ranking the Henry's Garrett's Ranking technique was employed. Respondents were asked to assign the rank for the climatic factors and the outcomes of such ranking were converted into score value by using formula,

$$\text{Per cent position} = \frac{100(R_{ij} - 0.5)}{N_j}$$

Where, R_{ij} = Rank given for the ith variable by jth respondents

N_j = Number of variables ranked by jth respondents

3. Results and Discussion

For addressing the changing climate in any region there is need to know the perception of farmers on climate change. Before that it is also important to know the socio-economic characteristics of selected farmers i.e. family size, farming

experience, land use pattern, cropping pattern were studied.

3. Distribution of farmers according to size of family

Family size of the selected farmers of four districts namely Amravati, Akola, Washim and Gadchiroli are presented in table 3.

Table 3: Distribution of farmers according to size of family

Sr No.	Particulars	Amravati	Akola	Washim	Gadchiroli
1	Small (up to 4)	27 (45.00)	25 (41.67)	29 (48.33)	22 (36.67)
2	Medium (5-10)	30 (50.00)	27 (45.00)	27 (45.00)	31 (51.67)
3	Large (above 10)	3 (5.00)	8 (13.33)	4 (6.67)	7 (11.67)
	Total	60 (100.00)	60 (100.00)	60 (100.00)	60 (100.00)

(Figures in parenthesis indicate the percentage to total)

It is observed from the table that from Amravati district, 3 families having more than 10 members in their family whereas 30 families having 5 to 10 family members and 27 families having maximum 4 members in their family. In Akola district, 8 families having more than 10 members in their family whereas 27 families having 5 to 10 members in their family and 25 families having maximum 4 members in their family. In Washim district, it is noticed that only 4 families having more than 10 members in their family whereas 27 families having 5 to 10 members and 29 families having up to 4 members in their family. In Gadchiroli district, it is

noticed that only 7 families having more than 10 members in their family whereas 31 families having 5 to 10 members and 22 families having up to 4 members in their family. From this table it is concluded that, majority of farmers from this four districts were belonging to small and medium size of family.

2 Distribution of farmers according to their experience in farming

Farmers from Amravati, Akola, Washim and Gadchiroli district were distributed according to farming experience and is presented in table 2.

Table 2: Distribution of farmers according to their experience in farming

Sr No.	Particulars	Amravati	Akola	Washim	Gadchiroli
1	Low (≤ 9 years)	16 (26.67)	18 (30.00)	15 (25.00)	18 (30.00)
2	Medium (> 9 to ≤ 28 years)	33 (55.00)	32 (53.33)	37 (61.67)	29 (48.33)
3	High (> 28 years)	11 (18.33)	10 (16.67)	8 (13.33)	13 (21.67)
	Total	60 (100.00)	60 (100.00)	60 (100.00)	60 (100.00)

(Figures in parenthesis indicate the percentage to total)

It is observed from the above table that, in Amravati district about 55 per cent farmers were having more than 9 and up to 28 years of experience of farming followed by 26.67 per cent farmers having less than 9 years of farming experience and 18.33 per

cent famers having more than 28 years of experience in farming. In Akola district about 53.33 per cent farmers were having more than 9 and up to 28 years of experience of farming followed by 30 per cent farmers having less than 9 years of farming

experience and 16.67 per cent famers having more than 28 years of experience in farming.

It is observed from the above table that, in Washim district about 61.67 per cent farmers were having more than 9 and up to 28 years of experience of farming followed by 25 per cent farmers having less than 9 years of farming experience and 13.33 per cent famers having more than 28 years of experience in farming.

In Gadchiroli district about 48.33 per cent farmers were having more than 9 and up to 28 years of experience of farming followed by 30 per cent

farmers having less than 9 years of farming experience and 21.67 per cent famers having more than 28 years of experience in farming. It is concluded from the table that, from all four districts most of farmers having farming experience more than 9 years and up to 28 years respectively.

3 Land utilization pattern

Land utilization indicates the area of land actually utilized for different purpose like crop production, irrigated area, net sown area, fallow land, gross cropped area etc. The land use pattern of the selected farmers is shown in table 3.

Table 3: Land utilization pattern of selected farmers (Area in ha)

Sr No.	Particulars	Amravati	Akola	Washim	Gadchiroli
1	Total land holding	4.02 (100.00)	3.61 (100.00)	8.25 (100.00)	3.10 (100.00)
2	Fallow land	0.03 (0.75)	0.06 (1.66)	0.02 (0.24)	0.05 (1.61)
3	Net cultivated area	3.99 (99.25)	3.55 (98.34)	8.23 (99.76)	3.05 (98.39)
4	Area sown more than once	1.50 (37.31)	1.13 (31.30)	2.68 (32.48)	1.20 (38.71)
5	Gross cropped area	5.49	4.68	10.91	4.25
6	Cropping Intensity (%)	137.34	131.55	132.56	139.34

(Figures in parenthesis indicate the percentage to total land holding)

It is revealed from the table that the average gross cropped area for Amravati district was 5.49 ha. The net cultivated area was 99.25 per cent and fallow land 0.75 per cent, area sown more than once was 37.31 per cent of total land holding and cropping intensity was 137.34 per cent. The average gross cropped area for Akola district was 4.68 ha. The net cultivated area was 98.34 per cent and fallow land 1.66 per cent, area sown more than once was 31.30 per cent of total land holding and cropping intensity was 131.55 per cent. For Washim district, the average gross cropped area was 10.91 ha. The net cultivated area was 99.76 per cent and fallow land was 0.24 per cent, area sown more than once was 32.48 per cent of total land holding and cropping intensity was 132.56

per cent. The average gross cropped area for Gadchiroli district was 4.25 ha. The net cultivated area was 98.39 per cent and fallow land was 1.61 per cent, area sown more than once was 38.71 per cent of total land holding and cropping intensity was 139.34 per cent.

4 Cropping pattern

Cropping pattern of selected farmers is nothing but the results of past experience of farming, type of soil available, irrigation resources etc. The percentage area allocated to different crops with reference to gross cropped area by the selected farmers are presented in table 4.

Table 4: Cropping pattern of selected farmers

(Area in ha)

Sr. No	Particulars	Amravati	Akola	Washim	Gadchiroli
I	Kharif				
1	Cotton	1.63 (29.69)	1.93 (41.24)	4.91 (45.55)	0.00 (0.00)
2	Soybean	1.50 (27.32)	1.13 (24.15)	2.60 (24.12)	0.00 (0.00)
3	Tur	0.86 (15.67)	0.49 (10.47)	0.72 (6.68)	1.15 (27.06)
4	Kh Paddy	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.90 (44.71)
	Total	3.99 (72.68)	3.55 (75.86)	8.23 (76.35)	3.05 (71.77)
II	Rabi				
1	Gram	1.50 (27.32)	1.13 (24.15)	1.85 (17.16)	1.17 (27.53)
2	Wheat	0.00 (0.00)	0.00 (0.00)	0.70 (6.49)	0.00 (0.00)
	Total	1.50 (27.32)	1.13 (24.15)	2.55 (23.65)	1.17 (27.53)
III	Summer				
1	Vegetables	0.00 (0.00)	0.00 (0.00)	0.13 (1.19)	0.03 (0.70)
	Total	0.00 (0.00)	0.00 (0.00)	0.13 (1.19)	0.03 (0.70)
V	Gross cropped Area	5.49 (100.00)	4.68 (100.00)	10.91 (100.00)	4.25 (100.00)

(Figures in parenthesis indicate the percentage to GCA)

It is observed from the table that, gross cropped area for Amravati district was 5.49 hectare which consists of 72.68 per cent area under kharif crops and 27.32 per cent area under rabi crops. Among kharif crops the highest proportion of area was observed under cotton crop i.e. 29.69 per cent followed by soybean i.e. 27.32 per cent and tur i.e. 15.67 per cent whereas in rabi season, the highest area was observed under gram crop i.e. 27.32 per cent respectively. The gross cropped area for Akola district was 4.68 hectare which consists of 75.86 per cent area under kharif crops and 24.15 per cent area under rabi crops. Among kharif crops the highest proportion of area was observed under cotton crop i.e. 41.24 per cent followed by soybean i.e. 24.15 per

cent and tur i.e. 10.47 per cent whereas in rabi season, the highest area was observed under gram crop i.e. 24.15 per cent respectively.

For Washim district, the gross cropped area was 10.91 hectare which consists of 76.35 per cent area under kharif crops and 23.65 per cent area under rabi crops and 1.19 per cent under summer crops. Among kharif crops the highest proportion of area was observed under cotton crop i.e. 45.55 per cent followed by soybean i.e. 24.12 per cent and tur i.e. 6.68 per cent whereas in rabi season, the highest area was observed under gram crop i.e. 17.16 per cent followed by wheat i.e. 6.49 per cent. In summer season, farmers were taken different vegetables like chilli, brinjal, tomato etc. The area under these

vegetables were near about 1.19 per cent of total gross cropped area. For Gadchiroli district, the gross cropped area was 4.25 hectare which consists of 71.77 per cent area under kharif crops, 27.53 per cent area under rabi crops and near about 0.70 per cent of area under summer vegetables. Among kharif crops the highest proportion of area was observed under kharif paddy i.e. 44.71 per cent followed by tur i.e. 27.06 per cent whereas in rabi season, the highest area was observed under gram crop i.e. 27.53 per cent respectively. In this district, farmers were taken vegetables like chilli, brinjal during summer season having area of 0.70 per cent of total gross cropped area.

As most of farmers from Akola, Amravati district were not having irrigation facilities. These farmers were taking crops under rainfed condition. Therefore, for summer season, they were not taking any crop under cultivation.

Ranking of perception of farmers on productivity due to climate change for selected districts of Vidarbha

It is important to know the perception of farmers regarding climate change before taking any initiatives. Therefore, perception of farmers on productivity due to change in climate is analyzed and presented in table 5.6.7 and 8.

Table 5: Ranking of perception of farmers regarding climate change for Amravati district

Sr. No.	Statements	Average score	Rank
1	Temperature has been increased in recent years	71.47	1
2	Intensity of floods have been increased	23.93	10
3	Intensity of droughts have been increased	35.30	9
4	Sowing time has been changed due to changing climate	60.30	3
5	Cropping pattern has been changed	64.47	2
6	Heavy rain affects the grain formation in cereals	45.10	7
7	Pest infestations has been increased due to climate change	48.13	5
8	More occurrence of crop disease is observed due to changing climate	59.03	4
9	Income from agriculture is adversely affected due to climate change	46.30	6
10	Climate change causes rising cost of farming	43.97	8

Farmers from Amravati districts given their perception on climate change which were ranked and presented in table. It is observed from the table that, the statement i.e. temperature has been increased in

recent years was ranked first with average score 71.47 followed by sowing time has been changed due to changing climate ranked second with average score 60.30 and cropping pattern has been changed was ranked third with average score 64.47.

Table 6: Ranking of perception of farmers regarding climate change for Akola district

Sr. No.	Statements	Average score	Rank
1	Temperature has been increased in recent years	76.38	1
2	Intensity of floods have been increased	23.93	10
3	Intensity of droughts have been increased	35.30	9
4	Sowing time has been changed due to changing climate	59.93	3
5	Cropping pattern has been changed	64.47	2
6	Heavy rain affects the grain formation in cereals	41.12	8
7	Pest infestations has been increased due to climate change	48.13	5
8	More occurrence of crop disease is observed due to changing climate	59.03	4
9	Income from agriculture is adversely affected due to climate change	46.30	6
10	Climate change causes rising cost of farming	43.40	7

Farmers from Akola districts given their perception on climate change which were ranked and presented in table. It is observed from the table that, the statement i.e. temperature has been increased in

recent years was ranked first with average score 76.38 followed by cropping pattern has been changed was ranked second with average score 64.47 and sowing time has been changed due to changing climate ranked third with average score 59.93.

Table 7: Ranking of perception of farmers regarding climate change for Washim district

Sr. No.	Statements	Average score	Rank
1	Temperature has been increased in recent years	69.97	1
2	Intensity of floods have been increased	48.07	6
3	Intensity of droughts have been increased	35.30	10
4	Sowing time has been changed due to changing climate	58.87	2
5	Cropping pattern has been changed	58.77	3
6	Heavy rain affects the grain formation in cereals	43.25	7
7	Pest infestations has been increased due to climate change	48.38	5
8	More occurrence of crop disease is observed due to changing climate	50.68	4
9	Income from agriculture is adversely affected due to climate change	42.72	8
10	Climate change causes rising cost of farming	42.00	9

Farmers from Washim districts given their perception on climate change which were ranked and presented in table. It is noticed from the table that, the statement i.e. temperature has been increased in

recent years was ranked first with average score 69.97 followed by sowing time has been changed due to changing climate was ranked second with average score 58.87 and cropping pattern has been changed was ranked third with average score 58.77.

Table 8: Ranking of perception of farmers regarding climate change for Gadchiroli district

Sr. No.	Statements	Average score	Rank
1	Temperature has been increased in recent years	65.38	2
2	Intensity of floods have been increased	65.53	1
3	Intensity of droughts have been increased	37.68	9
4	Sowing time has been changed due to changing climate	53.28	3
5	Cropping pattern has been changed	52.72	4
6	Heavy rain affects the grain formation in cereals	43.28	8
7	Pest infestations has been increased due to climate change	46.88	6
8	More occurrence of crop disease is observed due to changing climate	45.25	7
9	Income from agriculture is adversely affected due to climate change	36.47	10
10	Climate change causes rising cost of farming	51.52	5

Farmers from Gadchiroli districts given their perception on climate change which were ranked and presented in table. It is observed from the table that, the statement i.e. intensity of floods have been increased was ranked first with average score 65.53 followed by temperature has been increased in recent years was ranked second with average score 65.38

and sowing time has been changed due to changing climate ranked third with average score 53.28.

CONCLUSION

The study reveals that the majority of farmers in Amravati, Akola, and Washim districts have observed a rise in temperature in recent years, leading to shifts in sowing time and cropping patterns. In contrast, farmers in Gadchiroli district reported an increase in flood intensity due to

changing climatic conditions. Given these challenges, there is a critical need for increased investment in research to develop heat-resistant crop varieties, which can help mitigate productivity losses caused by rising temperatures. Additionally, promoting crop diversification, implementing climate-smart agricultural practices, and adopting region-specific cropping patterns should be prioritized as key mitigation strategies. These measures will enhance resilience and preparedness for climate extremes in the Vidarbha region, ensuring sustainable agricultural growth and farmers' well-being.

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Strengthening Tribal Agriculture: Exploring Opportunities for Minor Millets in Chhattisgarh

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ABSTRACT

The present study, "Minor Millets in Chhattisgarh: Exploring Opportunities for Sustainable Agriculture Development in Tribal Areas," aims to promote minor millets as a viable and sustainable agricultural option for tribal farmers in Chhattisgarh. The study seeks to address challenges related to market access, infrastructure, and policy support to increase farm income, improve food security, and contribute to environmental sustainability. The study highlights the growing demand for minor millets due to their nutritional value, gluten-free status, and cultural significance. The major constraints in marketing minor millets include lack of market access (95.87%), non-availability of marketing news and market intelligence (84.53%), and lack of cooperative and regulated markets (90.72%). The major constraints in producing minor millets include lack of technical knowledge (92.78%) and lack of resources (90.72%). The marketing efficiency ratio was 8.94 for Channel-I (Producer-Consumer) and 3.31 for Channel-II (Producer-Retailer-Consumer). The average cost of cultivation per quintal of kodo millet, little millet, and finger millet was Rs. 3317.50, Rs. 1776.95, and Rs. 11674.57, respectively. The overall input-output ratio was 1:1.20, 1:1.40, and 1:1.16 for kodo millet, little millet, and finger millet, respectively. The study concludes that minor millets offer significant opportunities for tribal farmers in Chhattisgarh to diversify their income sources, improve food security, and contribute to environmental sustainability. However, addressing the challenges related to market access, infrastructure, and policy support is crucial to promoting minor millets as a viable and sustainable agricultural option.

INTRODUCTION

Many small-grained cereals are constituted by the term "Millets". Millets are elemental cereals in India and consumed by large division of population belonging to lower income strata. Being non-glutinous, millets are safe for people suffering from gluten allergy and celiac disease. Therefore, millets are now being popularized by "**Miracle grains/ Adbhut Anaj and nutri-cereals**". Millet belongs to Poaceae family and comprises of crops like pearl millet, sorghum, finger millets. Minor millets contain Foxtail millet, Kodo millet, Proso millet, barnyard millet and little millets. Globally, millet production was estimated 27.83 million tons (FAO, 2014). Nigeria (11.94%) is second largest producer of millets after India (41.04%) in the world.

Chhattisgarh state located in central India, has a rice agricultural heritage and also known for its diverse cropping pattern. In recent years, there has been a growing recognition of the importance of

minor millets as sustainable and nutritious alternatives to major staple crops. Chhattisgarh with its varied agro-climatic zones, provides an ideal environment for the cultivation of these crops by diversity the cropping system with minor millets, farmers can reduce their dependence on a few crops and enhance their resilience to climate change and extreme weather condition. Promotion of minor millets in Chhattisgarh can help address nutritional deficiencies prevalent in the region and promote food security at the household and community level. Minor millets have the potential to provide an additional income to the farmer of Chhattisgarh. These crops requires less water and are less resource intensive compared to major crops like rice and wheat. Furthermore, value addition activities such as processing and marketing of millet products can create new avenues for the entrepreneurship and rural employment.

In 2015 India recorded 682.33 thousand hectare area of millets with production of 429.9

thousand tons and yield 630 Kg/ha. From respective states Madhya Pradesh (33.4%), invade maximum area of millets followed by Chhattisgarh (16.5%), Uttarakhand (9.5%), Maharashtra (8.4%), Gujarat (5.6%), Tamil Nadu (4.8%) and Andhra Pradesh (4.1%). (Source: directorate of economics and statistics 2015). Bastar district of Chhattisgarh is one of the largest congregations of tribal population (67.4%), dweller mainly cultivated millets on upland situations and form major ingredient of their daily consumption of food. Millets are nutritionally rich, significant as a rainfed crop which forms a part of a multi cropping system, in the sense that it is mostly grown along with legumes and oilseeds. Keeping these issues in view, study was conducted in tribal area of Chhattisgarh with the following objectives for meaningful conclusion.

Objectives

- i. To examine the growth rate of Area, Production and Productivity of Minor Millets.
- ii. To work out the cost and returns of minor millets.
- iii. To study about marketing practices and marketing efficiency of minor millets in the selected area.
- iv. To identify the constraints in production and marketing of minor millets and suggestion to overcome them.

Methodology

The study is based on primary data collected by Tribal district in Chhattisgarh. Chhattisgarh state consists of 33 districts out of which Bastar district have been selected purposively because the existence of maximum area under minor millets. Out of the total 7 blocks of Bastar district only one third of the total blocks i.e., Lohandiguda & Bastanar blocks were selected and four villages namely Mardum, Matnaar, Kilepal and Turangur were selected purposively. Out of 610 farm families in selected villages a sample of 15 percent respondents are going to be selected by using probability proportional to size techniques subject to condition that at least 10 percent of respondents should be included in sample from each categories viz, marginal, small, medium and large of farms for the collection of the both primary and secondary data has been collected from the various published sources. The simple tabular analysis was employed to present the data regarding the existing farming pattern, cost, return and profitability.

Compound Growth Rate

The compound growth rates in area, production and productivity of minor millets were worked out for Bastar district of Chhattisgarh state by fitting an exponential function was estimated by using non linear trained equation i.e.

Where,

$$Y = ab^t$$

$$\log y = \log A + t \log B$$

$$Y =$$

Area/Production/Productivity of millets

$$a = \text{Constant}$$

B = Regression coefficient or trained value

t = time in year

Cost Concept

To work out the cost of cultivation standard method of cost of cultivation employed by Commission on Agricultural Costs and Price (CACP), Directorate of Economics and Statistics, Government of India was adopted.

Income measures

(a) Gross income

$$\text{Gross income} = \text{Net income} + \text{Cost}$$

$$C_2$$

(b) Net income

$$\text{Net income} = \text{Gross income} - \text{Cost}$$

$$C_2$$

(c) Family labour income

It includes net income or loss plus imputed value of wages for the labour of farmer and his family.

(d) Farm business income

It is the gross income minus total expenses of production excluding wages of family labour, interest on owned capital and rental value of land. It is measure of the earnings of farmer and his family for their capital investment, labour and managerial work.

$$\text{F.B.I.} = \text{Family labour income} + \text{interest on working capital} + \text{Rental value of land}$$

RESULTS AND DISCUSSION

From table 1 the general characteristics of sample households represented and also the table revealed that the average family size was 6.92. It is varied from 6.46 in marginal farms to 7.71 in large farms. The social groups of schedule tribes were more than other backward caste i.e. 91.75 percent and 8.25 respectively. The main occupation of the sample households belongs mainly

to agriculturist that is 59.47 percent. And the literacy percent was 71.17 percent.

Table 1 Demographic particulars of minor millets farmer of selected study area.

S. N.	Particulars	Marginal	Small	Medium	Large	Overall
1	Total number of households	56	25	9	7	97
2	Average size of holding in ha.	1.76	2.05	3.65	5.25	3.18
	Average Family members	6.46	7.16	8.55	7.71	6.92
3	Social group					
a)	Schedule tribe	51 (91.07)	24 (96.0)	8 (88.88)	6 (85.71)	89 (91.75)
b)	Other backward caste	5 (8.92)	1 (4.00)	1 (11.11)	1 (14.28)	8 (8.25)
	Total	56 (100)	25 (100)	9 (100)	7 (100)	97 (100)
4	Occupation					
a)	Agriculture	132 (61.12)	69 (67.65)	25 (55.55)	19 (38.77)	245 (59.47)
b)	Agriculture labour	55 (25.46)	23 (22.54)	12 (26.67)	24 (48.97)	114 (27.66)
c)	Govt. and private service	5 (23.31)	2 (1.96)	2 (4.45)	3 (6.12)	12 (2.91)
d)	Others (Business)	24 (11.11)	8 (7.84)	6 (13.33)	3 (6.14)	41 (9.95)
	Total	216 (100)	102 (100)	45 (100)	49 (100)	412 (100)
5	Education					
a)	Illiterate	29.55	29.54	26.58	25.00	28.82
b)	Literacy percentage	70.44	70.45	73.41	75	71.17

Note: Figure in the parentheses denotes percentage to the total

Land use pattern of sample households

From the table 2 it clearly shows that total owned area of marginal, small, medium, large and overall as 98.63, 89.7, 76.45, 90.63 and 88.86

respectively. The overall irrigated area was 26.61 and un-irrigated area was 69.30, where the major source of irrigation was through tube wells i.e., 59.07 percent to the total irrigated area followed by pond 28.44 and well 3.32 percent respectively.

Table 2. Land use pattern and irrigation area of sample households of selected study area (farm/ha)

	Particulars	Marginal	Small	Medium	Large	Overall
Land use pattern	Total operational area	98.63	89.7	76.45	90.63	88.86
	Total irrigated area	10.92 (15.97)	24.01 (26.65)	31.99 (41.85)	39.78 (43.84)	26.61 (30.70)
	Total unirrigated area	82.98 (84.03)	66.7 (73.35)	45.09 (58.15)	50.81 (56.16)	61.40 (69.40)
	Total owned area	98.63 (100)	89.7 (100)	76.45 (100)	90.63 (100)	88.86 (100)
Source of irrigation	Tube well	8.33 (76.28)	16.71 (69.59)	18.13 (56.67)	19.71 (49.86)	15.72 (59.07)
	Pond	2.2 (20.15)	6.15 (25.61)	9.89 (30.91)	12.05 (30.49)	7.57 (28.44)
	Well	0.39 (3.57)	1.15 (4.80)	3.97 (12.4)	7.77 (19.65)	3.32 (12.49)
	Total irrigated area	10.92 (100)	24.01 (100)	31.99 (100)	39.53 (100)	26.61 (100)

Note: Figures in parentheses denotes the percentage of total cultivated area

Cropping pattern

The cropping pattern of sample households is presented in table 4.4. from the table it is observed that total the percentage of kharif cropped area was 90.23, 79.17, 70.50, 69.50 and 76.17 percent of marginal, small, medium, large and overall respectively. It is found from the table that paddy crop has occupied more area 37.05 ha per farm followed by kodo millet 14.45

ha per farm. The percentage of rabi cropped area was 9.77, 20.83, 29.50, 30.50 and 23.83 of marginal, small, medium, large and overall respectively. The cropping intensity of study area was observed 110.85, 126.30, 141.85, 143.90 and 131.35 percent of marginal, small, medium, large and overall respectively. Cropping intensity is seen increasing as the farm size increases.

Table 3. Cropping Pattern of Sample households of selected study area (farm/ha)

S.No.	Particulars	Marginal	Small	Medium	Large	Overall
	Kharif					
	Paddy	50.36 (46.06)	40.65 (35.25)	28.77 (26.53)	28.42 (21.79)	37.05(31.58)
	Kosra rice	5.52 (5.04)	12.94 (11.22)	11.35 (10.46)	17.15 (13.15)	11.75 (10.01)
	Kodomillet	12.87 (11.77)	13.36 (11.58)	14.77 (13.62)	16.70(12.85)	14.45 (12.31)
	Little millet	8.26 (7.55)	8.01 (6.95)	10.14 (9.35)	9.84 (7.55)	9.06 (7.75)
	Finger millet	17.96 (16.42)	11.57 (10.03)	5.83 (5.37)	6.38 (4.90)	10.45 (8.90)
	Urd	1.12 (1.02)	2.27 (1.20)	2.77 (2.55)	6.95 (5.35)	3.28 (2.80)
	Sesame	2.54 (2.32)	2.49 (2.15)	2.82(2.60)	5.19 (3.90)	3.30 (2.85)
	Sub total	98.63 (90.23)	91.29 (79.17)	76.45 (70.50)	90.63 (69.50)	89.34(76.17)
	Rabi					
	Paddy	6.13 (5.60)	16.01 (13.90)	22.09 (20.37)	27.78 (21.30)	18.00 (15.35)
	Tomato	2.12 (1.93)	3.6 (3.12)	4.06 (3.75)	4.75 (3.65)	4.98(4.25)
	Chick pea	1.34	2.25	3.28	3.9	2.69
	Chilli	1.1 (1.10)	2.15 (1.86)	2.56 (2.36)	3.35 (2.56)	2.29 (1.95)
	Sub total	10.69 (9.77)	24.01 (20.83)	31.99 (29.50)	39.78 (30.50)	27.96 (23.83)
	Total croppedarea	109.32 (100)	115.3 (100)	108.44 (100)	130.41 (100)	117.3 (100)
	Net croppedarea	98.63	91.29	76.45	90.63	89.3
	Croppingintensity	110.85	126.30	141.85	143.90	131.35

Note:- Figure in parentheses denotes the percentage to the total cropped area

Compound growth rate

The compound growth rate of minor millets was calculated from the secondary data collection of 10 years from 2009-10 to 2018-19. The table reveals that in Bastar district of Chhattisgarh state the

area, production and productivity of minor millets crop increases and showed the positively significant growth rate of 12.20 percent 13.72 percent and 6.54 percent respectively.

Table 4. Compound growth rate of Area, Production and Productivity of minor millets

Particular	Area (%)	Production (%)	Productivity (%)
Compound growth rate	13.72*	6.54*	12.20*

Note:-* Significant at 1% level of significance

Economics of kodo millet

The output of yield value per hectare and cost of production per qt. of kodo millet on sample farms have been worked out in table 5. The table revealed that the average yield per hectare of kodo millet was 8.09 qt. The cost of production per qt. on an average estimated Rs 3317.48. It decreased with the rise in farm size due to higher yields to give large farm's cost of cultivation. The average production value per hectare came to Rs. 32360. It was Rs. 27290, Rs.30720, Rs 33520 and Rs. 37400 per hectare respectively on the

marginal, small, medium and large farms. The higher output value was associated with the higher yield on large farms. Sample farms of different size groups have been worked out for net income, family labour income and farm business income per hectare in table 4.9 and fig4.12. It can be observed from the table 5 that on an average the value of net income Rs. 5521.55, family labour income Rs. 6651.55 and farm business income Rs. 17122.6 per hectare. Estimated value of average input-output in kodo millet was 1.20.

Table 5: Cost and return per quintal of Kodo (Rs. /qtl/ ha.)

S.No.	Particulars	Farm Size				
		Marginal	Small	Medium	Large	Overall
1.	Gross cost (Rs/ha)	21925.25	26111.05	28237.1	31080.35	26838.45
2.	Yield (qt/ha)	6.98	7.68	8.38	9.35	8.09
3.	Price (Rs/qt)	4000	4000	4000	4000	4000
4.	Value of production(Rs/ha)	27920	30720	33520	37400	32360
5.	Cost of production (Rs/qt)	3141.15	3399.87	3369.58	3324.10	3317.48
6.	Output value (Rs)	27920	30720	33520	37400	32360
7.	Net income (Rs)	5994.75	4608.95	5282.9	6319.65	5521.55
8.	Family labour income	6594.77	5678.95	6562.9	7889.65	6651.55
9.	Farm business income	15923.42	15377.7	17288.55	20021	17122.6
10.	Input-Output ratio	1:1.27	1:1.17	1:1.18	1:1.20	1:1.20

Cost and returns

From the table 6 it is observed that on an average Cost A1, Cost A2, Cost A2+family labour, Cost B1, Cost B2, Cost C1, Cost C2 and Cost 3 were worked out to Rs.15237.4, Rs. 15327.4, Rs. 18987.35, Rs. 15610.93, Rs. 25708.45, Rs. 19360.93, Rs. 29458.4 and Rs.31080.01 per

hectare respectively for the sample farms. The average income over different cost i.e. income over Cost A, A2, A2+family labour, B1, B2, C1, C2 and C3 were Rs. 17122.6, Rs.17122.6, Rs. 13372.65, Rs.16749.07, Rs. 6651.55, Rs. 12999.07, Rs.2901.6 and Rs. 1279.99 per hectare.

Table 6: Details of total cost, cost concept wise income over different cost in kodo millet (Rs/ha)

S. No.	Particulars	Farm size				
		Marginal	Small	Medium	Large	Overall
A	Break-up of cost					
1	Cost A1	11996.58	15342.3	16231.45	17379	15237.4
2	Cost A2	11996.58	15342.3	16231.45	17379	15237.4
3	Cost A2+family labour	16196.6	19242.3	19831.45	20679	18987.35
4	Cost B1	12316.23	15689.05	16618.1	17820.35	15610.93
5	Cost B2	21325.23	25041.05	26957.1	29510.35	25708.45
6	Cost C1	16516.23	19589.05	20218.1	21120.35	19360.93
7	Cost C2	25525.23	28941.05	30557.1	32810.35	29458.4
8	Cost C3	27077.75	29835.15	32012.81	35394.35	31080.01
B	Income over different cost					
9	Income over cost A1	15923.42	15377.7	17288.55	20021	17122.6
10	Income over cost A2	15923.42	15377.7	17288.55	20021	17122.6
11	Income over A2+FL	11723.4	11477.7	13688.55	16721	13372.65
12	Income over Cost B1	15603.77	15030.95	16901.9	19579.65	16749.07
13	Income over Cost B2	6594.77	5678.95	6562.9	7889.65	6651.55
14	Income over Cost C1	11403.77	11130.95	13301.9	16279.65	12999.07
15	Income over Cost C2	2394.77	1778.95	2962.9	4589.65	2901.6
16	Income over cost C3	842.25	884.85	1507.19	2005.65	1279.99

Economics of little millet crop

The output of yield value per hectare and cost of production per qt. of little millet on sample farms have been worked out in table 7. The table revealed that the average yield per hectare of little millet was 6.57 qt. The cost of

production per qt. on an average estimated Rs 1776.95. production cost for marginal, small, medium and large farms was found Rs. 1776.95, Rs. 1637.70, Rs. 1962.28, Rs.1918.12 and Rs. 1614.92 per qt. respectively. It decreased with the rise in farm size due to higher yields to give large farm's cost

of cultivation. The average production value per hectare came to Rs.16425 It was Rs. 12450, Rs.1962.28, Rs 1918.12 and Rs. 1614.92 per hectare respectively on the marginal, small, medium and large farms. The higher output value was associated with the higher yield on large farms. Sample farms of different size groups have been worked out for net

income, family labour income and farm business income per hectare in table 4.13 and fig4.16. It can be observed from the table 7 that on an average the value of net income Rs. 3429.45, family labour income Rs. 4795.43 and farm business income Rs. 8489.05 per hectare. Estimated value of average input-output in little millet was 1.40.

Table 7. Details of cost and return of little millet (Rs. /qtl. /ha.)

S.N.	Particulars	Farm Size				
		Marginal	Small	Medium	Large	Overall
1.	Gross cost (Rs/ha)	8155.76	11675.6	13139.13	13726.83	11674.57
2.	Yield (qt/ha)	4.98	5.95	6.85	8.5	6.57
3.	Price (Rs/qt)	2500	2500	2500	2500	2500
4.	Value of production(Rs/ha)	12450	14875	17125	21250	16425
5.	Cost of production (Rs/qt)	1637.70	1962.28	1918.12	1614.92	1776.95
6.	Output value (Rs)	12450	14875	17125	21250	16425
7.	Net income (Rs)	3569.85	2345.88	3858.75	6443.35	3429.45
8.	Family labour income	4314.24	3819.4	4955.88	8593.17	4795.43
9.	Farm business income	7211.7	7253.55	9044.42	12947.52	8489.05
10.	Input-Output ratio	1:1.52	1:1.27	1:1.30	1:1.54	1:1.40

Cost and returns

From the table 8 it is observed that on an average Cost A1, Cost A2, Cost A2+family labour, Cost B1, Cost B2, Cost C1, Cost C2 and Cost 3 were worked out to Rs.7310.95, Rs. 7310.95, Rs. 9010.95, Rs. 7451.07, Rs. 11004.57, Rs. 9151.07, Rs. 12704.57 and Rs. 13974.77 per hectare

respectively for the sample farms. The average income over different cost i.e. income over Cost A, A2, A2+family labour, B1, B2, C1, C2 and C3 were Rs. 8489.05, Rs.8489.05, Rs. 6789.05, Rs.8348.93, Rs. 4795.43, Rs. 6648.93, Rs.3095.43 and Rs. 1825.23 per hectare.

Table 8. Break-up of total cost and income over different cost in little milles crop (Rs/ha)

Particulars	Farm size				
	Marginal	Small	Medium	Large	Overall
Break-up of cost					
Cost A1	5238.3	7621.45	8080.58	8302.48	7310.95
Cost A2	5238.3	7621.45	8080.58	8302.48	7310.95
Cost A2+family labour	7338.3	9471.45	9580.58	9652.5	9010.95
Cost B1	5331.76	7751.6	8243.12	8476.83	7451.07
Cost B2	8135.76	11055.6	12169.12	12656.83	11004.57
Cost C1	7431.76	9601.6	9743.12	9826.83	9151.07
Cost C2	10235.76	12905.6	13669.12	14006.83	12704.57
Cost C3	11259.35	14196.16	15036.03	15407.51	13974.77
Income over different cost					
Income over cost A1	7211.7	7253.55	9044.42	12947.52	8489.05
Income over cost A2	7211.7	7253.55	9044.42	12947.52	8489.05
Income over A2+FL	5111.7	5403.55	7544.42	11597.5	6789.05
Income over Cost B1	7118.24	7123.4	8881.88	12773.17	8348.93
Income over Cost B2	4314.24	3819.4	4955.88	8593.17	4795.43
Income over Cost C1	5018.24	5273.4	7381.88	11423.17	6648.93
Income over Cost C2	2214.24	1969.4	3455.88	7243.17	3095.43
Income over cost C3	1190.65	678.84	2088.97	5842.49	1825.23

The output of yield value per hectare and cost of production per qt. of finger millet on sample farms have been worked out in table 9. The table revealed that the average yield per hectare of finger millet was 14.4 qt. The cost of production per qt. on an average estimated Rs 2504.21. production cost for marginal, small, medium and large farms was found Rs. 2572.51, Rs.2413.09, Rs. 2203.00 and Rs. 2164.40 per qt. respectively. It decreased with the rise in farm size due to higher yields to give large farm's cost of cultivation. The average

production value per hectare came to Rs. 38880. It was Rs. 39200, Rs.45675, Rs 55930 and Rs. 46926 per hectare respectively on the marginal, small, medium and large farms. The higher output value was associated with the higher yield on large farms. It can also be observed from the table on an average the value of net income Rs. 9863.98, family labour income Rs. 9963.25 and farm business income Rs. 20839.48 per hectare. Estimated value of average input-output in finger millet was 1.16.

Table 9. details of cost and return per quintal of finger millet (Rs./qtl./ha.)

S.No.	Particulars	Farm Size				
		Marginal	Small	Medium	Large	Overall
1.	Gross cost	28812.15	31490.86	35203.98	37617.04	33336.02
2.	Yield	11.2	13.05	15.98	17.38	14.4
3.	Price	3500	3500	3500	3500	3500
4.	Value of production	39200	45675	55930	46926	38880
5.	Cost of production	2572.51	2413.09	2203.00	2164.40	2508.35
6.	Output value	39200	45675	55930	46926	38880
7.	Net income	10387.85	14184.14	20726.02	9308.96	9863.98
8.	Family labour income	11187.85	15454.14	22166.02	11078.96	9963.25
9.	Farm business income	22758.25	28204.79	37280.38	27325.5	20839.48
10.	Input-Output ratio	1:1.36	1:1.45	1:1.58	1:1.24	1:1.16

Cost and returns

From the table 10 it is observed that on an average Cost A1, Cost A2, Cost A2+family labour, Cost B1, Cost B2, Cost C1, Cost C2 and Cost 3 were worked out to Rs.18040.52, Rs. 18040.52, Rs. 22353.02, Rs. 18531.5, Rs. 28916.75, Rs. 22844, Rs. 33229.25 and Rs.

36900.35 per hectare respectively for the sample farms. The average income over different cost i.e. income over Cost A, A2, A2+family labour, B1, B2, C1, C2 and C3 were Rs. 20839.48, Rs.20839.48, Rs. 16526.98, Rs.20348.5, Rs. 9963.25, Rs. 16036, Rs.5650.75 and Rs. 1979.15 per hectare.

Table 10. Details of total cost and income over different cost infinger millet crop (Rs/ha)

Particulars	Farm size				
	Marginal	Small	Medium	Large	Overall
Break-up of cost					
Cost A1	16441.75	17470.21	18649.62	19600.5	18040.52
Cost A2	16441.75	17470.21	18649.62	19600.5	18040.52
Cost A2+family labour	21541.75	21970.21	22849.62	23050.5	22353.02
Cost B1	16840.15	17921.86	19182.98	20181.04	18531.5
Cost B2	28012.15	30220.86	33763.98	35847.04	28916.75
Cost C1	21940.15	22421.86	23382.98	23631.04	22844
Cost C2	33112.15	34720.86	37963.98	39297.04	33229.25
Cost C3	63423.36	38192.94	41760.37	43226.74	36900.35
Income over different cost					
Income over cost A1	22758.25	28204.79	37280.38	27325.5	20839.48
Income over cost A2	22758.25	28204.79	37280.38	27325.5	20839.48
Income over A2+FL	17658.25	23704.79	33080.38	23875.5	16526.98

Income over Cost B1	22359.85	27753.14	36747.02	26744.96	20348.5
Income over Cost B2	11187.85	15454.14	22166.02	11078.96	9963.25
Income over Cost C1	17259.85	23253.14	32547.02	23294.96	16036
Income over Cost C2	6087.85	10954.14	17966.02	7628.96	5650.75
Income over cost C3	2776.64	7482.06	14169.63	3699.26	1979.15

Marketing pattern of millets

Marketing channels

The following two marketing channels are given below for minor millets:

Channel –I : Producer → Consumers.

Channel –II : Produce → Retailers of minor millets → Consumers.

Marketing cost and price spread

The below table 11 clearly indicates the marketable surplus of kodo millet, little millet and finger millet were 30.57 qt.,20.43 qt.,46.17qt. and total production were 28.91 qt., 23.08qt. and 50.28 qt. respectively. The overall average of marketable surplus of kodo millet was 90.70 percent, little millet

was 88.60 percent and finger millet was 91.80 percent of the total production. It was noticed from table that in kodo millet higher marketable surplus was witnessed in large size farm, in little millet it was witnessed in medium size farm and in finger millet it was witnessed in marginal size of farm.

Table 11. Marketable surplus of minor millets of sample farmers (qt/farm)

Particulars	Marginal	Small	Medium	Large	Overall
Kodo Millet					
Total production	20.43 (100)	24.75 (100)	39.38 (100)	50.10 (100)	28.91(100)
Retain for seed	0.98 (4.80)	1.05 (4.25)	1.75 (4.45)	2.02 (4.03)	2.29 (4.38)
Consumption	1.00 (4.90)	1.25 (5.05)	1.98 (5.02)	2.35 (4.70)	2.95 (4.92)
Total quantityutilized	1.98 (9.70)	2.3 (9.30)	3.73 (9.47)	4.37 (8.75)	5.24 (9.30)
Marketable surplus	18.45 (90.30)	22.45 (90.70)	35.65 (90.53)	45.73 (91.25)	30.57 (90.70)
Little Millet					
Total production	15.13 (100)	18.20 (100)	28.07 (100)	30.92 (100)	23.08 (100)
Retain for seed	0.65 (4.30)	0.98 (5.38)	1.30 (4.63)	1.90 (6.15)	1.20 (5.20)
Consumption	0.75 (4.95)	1.05 (5.76)	1.95 (6.95)	2.00 (6.45)	1.43 (6.20)
Total quantityutilized	1.4 (9.25)	2.03 (11.15)	3.25 (11.60)	3.90 (12.60)	2.65 (11.40)
Marketable surplus	13.73 (90.75)	16.17 (88.85)	24.82 (88.40)	27.02 (87.40)	20.43 (88.60)
Finger Millet					
Total production	35.92 (100)	48.07 (100)	54.65 (100)	62.50 (100)	50.28 (100)
Retain for seed	1.00 (2.78)	1.25 (2.60)	1.98 (3.62)	2.05 (3.30)	1.57 (3.15)
Consumption	1.95 (5.53)	2.15 (4.47)	2.95 (5.40)	3.12 (4.50)	2.54(5.05)
Total quantityutilized	2.95 (8.22)	3.4 (7.07)	4.93 (9.02)	5.17 (8.30)	4.11 (8.20)
Marketable surplus	32.97 (91.78)	44.67 (92.93)	49.72 (90.98)	57.33(91.70)	46.17 (91.80)

Note: Figures in parenthesis denotes the percentages of total quantity produced.

Marketing charges and price spread of minor millets

It was obtained from table 12 that, the total marketing charges paid by producer in channel-I was Rs. 95 and in channel- II it was found Rs.145 per quintal. Total marketing charges paid by retailer

was obtained Rs. 225 per quintal. For channel, price paid by the consumer was obtained Rs.1225 per qt. and producer’s share in consumer’s rupee in channel-I was obtained 88.82 percent and for channel II it was obtained 85.5 percent.

Table 12. Marketing charges paid by various intermediaries in different channels of minor millet crops (Rs/qt.)

S. No.	Particulars	Overall	
		Channel-I	Channel-
A. Marketing cost incurred by producer			
1	Transportation charge	55	65
2	Cleaning	0	30
3	Mandi Fees	0	0
4	Loading/Unloading Charge	40	50
	Subtotal	95	145
B. Marketing cost incurred by retailer			
1	Transportation charge		70
2	Mandi fees		40
3	Weighting and packaging		65
4	Loading/unloading charge		50
5	Miscellaneous		
	Subtotal		225

Table 13. Price spread of minor millets in different channels (Rs./qt.)

S. No.	Particulars	Overall	
		Channel-I	Channel-
1	Gross price received by farmers	850	1000
	i) Cost incurred by farmer	95	145
	ii) Net price received by farmer	755 (88.82)	855 (85.5)
2	Retailer		
	i) Price paid		1150
	ii) marketing cost		225
	iii) Marketing margin		199.5
	iv) Price received		950.50
3	Consumer		
	i) Price paid	850	1225
	Price spread	95	430.5
	MC+MM	95	524.5
4	Producer's share in consumer's rupee	88.82	85.5

Marketing Efficiency

Table 14 reveals that in channel-I total marketing cost was found Rs.95 per qt. and price paid by consumer was Rs. 850 per quintal, thus marketing efficiency ratio obtained was 8.94. In channel- total

marketing cost was found Rs.370, total marketing margin was Ra. 199.5 and price paid by consumer was Rs. 1225 per quintal, thus marketing efficiency ratio was obtained 3.31.

Table 14. Different marketing channel of minor millets in tribal farmers of selected area (Rs./qt.)

S.No.	Particulars	Channel-I	Channel- II
1	Net price received by farmers	755	855
2	Total Marketing Cost	95	370
3	Total marketing margin	0.0	199.5
4	MM+MC	95	524.5
5	Price paid by consumer	850	1225
6	Marketing efficiency ratio	8.94	3.31

Constraints

It was observed that the constraints in production of minor millets was lack of technical knowledge i.e. 95.87 percent followed by lack of resources was 90.72 percent and low productivity was 79.38. and constraints in marketing faced by the

respondents of minor millets are presented in table 16 less price of crop i.e. 92.78 percent followed by lack of co-operative and regulated market was ranked first i.e. 90.72 percent in the study area.

Table 15. Constraint in production of minor millets of tribal farmers.

S.No.	Constraints	No. of farmers	Rent
1	Lack of technical knowledge	93(95.87)	
2	Lack of unavailability resources	88(90.72)	
3	Low productivity	77(79.38)	
4	Lack of HYV seeds	65(67.01)	
5	Lack of recommended package practices of crops	50(51.55)	
6	Lack of financing	54(55.67)	
7	Lack of soil testing facilities	45(46.40)	

Note: Figures in the parenthesis denotes the percentage of overall farmers (N=97)

Table 16. Constraint in marketing of minor millets of tribal farmers.

S.No.	Constraints	No. of farmers	Rank
1	Less remunerative price of crop millets	90 (92.78)	I.
2	Non availability of Market intelligence and marketing news were	82 (84.53)	II.
3	Lack of co-operative and regulated market	88(90.72)	III.
4	Lack of timely transportation service from village to market	72 (74.23)	IV.
5	Insufficient storage facilities	54	V.

Note: Figures in parenthesis denotes the percentage of overall farmers (N=97)

Conclusion:-

The study concludes that minor millets offer significant opportunities for tribal farmers in Chhattisgarh to diversify their income sources, improve food security, and contribute to environmental sustainability. The study highlights the growing demand for minor millets due to their nutritional value, gluten-free status, and cultural significance. The major constraints in marketing minor millets include lack of market access (95.87%), non-availability of marketing news and market intelligence (84.53%), and lack of cooperative and regulated markets (90.72%). The major constraints in producing minor millets include lack of technical knowledge (92.78%) and lack of resources (90.72%). The marketing efficiency ratio was 8.94 for Channel-I (Producer-Consumer) and 3.31 for Channel-II (Producer-Retailer-Consumer). The average cost of cultivation per quintal of kodo millet, little millet, and finger millet was Rs. 3317.50, Rs. 1776.95, and Rs. 11674.57, respectively. The overall

input-output ratio was 1:1.20, 1:1.40, and 1:1.16 for kodo millet, little millet, and finger millet, respectively. The study concludes that minor millets offer significant opportunities for tribal farmers in Chhattisgarh to diversify their income sources, improve food security, and contribute to environmental sustainability. However, addressing the challenges related to market access, infrastructure, and policy support is crucial to promoting minor millets as a viable and sustainable agricultural option. However, addressing the challenges related to market access, infrastructure, and policy support is crucial to promoting minor millets as a viable and sustainable agricultural option.

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Economic analysis of tomato production under drip irrigation method in Western Maharashtra

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ABSTRACT

This study was carried out to assess the economic benefits of drip irrigation over the surface irrigation systems pertains to the cultivation of summer tomato in western Maharashtra of India. For this purpose, the primary data was collected from 80 farmers comprises of 40 adoptors and 40 non-adoptors of drip irrigation method. The collected data is analyzed on the basis of tabular method with simple statistical tools including averages, percentage and frequency distribution. Furthermore, the internal rate of returns (IRR), Net Present Worth (NPW) and benefit-cost ratio (BCR) were also computed to examine the economic viability of the investment made for drip irrigation system. The tomato productivity was higher by 26.63 per cent in respect of drip farms than that of non-drip farms. In case of drip farms, the net returns from tomato were noticed to Rs. 64000.62. Such returns were higher by Rs. 50346.07 than that of non-drip farms. In case of drip farms, the per quintal cultivation cost of summer tomato was Rs. 433.96 and for non-drip farms it was Rs. 463.44. The IRR was found 31.04 per cent which was more than the market rate of interest indicates that, the investment made on drip irrigation set was economically viable. Therefore, it is recommended that the adoption of drip irrigation method be encouraged among the farmers for efficient use of irrigation water.

Key words: Tomato, water use efficiency, productivity, drip irrigation,

INTRODUCTION

Groundwater has emerged as a predominant source of fresh water to fulfill increasing water demand of various sector of economy (Matthew *et al.* 2009, Singh *et al.* 2019, Jia *et al.* 2020). India endowed with world's largest area under irrigation and primarily dependent on groundwater (Shah 2009). Indian agriculture sector alone consumes 89% of total groundwater draft as irrigation (Kishore *et al.* 2022). The increasing dependence on groundwater resulted into faster depletion of groundwater resources in the country and more serious in Maharashtra also. In the context of over exploitation of groundwater causing water scarcity, more efficient irrigation method like micro-irrigation could be a suitable demand management measure. Properly designed and managed drip and sprinkler irrigation system have irrigation efficiency about 90% and 70% respectively, contrast to surface irrigation method with 40% (INCID 1994, Dhawan 2002, Saleth 2009). At overall, micro-irrigation shows superiority over other traditional irrigation methods in term of water-use efficiency, energy saving, yield increase and water productivity (Narayanamoorthy and Deshpande 2005, Kumar and Palanisami 2010,

Chandrakanth *et al.* 2013). In year 2015, government bundled all ongoing irrigation schemes as Pradhan Mantri Krishi Sinchayee Yojna (PMKSY) in which micro-irrigation is an integral component. With this backdrop, this study is an attempt for economic evaluation of this drip irrigation method is essential for providing justification to its high investment in the context of different merits including water saving and gain in yield of commercially important crop such as tomato.

METHODOLOGY

The study was conducted in Western Maharashtra, India. The tahsilwise acreage along with related information (2022-23) of summer tomato under micro-irrigation followed in Ahmednagar and Nashik districts were obtained from the District Superintendent Agricultural Office, of respective districts. The drip irrigation method for tomato has become popular in these districts. Therefore, the said districts were purposively selected for the present study.

On the basis of collected data, area of summer tomato under micro-irrigation in Sangamner and Igatpuri tahsils was 1856.80 and 1123.16 hectares (2021-22) which constituted nearly 16.43

and 8.61 per cent of the total area of this crop under micro-irrigation in Ahmednagar and Nashik districts, respectively. So, these tahsils were selected on area proportionate basis for the present study.

The lists of drip adopting summer tomato cultivators were obtained from the Taluka Agricultural Office of these respective tahsils. Through such lists, the villages namely Nimaj and Khandgaon from Sangamner tahsil and the villages Pimpalgaon Ghadga and Sakuri from Igatpuri tahsil were selected on highest area basis. The farmers using 'drip' and 'surface' irrigation methods for tomato crop are respectively termed as drip adoptors and drip non-adoptors. Ten drip adoptors and the same number of drip non-adoptors from each selected villages of these corresponding tahsils were chosen by simple randomization method. Accordingly, the sample size maintained from each selected tahsil was of 20 adoptors and 20 non-adoptors of drip irrigation method. Thus, the total sample size from these two tahsils comprised of 40 adoptors and 40 non-adoptors of drip irrigation method.

The farmers who cultivate summer tomato using water available from well and bore wells for irrigation by applying drip and surface

methods were considered only for the study. This was practiced to avoid the differential impact of source of irrigation on tomato productivity. The farmers who cultivate tomato using surface method of irrigation and are located nearer to the field of drip adoptors were selected purposively as drip non-adoptors. This was practiced so as to minimize the differences between soil quality and other agro-climatic factors in case of both of the categories of farmers.

The data on different aspects of summer tomato cultivation pertaining to year 2022-23 were collected with the help of specially designed pretested questionnaire. A tabular method was used in most of the parts of this investigation for estimating result from collected data. In order to judge the economic viability of investment on drip irrigation set for tomato production, the NPW, BCR and IRR were computed by using the discounted cash flow techniques (Navadkar *et.al.*, 2017).

RESULTS AND DISCUSSION

Investment on drip irrigation set

The per hectare investment on drip irrigation set for summer tomato grown by sample farmers is given in Table 1.

Table 1: Per hectare investment on drip irrigation set for summer tomato

Sr. No.	Particulars of drip set components	Unit	Quantity	Cost (Rs.)	%
1	PVC pipe (Main)	m	175	3850.00	3.09
2	PVC pipe (Sub-Main)	m	100	1550.00	1.24
3	LDPE Lateral	m	8250	97350.00	78.17
4	GTO for LDPE	No.	175	665.00	0.53
5	Screen filter	No.	2	6200.00	4.98
6	Control valve	No.	2	980.00	0.79
7	Flush valve	No.	2	1160.00	0.93
8	Lateral end cap	No.	175	498.75	0.40
9	Venchury / Injecting Pump	No.	2	6314.00	5.07
10	Other (Elbow, Joiner, Reducer, Pressure gauge)	No.	-	2225.00	1.79
11	Installation charges	Rs.	3750	3750.00	3.01
	Total		-	1,24,542.75	100.00

The per hectare total investment on drip irrigation set for summer tomato (including installation charges) was Rs. 1,24,542.75. The important items of total investment were expenditure on LDPE lateral (78.17 per cent) followed by Venchury / Injecting Pump (5.07 per cent), screen filter (4.98 per cent) and PVC pipe for main line (3.09

per cent). The per hectare charges incurred on installation of drip irrigation set for summer tomato has constituted 3.01 per cent of the total investment.

Cost of cultivation of summer tomato

The magnitude and structure of cultivation cost of summer tomato grown by drip adoptors and drip non-adoptors varied in accordance

with the differentials in use levels of various inputs for this crop. The details of cost of cultivation of summer tomato crop are presented in Table 2.

The interest on working capital was calculated at the rate of 6.00 per cent per annum. The depreciation on drip set component was computed by flat rate of 10 per cent of drip set's total investment. The interest on drip set's fixed capital (total investment of Rs. 1,24,542.75) was estimated at the rate of 10.00 per cent per annum and the it was amortized into two seasons in a year.

The total cultivation cost (i. e. Cost 'C') of summer tomato cultivated by drip adopters

was worked out to Rs. 4,32,331.13, whereas, it was observed to Rs. 3,64,614.85 in case of drip non-adopters. It seems that the cultivation cost of summer tomato was higher by Rs. 67,716.28 in respect of former category of cultivators as compared to latter. Among the different items of cultivation cost of summer tomato, the total human labour (hired & family), rental value of land, fertilizer & micro-nutrients , plant protection and manures, were the major items with share of 24.79, 19.13, 10.26, 8.24 and 8.23 per cent, respectively in case of drip adopters category of farms.

Table 2: Per hectare cost of cultivation of summer tomato

Sr. No	Item of cost		Drip adopters			Drip non-adopters		
			Quantity	Cost (Rs.)	%	Quantity	Cost (Rs.)	%
1	Hired human labour (Man days)	Male	52.50	19425.00	4.49	37.50	13875.00	3.81
		Female	185.00	48100.00	11.13	152.50	39650.00	10.87
2	Bullock labour (Pair days)		0.83	1650.00	0.38	1.25	2500.00	0.69
3	Machine power		-	16975.00	3.93	-	17575.00	4.82
4	Manures (Qtls.)		117.83	35597.50	8.23	104.18	31145.00	8.54
5	Seedlings (Nos.)		18907.50	24579.75	5.69	19707.50	25225.60	6.92
6	Fertilizers/Micronutrients			44358.30	10.26		37890.15	10.39
7	Plant protection			35637.50	8.24		33120.00	9.08
8	Weedicide			612.50	0.14		2642.50	0.72
9	Mulching paper			7968.00	1.84		-	-
10	Staking of plants			24682.50	5.71		19875.00	5.45
11	Irrigation charges			8385.75	1.94		8917.50	2.45
12	Incidental expenditure			700.00	0.16		662.50	0.18
13	Repairs on farm imple./machi.			1175.00	0.27		1075.00	0.30
14	Working capital			269846.80	62.42		234153.25	64.22
15	Interest on working capital			16190.81	3.75		14049.20	3.85
16	Depreciation on farm imple./machi.			5395.00	1.25		4900.00	1.34
17	Depreciation on drip set			5604.42	1.30		-	-
18	Land revenue & other taxes			32.13	0.01		32.25	0.01
19	Cost 'A'			297069.16	68.73		253134.70	69.42
20	Rental value of land			82689.83	19.13		63012.65	17.28
21	Interest on fixed capital			6695.00	1.55		5392.50	1.48
22	Interest on drip set capital			6227.14	1.44		-	-
23	Cost 'B'			392681.13	90.83		321539.85	88.18
24	Family labour (Man days)	Male	65.00	24050.00	5.56	72.50	26825.00	7.36
		Female	60.00	15600.00	3.61	62.50	16250.00	4.46
25	Cost 'C'			432331.13	100.00		364614.85	100.00
26	Output (qtls.)		996.25	496331.75		786.75	378269.40	
27	Per qtl cost (Rs.)			433.96			463.44	

As regards to drip non-adopters category also the major items of cultivation cost were

the total human labour (hired & family), rental value of land, fertilizer & micro-nutrients , plant protection

and manures constituting share of 26.50, 17.28, 10.39, 9.08 and 8.54 per cent, respectively. In respect of drip adopters category of farmers, the cost 'A' and 'B' were estimated to Rs. 2,97,069.16 and Rs. 3,92,681.13, while, these costs were observed to Rs. 2,53,134.70 and Rs. 3,21,539.85 in case of drip non-adopters category, respectively. Such costs in regard to drip adopters growing summer tomato crop were noticed as higher by Rs. 43,934.46 and Rs. 71,141.28. The mulching paper, depreciation on drip set and interest on fixed capital of drip set were the additional items of costs incurred by drip adopters as compared to non-adopters and it was around 4.58 per cent of the total cost, which resulted in high cost of tomato cultivation.

Profitability of summer tomato

Table 3: Per hectare cost and returns of summer tomato

Sr. No.	Particulars	Drip adopters	Drip non-adopters	Additional costs & returns	% change	IBCR
1	Production (Qtls.)	996.25	786.75	-	26.63	
2	Gross returns (Rs.)	496331.75	378269.40	118062.35	31.21	
3	Cost 'A' (Rs.)	297069.16	253134.70	43934.46	17.36	2.69
4	Cost 'B' (Rs.)	392681.13	321539.85	71141.28	22.13	1.66
5	Cost 'C' (Rs.)	432331.13	364614.85	67716.28	18.57	1.74
6	Profit at cost 'A' (Rs.)	199262.59	125134.70	74127.89	59.24	
7	Profit at cost 'B' (Rs.)	103650.62	56729.55	46921.07	82.71	
8	Profit at cost 'C' (Rs.)	64000.62	13654.55	50346.07	368.71	
9	B:C ratio at cost 'A'	1.67	1.49			
10	B:C ratio at cost 'B'	1.26	1.18			
11	B:C ratio at cost 'C'	1.15	1.04			

The cost 'A', 'B' and 'C' were found to be higher by 17.36, 22.13 and 18.57 per cent in respect of drip adopters category than that of drip non-adopters. The per hectare net returns at cost 'A' were noticed as higher by Rs. 74,127.89 in case of former category of farms than the latter, whereas, that was found higher by Rs. 50,346.07 at cost 'C' in respect of drip adopters category of farmers as compared to drip non-adopters. At estimated gross costs and gross returns of respective categories of sample farmers, the B:C ratio for summer tomato produced by drip adopters was 1.15 and it was 1.04 in case of drip non-adopters. While, the IBCR of added returns and added costs was observed to 2.69, 1.66 and 1.74 at cost 'A', 'B' and 'C', respectively.

The comparative estimates of per hectare production, gross returns and profit at different levels of costs are presented in Table 3.

It is evident from table that the per hectare production of summer tomato in the case of drip adopters category of farmers was 996.25 quintals, while, it was 786.75 quintals in respect of drip non-adopters. The higher production of 26.63 per cent i. e. 209.50 quintals was found in the case of former category of farmers as compared to latter. It indicates that the per hectare production of summer tomato cultivated by drip adopters was relatively higher than the drip non-adopters in quantitative as well as in a qualitative terms. The magnitude of per hectare gross returns in respect of drip adopters was observed to Rs. 4,96,331.75 as against Rs. 3,78,269.40 in case of drip non-adopters.

Water and electricity consumption, saving and efficiency

The estimates of per hectare cultivation cost, water and electricity consumption of tomato crop grown by drip adopters and non-adopters were worked out and presented in Table 4.

It is apparent from table that the per quintal cultivation cost of summer tomato crop in respect of drip adopters category was estimated to Rs. 433.96, which was lower by 6.36 per cent than that of drip non-adopters (Rs. 463.44). This was mainly because of higher yield of tomato crop produced by drip adopters.

Table 4: Comparative water and electricity consumption, saving and efficiency

Sr. No.	Particulars	Drip adopters	Drip non-adopters	% change
1	Yield of tomato (Qtls./Ha.)	996.25	786.75	26.63
2	Cultivation cost of tomato (Rs./Ha.)	4,32,331	3,64,614	18.57
3	Cultivation cost of tomato (Rs./Qtl.)	433.96	463.44	-6.36
4	Water consumption (HP Hrs./Ha.)	627.04	861.97	-27.25
5	Water saving (HP Hrs./Ha.)	234.92	-	-
6	Water use efficiency			
	a) Output per water use (Qtls./HP Hrs.)	1.59	0.91	74.07
	b) Water used per Qtls. of output (HP Hrs./Qtls.)	0.63	1.10	-42.55
7	Electricity consumption (Kwh./Ha.)	470.28	646.47	-27.25
8	Electricity saving (Kwh./Ha.)	176.19	-	-
9	Electricity use efficiency			
	a) Output per electricity use (Qtls. / Kwh.)	2.12	1.22	74.07
	b) Electricity used per Qtls. of output (Kwh./Qtls.)	0.47	0.82	-42.55

(HP hours = No. of hours of electric motor in operation × HP of electric motor)

(Kwh. = No. of hours of electric motor in operation × 0.750 Kwh)

The per hectare water consumption for any crop is determined by various factors viz; horse power of pump set, water level in well, size of delivery pipe, distance between place of water source and field of a crop to be irrigated, type of soil, etc. These factors considerably vary across the farms. Most of the research stations measure water consumption in terms of centimeters (cm) on installation of drip irrigation system. But in practice, the measurement of water in terms of centimeters is not an easy task at field level. It is due to that the horse power (HP) of pump set and water level in well differ from farm to farm. In order to overcome such difficulties, the water consumption in case of present study was computed in terms of HP hours of electric motor in operation to irrigate the tomato crop. Therefore, the HP hours were calculated by multiplying the HP of pump set with hours of water used to irrigate this crop. The per hectare water consumption for summer tomato produced under drip irrigation system was 627.04 HP hours. It was significantly lower (27.25per cent) as compared to summer tomato cultivated under surface method of irrigation. The latter method of irrigation has required 861.97 HP hours for the same work. This has indicated per hectare saving of 234.92 HP hours. Such number of hours can be made available for other crops.

The water consumption per unit area is a good indicator to measure the efficiency of water use in respect of both of the categories of farmers growing tomato crop. But, the water consumed to produce one quintal of tomato is the most appropriate method to judge the water use efficiency under these methods of irrigation. With a view to arrive at per quintal water requirement, the per hectare water consumption is divided by per hectare yield of summer tomato. The analysis showed that the summer tomato cultivated by drip irrigation method consumes 0.63 HP hours of water to produce one quintal. While, 1.10 HP hours of water was used to produce one quintal of tomato under surface method of irrigation.

In order to estimate the quantity of electricity saved, it is assumed that the extent of utilization of electric power is 0.750 Kwh per HP for each operation hour of pump set. Since all the sample farmers of both of the categories have used electric pump sets, the HP hours of water consumption for tomato production were multiplied by 0.750 Kwh to arrive at per hectare consumption of electricity. The results indicate that the electricity consumption for summer tomato production in the case of drip adopters category was 470.28 Kwh, whereas, it was 646.47 Kwh in respect of non-adopters. It does mean that the per hectare electricity consumption saved was of 176.19 Kwh. As like in case of water consumption,

the electricity required to produce one quintal of tomato is computed by dividing per hectare electricity consumption by per hectare yield of tomato crop. As regards to drip adopters category, the electricity used to produce one quintal of tomato was estimated to 0.47 Kwh and it was worked out to 0.82 Kwh in respect of drip non-adopters. It shows electricity saving of 0.35 Kwh per quintal of summer tomato produced on drip adopters farm.

Economic viability of investment made on drip irrigation set

In order to judge the economic viability of investment made on drip irrigation set for summer tomato cultivation, the Net Present Worth (NPW), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR) were estimated by utilizing the discounted cash flow technique. Accordingly, the results are presented in Table 5.

Table 5: Economic viability of investment made on drip irrigation set

Particulars	Discount rate %	NPW (Rs.)	BCR	IRR (%)
At original cost and benefits	10	240316.33	1.95	-
	15	183210.60		31.04
	20	141282.30		36.85
At original benefit and 10% increase in cost	10	156623.10	1.77	-
	15	105547.51		25.33
	20	68046.67		29.07
At original cost and 10% decrease in benefit	10	125435.76	1.75	-
	15	80070.74		23.83
	20	46762.73		27.02

To work out the NPW, BCR and IRR, some realistic assumptions were made for estimating the cash inflows and outflows from drip set investment. Such assumptions were, (i) The economic life period of drip set is considered as ten years, (ii) The additional cost and income due to use of drip irrigation system was taken into consideration to estimate the impact of this technology (iii) The cultivation cost and income generated through drip irrigation system was not remaining constant during entire life period of drip set therefore by assuming the conditions viz; At original benefit and 10% increase in cost and then at original cost and 10% decrease in benefit the economic viability of investment made on drip irrigation set was tested (iv) Different discount rates were considered to undertake the sensitivity of investment to change the capital cost. The assumed discount rates were 10, 15 and 20 per cent as alternatives for representing various opportunity costs of capital, (v) The summer tomato crop cultivation technology assumed as unchanged during entire life period of drip set.

The results revealed that the BCR was observed to 1.95, 1.77 and 1.75 at original cost &

benefits, at original benefit & 10% increase in cost and at original cost & 10% decrease in benefit, respectively. Considering discount rates of 10 and 15 per cent, the IRR of drip set investment was arrived to 31.04 per cent, whereas, it was found to 36.85 per cent at discount rates of 15 and 20 per cent at original cost and benefits. IRR was found 25.33 & 29.07 per cent at discount rates of 10 & 15 per cent and 15 & 20 per cent, respectively considering the original benefit and 10% increase in cost. At original cost and 10% decrease in benefit, IRR was found 23.83 & 27.02 per cent at discount rates of 10 & 15 per cent and 15 & 20 per cent, respectively. The IRR was more than the market rate of interest in all the three conditions indicates the economically viable investment made on the drip set for summer tomato.

Constraints faced by sample farmers in adoption of drip irrigation system

The constraints faced by sample farmers in operation of drip irrigation system for summer tomato are depicted in Table 6.

Table 6: Constraints faced by sample farmers in adoption of drip irrigation system

Sr. No	Nature of problem	Drip adopters (N = 40)	%
1	Inconvenience to perform interculturing operations	34	85.00
2	Irregular electric supply with low voltage	31	77.50
3	High investment cost	26	65.00
4	Lack of after sale service	22	55.00
5	Improper pressure hinders uniform distribution of water	21	52.50
6	Clogging of drippers	19	47.50
7	Spare parts are costly	18	45.00
8	Problem of rodents	17	42.50

The 85.00 per cent of the adopters of drip irrigation system for summer tomato have reported the constraint regarding inconvenience to perform interculturing operations, while the constraint of 'irregular electric supply with low voltage, has been raised by 77.50 per cent of the total adopters of drip. The 'high investment cost' was a constraint of 65.00 per cent of the sample cultivators. The 'lack of after sale service' and 'Improper pressure hinders uniform distribution of water' have been faced by 55.00 and 52.50 per cent of the drip adopters respectively. A problem viz., 'Clogging of drippers', 'Spare parts are costly' and 'Problem of rodents' has been reported by 47.50, 45 and 42.50 per cent of the adopter farmers, respectively.

CONCLUSIONS

The tomato productivity was higher by 26.63 per cent in respect of drip farms than that of non-drip farms. In case of drip farms, the net returns from tomato were noticed to Rs. 64000.62. Such returns were higher by Rs. 50346.07 than that of non-drip farms. In case of drip farms, the per quintal cultivation cost of summer tomato was Rs. 433.96 and for non-drip farms it was Rs. 463.44. The IRR was found 31.04 per cent which was more than the market rate of interest indicates that, the investment made on drip irrigation set was economically viable. Inconvenience to perform interculturing operations, irregular electric supply with low voltage, high investment cost and lack of after sale service were reported as some of the major constraints in the adoption of drip irrigation system for summer tomato.

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Status and Constraints of Agro-Tourism Centers in Ratnagiri District of Maharashtra

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ABSTRACT

The current study was conducted to understand the different constraints faced by the Agro tourism centers (ATC's) in Ratnagiri District of Maharashtra. Such research is needed to improve business efficiency, to identify strategies and practices to maximize profitability and guide policies and investment. For this purpose, data was collected from six Agro-tourism centers in four tahsils of Ratnagiri district viz; Khed, Dapoli, Guhagar and Mandangad. To analyse the the different constraints faced by the Agro tourism centres Garrett's ranking technique was used. The results identified the major constraints in Agro tourism centers in this region. The major constraints faced by the entrepreneurs in establishment of ATC's were lack of fund for establishment of ATCs, lack of government support, complexity of license procedure, lack of training for Agro-tourism etc. Whereas major management constraints were high maintenance cost, lack of skilled person, seasonality in arrivals, difficulties in advertisement and other minor constraints were inability to introduce more activities/facilities, lack of awareness of technology advances in ATC, lack of knowledge and skills on the part of the farmer etc.

INTRODUCTION

Agri-tourism a relatively new segment of the agriculture sector, links tourism and agriculture, creating plenty of opportunities for both sectors for its growth. Gannon (1994) defined Agro tourism as "A range of activities, services and amenities provided by farmers and rural people to attract tourists to their area in order to generate extra income for their business." Agro-tourism is an emerging trend in the field of agriculture as well as Indian tourism industry, it is complimentary to traditional agricultural activities.

The activities involved in Agro-tourism include educational visits, staying on a farm, outdoor sports, participation in the rural lifestyle and local community, enjoying locally produced food, enjoyment of the natural environment and rural heritage, cultural activities, gift shop, processing and production tour, tree house, multi-cuisine restaurant, fishing, house boating, hunting, trekking, etc (Jincy

and Reshm, 2022). Agrotourism not just benefit the farmers but society as a whole. Rural people get jobs, agricultural customs and heritage are preserved, local food systems are promoted, and visitors can learn about sustainable farming practices. In general, Agrotourism supports sustainable development.

Objectives

- 1) To examine the status of Agro-tourism centers in Konkan Region
- 2) To analyse the constraints faced by Agro-tourism centers in Ratnagiri District

METHODOLOGY

The present study was be based on primary and secondary data. The primary data was collected from six Agro-tourism centers in four tahsils of Ratnagiri district viz; Khed, Dapoli, Guhagar and Mandangad. Secondary data was collected from research papers, reports of Directorate of tourism, Maharashtra.

Table 1. Details of selected Agro tourism centers (ATC)

Sr. no.	Name of Agro tourism centers	Tahsil	Establishment year
1	Amrutej Nisarg Sahavas	Dapoli	2005
2	Majhya mamachya Gaon Agri-tourism center	Guhagar	2012
3	Bleu Green Exotica Agro-tourism center	Mandangad	2015
4	Shreepooja Agri-tourism center	Guhagar	2016
5	Vakratund Agri-tourism center	Dapoli	2016
6	Green magic Agri-tourism center	Khed	2018

Garrett's Ranking Technique

To analyse the different constraints faced by the Agro tourism centres Garrett's ranking technique was used. Basically, it gives the change of orders of constraints and advantages into numerical scores.

Garrett's formula for converting ranks into per cent is given by

$$\text{Per cent position} = 100 \times (R_{ij} - 0.5) / N_j$$

Where,

R_{ij} = rank given for i^{th} factor by j^{th} individual

N_j = number of factors ranked by j^{th} individual

The per cent position of each rank then converted into scores referring to given by Garret. Individual respondents will be added together and divided by the total number of the respondents for whom response received. These mean scores for all the factors will be arranged in descending order, ranks will be given and most important factors could be identified. Garrett's ranking technique will be

Table 1. Division wise Agro-tourism centres in Maharashtra

Sr. No.	Region	No. of ATC	Per cent to total ATC's
1	Pune	294	42.79
2	Konkan	218	31.73
3	Amravati	33	4.80
4	Nagpur	79	11.50
5	Nashik	56	8.15
6	Aurangabad	7	1.02
Total		687	100

(Source: Directorate of tourism, Maharashtra)

The western costal region of Maharashtra is known as the Konkan region. The Konkan region has geographic, historical, and cultural richness which is favourable for the growth of the tourism sector in the area. "Konkan has the religious milieu and known as the Land of 'Parshuram'". (Patil, S. (2012). Konkan

adopted for studying the problems faced by Agro tourism centres.

RESULT AND DISCUSSION**Status of Agro-tourism centers**

Maharashtra was the first state in the country to recognize the potential of Agrotourism and remained at the forefront of implementing and promoting agri-tourism. At present, there are 687 Agro-tourism centers spread across 36 districts of Maharashtra. There are six administrative divisions of Maharashtra State namely Pune, Konkan, Amravati, Nagpur, Nashik and Aurangabad. Table 2. present the division wise distribution of Agro tourism centers. It reveals that the Pune division is ranked at the top with 42.79% of Agro tourism centers followed by Konkan division with 31.37%, Nagpur (11.50%), Nashik (8.15%), Amravati (4.80) and Aurangabad (1.02%).

region comprises the five districts viz., Palghar, Thane, Raigad, Ratnagiri and Sindhudurg. The Total 218 Agro tourism are registered in Konkan region.

Table 3. depict the district wise Agro tourism centers in Konkan region. Table revealed that Raigad district have the greater number of Agro

tourism centers i.e. 35.78% followed by Palghar Sindhudurg (10.55%) (22.02%), Thane (17.89%), Ratnagiri (13.76%) and

Table 3. Distribution of Agro tourism centers in Konkan region

Sr. no.	District	No. of ATC	Per cent to total ATC's
1	Palghar	48	22.02
2	Thane	39	17.89
3	Raigad	78	35.78
4	Ratnagiri	30	13.76
5	Sindhudurg	23	10.55
Total		218	100

(Source: Directorate of tourism, Maharashtra)

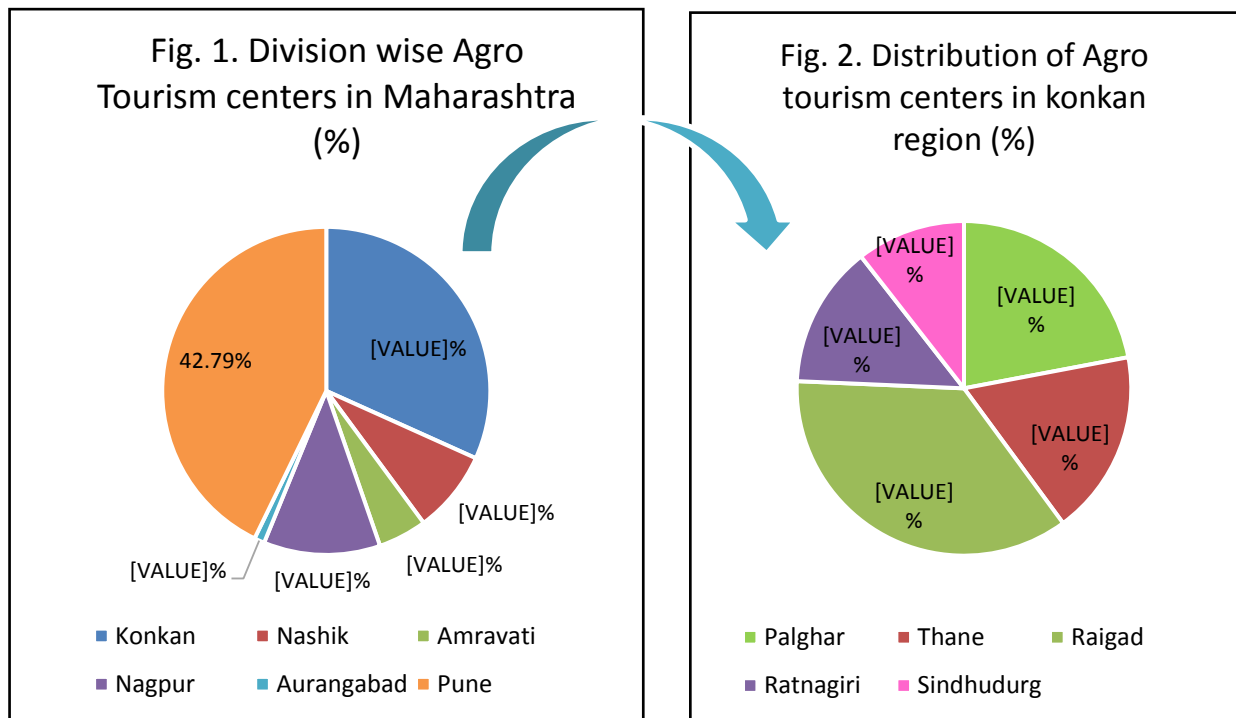


Table 4. Expansion of Agro tourism centers from 2016-2024

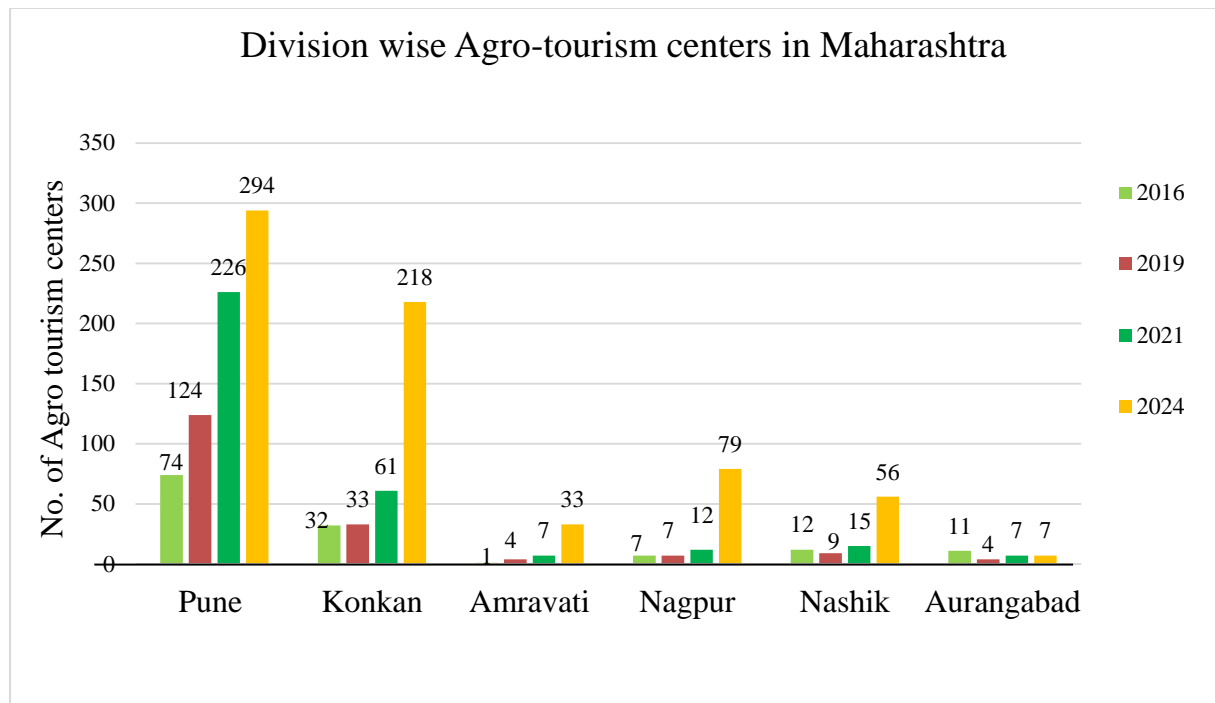
Sr. no.	Division	2016	2019	2021	2024	% change in 2024 over 2016
1	Pune	74	124	226	294	297.30
2	Konkan	32	33	61	218	581.25
3	Amravati	1	4	7	33	3200.00
4	Nagpur	7	7	12	79	1028.57
5	Nashik	12	9	15	56	366.67
6	Aurangabad	11	4	7	7	-36.36
total		137	181	328	687	401.46

(Source: Martindia.org)

The table 4 and fig. 3 shows the expansion of Agro-tourism centers across different divisions from 2016 to 2024. A significant increase is observed in all regions except Aurangabad. Amravati experienced the highest per cent change over 2016 (3200%), followed by Nagpur (1028.57%) and Konkan

(581.25%). Pune had the highest number of Agro-tourism centers (294) in 2024. The total number of centers increased from 137 in 2016 to 687 in 2024, reflecting a 401.46% rise. This suggests a growing interest and investment in Agro-tourism, contributing to rural economic development.

Fig. 3. Expansion of Agro tourism centers from 2016-2024



Constraints face by Agro tourism Centers
In the study area, the entrepreneurs of Agro-

tourism centre experienced a various constraint in establishment of Agro tourism centers.

Table 5. Constraint faced in Establishment of ATC

Sr. No.	Constraints	Mean score	Rank
1	Lack of fund for establishment of ATCs.	70.00	I
2	Non- availability of literature related to Agro-tourism activity.	30.00	VI
3	Lack of government support.	66.17	II
4	Complexity of license procedure of the government departments.	55.17	III
5	Lack of training for Agro-tourism.	43.33	IV
6	lack of basic amenities (water, electricity sanitation etc.)	35.33	V

From the contents of Table 5, it is evident that the Most significant constraint faced by the majority of ATC entrepreneur with highest garrette mean score 70 (Rank I), was Lack of fund for establishment of ATC, as it requires huge investment for setting up of ATC. Lack of government support was the second most significant obstacle that ATC entrepreneur had

to deal, with the garrette mean score 66.17 (Rank II). The other major constraints that the ATC entrepreneur identified were complexity of license procedure of the government departments. (with mean score 55.17 or Rank III), Lack of training for Agro-tourism entrepreneurs (with mean score 43.33 or Rank IV), Lack of basic amenities like

water, sanitation, electricity etc (Rank V having garrette mean score 35.33). The minor constraint encountered was non-availability of literatures related to Agro-tourism activity with the least garrette mean score 30.

Table 6. revealed that the Most prominent constraint faced by the majority of ATC entrepreneur was high cost of maintaining the ATC with highest garrette mean score 77 (Rank I). Lack of skilled person in the ATC for providing services to visitors

was the second most significant issue that ATC entrepreneur had to deal, with the garrette mean score 71.83 (Rank II). The other major constraints that the ATC entrepreneur found were seasonality in arrivals of tourists (with garrete mean score 61.17 or Rank III), Difficulties and high cost required for advertisement (Rank IV with garrete mean score 57), Lack of visitors as the preference for ATC is too less than other tourism sites (Rank V with mean score 47).

Table 6. Constraint faced in management of ATC

Sr. No.	Constraints	Mean score	Rank
1	Maintenance cost is high	77.00	I
2	Inability to introduce more activities / facilities	46.00	VI
3	Lack of awareness of technology advances in ATC	35.50	VII
4	Non-Willingness of the tourists to purchase farm products	21.00	IX
5	Lack of skilled person in Agro-tourism.	71.83	II
6	Lack of knowledge and skills on the part of the farmer	31.83	VIII
7	Difficulties in advertisement	57.00	IV
8	Less number of visitors	47.00	V
9	seasonality in arrivals	61.17	III

The minor constraint encountered while management of ATC were Inability to to introduce the more activities with the garrette mean score 46 (Rank VI), lack of awareness of technology advances in ATC with the garrette mean score 35.5(Rank VII), Lack of knowledge and skills on the part of the farmer (Rank VIII with mean score 31.83), Non willingness of tourists to purchase farm products (Rank IX with mean score 21).

CONCLUSIONS

Agro-tourism is an emerging trend in the field of agriculture as well as Indian tourism industry, it is complimentary to traditional agricultural activities which help the farmers to earn additional income from their existing farm. Maharashtra state has a great potential to the development of Agri-Tourism specially in Konkan region because of its geographical, historical, and cultural richness which attracts the tourist. It was observed that significant increase in number of ATC's in all division of Maharashtra except Aurangabad, suggesting a growing interest and investment in Agro-tourism.

Constraints identification is very important for the growth of this sector. By analysing the constraints, the improvement can be made in investment plan, policies formulation etc. and best resource allocation can be achieved. From this study we come to the conclusion that major constraints faced by the entrepreneurs in establishment of ATC's were lack of fund for establishment of ATCs, lack of government support, complexity of license procedure, lack of training for Agro-tourism etc. Whereas major management constraints were high maintenance cost, lack of skilled person, seasonality in arrivals, difficulties in advertisement and other minor constraints were inability to introduce more activities/facilities, lack of awareness of technology advances in ATC, lack of knowledge and skills on the part of the farmer etc.

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Modelling and Forecasting Retail Prices of Maize for Lasalgaon Market of Maharashtra

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ABSTRACT

Maize is one of the world's most important cereal crops, helping to ensure food security in most poor countries. In India, maize is becoming the third most significant crop after rice and wheat. Hence, it is important to have some idea about future harvest prices before sowing. Therefore, the current study was conducted to develop a model for forecasting maize crop prices based on previous monthly modal maize prices in Lasalgaon market of Maharashtra. The time series data on monthly wholesale price data for a period of 11 years (October 2012 to September 2022) was used for this purpose. To test the reliability of model MAPE, AIC, R² and BIC Criterion were used. The model was validated for the 14 month. The forecasted results suggest that there are expectations of increasing maize prices. Thus, farmers are recommended to increase maize acreage wherever adequate soil and agro-climatic conditions exist.

Key words: Prices, ARIMA, Forecast, ACF and PACF

INTRODUCTION

Maize (*Zea mays L.*) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. It is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 per cent (782 mt) in the global grain production. The United States of America is the largest producer of maize contributes nearly 35 per cent of the total production in the world and maize is the driver of the US economy. The USA has highest productivity (> 11.13 t ha⁻¹) which is double than the global average (5.92 t ha⁻¹). Whereas, the average productivity in India is 3.24 t ha⁻¹.

Maize is the third most important cereal crop in India after rice and wheat and is grown in a wide range of environments, extending from extreme semi-arid to sub-humid and humid region which predominantly occupies 82 per cent of the area under cultivation in the *kharif* season. It accounts for around 10 per cent of total food grain production in the country. The Indian maize sector has several opportunities in all its sub-sectors like seed, non-seed inputs, farm mechanization, processed foods, industrial products, market-related infrastructure, storage, processing etc.

Maharashtra ranked 3rd in area under and 2nd in maize production among different maize producing states in the year 2020-21. Maize is grown in almost all the districts of all the region of Maharashtra. But, Western Maharashtra and Marathwada are major maize producing region of Maharashtra. Nashik has highest area under maize followed by Aurangabad, Dhule, Ahmednagar and Jalgaon and in production, Nashik is at the top followed by Dhule, Aurangabad, Ahmednagar, Jalgaon and Jalna.

METHODOLOGY

Data Collection

The time series data on monthly prices of maize were collected from MSAMB, Pune for Lasalgaon market. The data related to monthly modal prices (Rs./qtl) were collected for the period of October 2012 to September 2022 (11 years) and were used for model fitting.

Auto Regressive Integrated Moving Average (ARIMA) Model

In ARIMA model (Box and Jenkins, 1976), the estimated value of a variable is supposed to be a linear combination of the past values and the past errors. Generally a time series can be modelled as a

combination of past values and errors, which can be denoted as ARIMA (p,d,q) which is expressed in the following form $Y_t = \theta_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \dots + \Phi_p Y_{t-p} + \epsilon_t - \theta_1 \epsilon_{t-1} - \theta_2 \epsilon_{t-2} - \dots - \theta_q \epsilon_{t-q} \dots(1)$ where Y_t and ϵ_t are the actual values and random error at time t , respectively, Φ_i ($i = 1, 2, \dots, p$) and θ_j ($j = 1, 2, \dots, q$) are model parameters, p and q are integers and often referred to as orders of autoregressive and moving average polynomials respectively. Random errors are assumed to be independently and identically distributed with mean zero and constant variance. Similarly, a seasonal model is represented by ARIMA (p, d, q) x (P, D, Q) model, where P = number of seasonal autoregressive (SAR) terms, D = number of seasonal differences, Q = number of seasonal moving average (SMA) terms. The main stages in setting up a forecasting ARIMA model are: (i) Model identification, (ii) Parameters estimation, (iii) Diagnostic checking and (iv) Forecasting. The ARIMA model is basically a data oriented approach that is adopted from the structure of the data itself.

RESULT AND DISCUSSION

I. Forecasting of prices of maize in Lasalgaon market

a. Identification of the Model

A seasonal, non-seasonal or both orders of differencing calculation were used to convert the

Table 1 ACF and PACF of maize prices in Lasalgaon market

Lags	Prices	
	ACF	PACF
1	0.182	0.182
2	0.058	0.025
3	0.007	-0.008
4	-0.176	-0.184
5	0.087	0.160
6	0.036	0.007
7	-0.096	-0.123
8	-0.001	0.000
9	-0.123	-0.072
10	-0.054	-0.018
11	0.045	0.022
12	0.091	0.120
13	-0.026	-0.114
14	-0.068	-0.065
15	-0.255	-0.221
16	-0.137	-0.030

research variables into stationary series before the ARIMA model was estimated. The attainment of stationary series could be through computation of autocorrelation (ACF) and partial auto-correlation functions (PACF) which are presented in the Table 1.

The presence of seasonality in the data was identified by carefully examining ACF and PACF up to 16 lags in the Table 1. However, the coefficient went to zero after the second lag, indicating that the series was stationary. The significance of each individual coefficient of the ACF and PACF was examined using the "t" test. Further, the lack of a peak at the first values demonstrated that the non-seasonal difference with $d=1$ was a suitable choice for achieving stationary series. Hence, based on ACF and PACF many models were tested. Finally, model (2,1,1) was ultimately determined to be the best model for predicting maize prices in the Lasalgaon market.

b. Model estimation

The model parameter was calculated and shown in a table by using SPSS software. From this Table 2, it was observed that the R^2 was 0.898. The value of the normalized BIC was lowest and worked out to 9.605 for the ARIMA (2,1,1) and this showed that the ARIMA model (2,1,1) was best suited for predicting maize prices in the Lasalgaon market.

Table 2 Estimates of the ARIMA model fitted for maize prices in Lasalgaon market

Sr. No.	Parameter	Estimates	SE ±	t value	Sig.
1	Constant	-2.351	9.205	-0.255	0.799
2	MAPE	5.18			
3	Df	15			
4	R ²	0.898			
5	BIC Value	9.605			

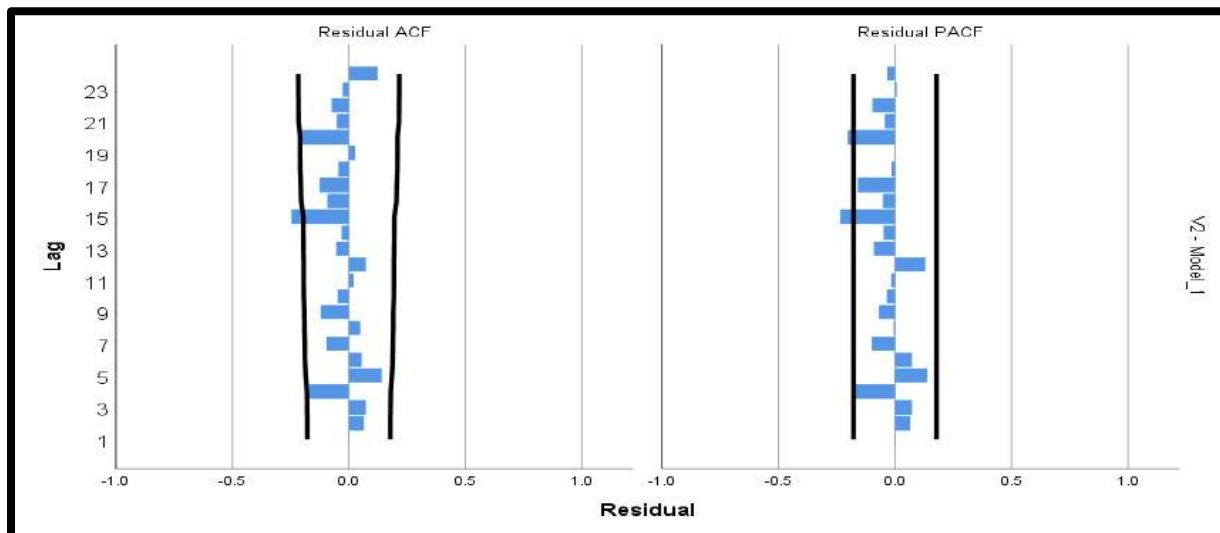


Fig. 1. Residual fit ACF and PACF of maize prices in Lasalgaon Market

c. Diagnostic checking

The residual diagnostics (Correlogram-Q-statistics) was carried out on ARIMA (2,1,1) in fig. 1 and estimated the coefficient for good forecast. The table 2 indicate that, the values of these statistics.

Given that the SBC statistic was shown lowest for the ARIMA model (2,1,1) was judged to be the best model for prices in the Lasalgaon market. Hence, the fitted ARIMA model for the maize price data in Lasalgaon market was $Y_t = -2.351 - 0.499Y_{t-1} - 0.318e_{t-1}$.

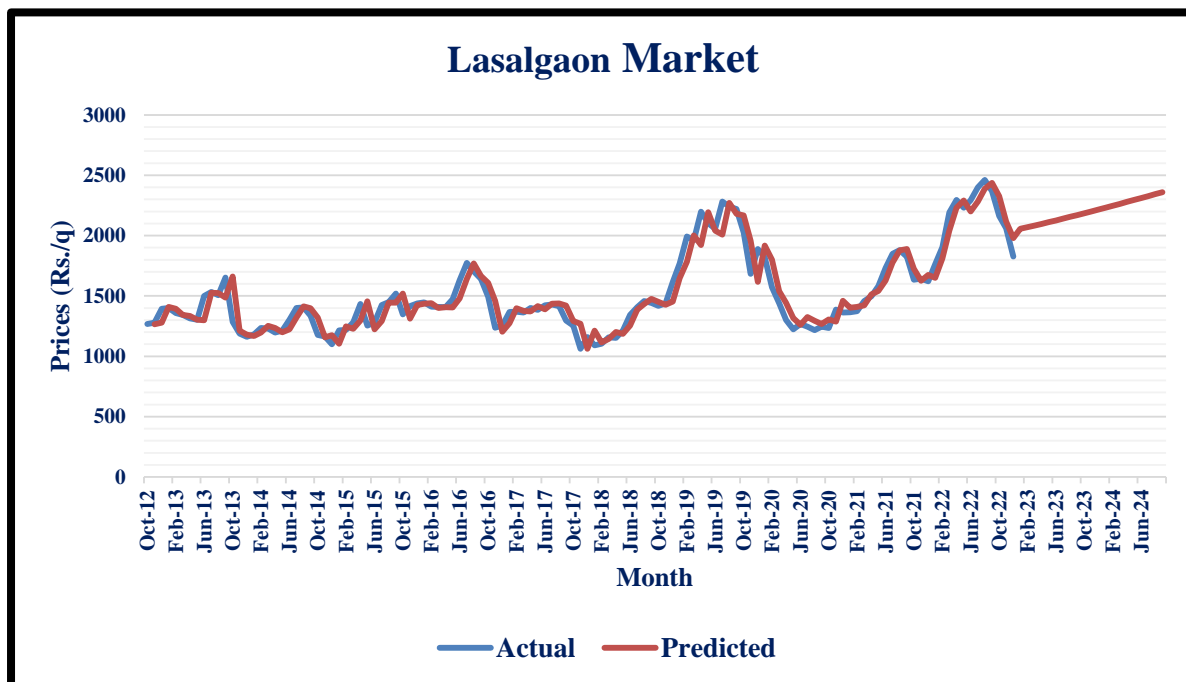


Fig. 2. Ex-ante and Ex-post forecast of monthly prices of maize in Lasalgaon market

d. Forecasting of prices

These entire joint statistics approved that, all the tentatively identified and estimated models were appropriate for forecasting the maize prices of the selected market. The values of these statistics are shown in Table 2. The model (2,1,1) was found to be the best model for prices in Lasalgaon market, since the statistic of AIC and Q statistics was found to be non-significant.

It revealed small differences between the actual and anticipated prices of maize in the Lasalgaon market and the forecasted values of prices showed an increasing trend in the Lasalgaon market. The predicted prices for maize on the market during 2023 will be high *i.e.*, Rs. 2216 per q, during the month of December and low *i.e.*, Rs. 2056 per q during the month of January, respectively. In 2024, the prices will be high in the month of September *i.e.*, Rs. 2360 per q and low *i.e.*, Rs. 2231 per q during the month of January.

Table 3 Ex-ante and Ex-post forecast of monthly prices of maize in Lasalgaon market

Year	Prices (Rs./qt)			Year	Prices (Rs./qt)		
	Actual	Predicted	Difference(%)		Actual	Predicted	Difference(%)
Oct-12	1268		-100	Apr-16	1406	1406	0
Nov-12	1279	1266	-1.02	May-16	1473	1404	-4.68
Dec-12	1393	1279	-8.18	Jun-16	1630	1480	-9.2
Jan-13	1401	1409	0.57	Jul-16	1773	1642	-7.39
Feb-13	1358	1394	2.65	Aug-16	1704	1770	3.87
Mar-13	1342	1343	0.07	Sep-16	1641	1665	1.46
Apr-13	1313	1334	1.6	Oct-16	1494	1609	7.7
May-13	1302	1304	0.15	Nov-16	1237	1459	17.95
Jun-13	1499	1298	-13.41	Dec-16	1254	1203	-4.07
Jul-13	1532	1526	-0.39	Jan-17	1367	1275	-6.73
Aug-13	1506	1523	1.13	Feb-17	1369	1398	2.12
Sep-13	1653	1487	-10.04	Mar-17	1363	1377	1.03
Oct-13	1286	1660	29.08	Apr-17	1401	1371	-2.14
Nov-13	1189	1212	1.93	May-17	1385	1415	2.17
Dec-13	1162	1179	1.46	Jun-17	1422	1390	-2.25
Jan-14	1181	1169	-1.02	Jul-17	1430	1435	0.35
Feb-14	1235	1196	-3.16	Aug-17	1416	1437	1.48
Mar-14	1230	1253	1.87	Sep-17	1297	1420	9.48
Apr-14	1197	1235	3.17	Oct-17	1255	1291	2.87
May-14	1212	1199	-1.07	Nov-17	1062	1269	19.49
Jun-14	1302	1223	-6.07	Dec-17	1160	1063	-8.36
Jul-14	1400	1321	-5.64	Jan-18	1091	1212	11.09
Aug-14	1404	1413	0.64	Feb-18	1105	1115	0.9
Sep-14	1336	1398	4.64	Mar-18	1158	1145	-1.12
Oct-14	1178	1321	12.14	Apr-18	1153	1202	4.25
Nov-14	1164	1157	-0.6	May-18	1213	1185	-2.31
Dec-14	1099	1174	6.82	Jun-18	1343	1254	-6.63
Jan-15	1215	1104	-9.14	Jul-18	1408	1387	-1.49
Feb-15	1219	1247	2.3	Aug-18	1457	1433	-1.65
Mar-15	1281	1228	-4.14	Sep-18	1443	1475	2.22
Apr-15	1433	1297	-9.49	Oct-18	1418	1450	2.26
May-15	1254	1455	16.03	Nov-18	1438	1426	-0.83
Jun-15	1282	1223	-4.6	Dec-18	1615	1454	-9.97
Jul-15	1424	1292	-9.27	Jan-19	1769	1647	-6.9
Aug-15	1449	1445	-0.28	Feb-19	1992	1783	-10.49
Sep-15	1520	1445	-4.93	Mar-19	1961	2001	2.04
Oct-15	1347	1520	12.84	Apr-19	2199	1922	-12.6
Nov-15	1415	1312	-7.28	May-19	2103	2194	4.33
Dec-15	1438	1424	-0.97	Jun-19	2056	2040	-0.78
Jan-16	1446	1436	-0.69	Jul-19	2282	2009	-11.96
Feb-16	1411	1441	2.13	Aug-19	2241	2271	1.34
Mar-16	1409	1401	-0.57	Sep-19	2221	2181	-1.8

Contd....

Table 3 Contd....

Year	Prices (Rs./qt)		
	Actual	Predicted	Difference(%)
Oct-19	2026	2168	7.01
Nov-19	1682	1957	16.35
Dec-19	1888	1616	-14.41
Jan-20	1820	1917	5.33
Feb-20	1572	1800	14.5
Mar-20	1439	1540	7.02
Apr-20	1300	1443	11
May-20	1224	1317	7.6
Jun-20	1267	1262	-0.39
Jul-20	1246	1326	6.42
Aug-20	1217	1294	6.33
Sep-20	1245	1267	1.77
Oct-20	1235	1305	5.67
Nov-20	1387	1288	-7.14
Dec-20	1362	1460	7.2
Jan-21	1364	1402	2.79
Feb-21	1374	1410	2.62
Mar-21	1458	1422	-2.47
Apr-21	1498	1514	1.07
May-21	1581	1542	-2.47
Jun-21	1731	1627	-6.01
Jul-21	1848	1777	-3.84
Aug-21	1879	1877	-0.11
Sep-21	1825	1889	3.51
Oct-21	1635	1724	5.44
Nov-21	1643	1625	-1.1
Dec-21	1622	1674	3.21
Jan-22	1763	1651	-6.35
Feb-22	1904	1812	-4.83
Mar-22	2191	2041	-6.85

Year	Prices (Rs./qt)		
	Actual	Predicted	Difference(%)
Apr-22	2295	2232	-2.75
May-22	2232	2290	2.6
Jun-22	2292	2201	-3.97
Jul-22	2398	2282	-4.84
Aug-22	2460	2388	-2.93
Sep-22	2369	2437	2.87
Oct-22	2163	2325	7.49
Nov-22	2062	2117	2.67
Dec-22	1826	1979	8.38
Jan-23	2125	2056	-3.25
Feb-23	2132	2069	-2.95
Mar-23	2158	2083	-3.48
Apr-23	1974	2097	6.23
May-23	1916	2111	10.18
Jun-23	1943	2126	-8.60
Jul-23	2144	2141	0.14
Aug-23	2140	2155	-0.69
Sep-23	2475	2170	14.05
Oct-23	2076	2185	-4.98
Nov-23	2193	2201	-0.36
Dec-23	2117	2216	-4.46
Jan-24	2177	2231	-2.42
Feb-24	-	2247	-
Mar-24	-	2263	-
Apr-24	-	2279	-
May-24	-	2295	-
Jun-24	-	2311	-
Jul-24	-	2327	-
Aug-24	-	2343	-
Sep-24	-	2360	-

CONCLUSION

- ❖ The results concluded that, the ARIMA 2 1 1 model was the most adequate and efficient model. The results of autocorrelation and partial autocorrelation of maize, there is no autocorrelation in the residual sequence. From the selected model in all two years of monthly maize prices were forecasted out of which for 14 months actual prices were compared. The forecasted results indicated that there might be increase in the maize prices in the Lasalgaon market. The forecasted prices of selected commodities were almost similar to actual prices with very good validation.
- ❖ A better understanding of maize price situation and future prices will facilitate farmers and end users to make appropriate decisions regarding buying and selling patterns hence government should take adequate policies. With this projection of increasing price of maize, it is

recommended for farmers to cultivate due to better yield and resulting good farm income. It will also use effective dissemination of market information such as price forecast to Stakeholders can play a great role in farm business decisions and checking price volatility.

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Marketing of White Onion in Raigad District

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ABSTRACT

Alibag white onions are historically grown using only traditional and genuine seeds. It has got a unique taste and colour due to soil texture in which it is grown. Final sample consisted of 10 villages and 120 white onion growers from Alibag and Pen tehsils. Two markets from each tehsil were selected namely Alibag and Wadkhal. In case of market functionaries, from each village one village trader was selected thus a total of ten village traders were selected randomly. Ten retailers were selected from each market, thus a total of 20 retailers were selected and two wholesalers from each market were selected, forming a total of four wholesalers. The study on marketing cost of white onion indicated that per quintal marketing cost was highest for wholesaler (85.43 qtl) followed by village trader (58.18 qtl), retailer (63.33 qtl) and producer (39.52 qtl). The producer's share in consumer rupee was highest in Channel-I (98.97Per cent), which was followed by Channel-II (80.65Per cent), Channel-III (74.60Per cent) and Channel-IV (74.06Per cent). The marketing efficiency was highest in Channel-I (88.56Per cent), followed by Channel-II (35.97Per cent), Channel-III (22.98Per cent) and Channel-IV (19.65Per cent).

KEYWORDS: White onions, Marketing cost, Producer's share in consumer rupee, Marketing efficiency.

INTRODUCTION

In every kitchen, onions (*Allium cepa*) play a crucial and indispensable role as a vegetable and condiment. On 29 September 2021 Alibag white onion has received GI tag for Alibag region for health benefits like heart ailments, remedy for cough, cold, fever and allergies and also heals wounds as it has antibiotic, antiseptic, antimicrobial properties and carminative properties. In Raigad district, Alibag white onions are historically grown using only traditional and genuine seeds. It has got a unique taste and colour due to soil texture in which it is grown. The white onion growing in the Raigad region does not have a strong aroma as red onion which is frequently found in markets. Its sweet flavour sets it apart from other onions in a big way. Alibag white onion is not entirely spherical in shape but appears slender towards the bottom which makes it aesthetically more appealing. White onions from Alibag can be identified by the way they are braided. The Alibag white onion has low pungency, pyruvic acid (1.05 µmol/g), sulphur content (2.02 mg/100g), TSS (9.450B), dry matter (9.22Per cent) and high protein (1.165Per cent), fat (0.80Per cent), fiber (2.18Per cent), quercetin (0.92 mg/100gm) as compared to other white onion varieties. White onion has medicinal properties like blood cleaning, it helps

with insomnia, heat related ailments and it boosts immunity.

METHODOLOGY

In this study, cultivators of white Alibag onion were chosen using a multistage sampling technique. The study's primary unit was the tehsil, its secondary unit was the village, and its final unit was the growers of Alibag white onion. Alibag and Pen tehsils were selected purposively on the basis of maximum area under Alibag white onion cultivation. For the selection of villages, list of villages growing Alibag white onion along with area prepared by referring revenue records of the Alibag and Pen tehsils and five villages from each tehsil were selected randomly. The lists of white onion cultivators were obtained from the revenue records of the selected villages. From each village, a sample of twelve white onion cultivators were drawn randomly. Thus, the final sample consisted of 10 villages and 120 white onion growers from Alibag and Pen tehsils. Two markets from each tehsil were selected namely Alibag and Wadkhal. In case of market functionaries, from each village one village trader was selected thus a total of ten village traders were selected randomly. Ten retailers were selected from each market, thus a total of 20 retailers were selected and two wholesalers

from each market were selected, forming a total of four wholesalers.

RESULTS AND DISCUSSION

Disposal of produce:

The per farm disposal pattern and losses in storage and transport of white onion were analyzed and presented in the Table 1.

It is observed from the Table 1 that, at overall level, the per farm total production of white onion was recorded to 28.86 quintal out of which 0.43 per cent, 0.35 per cent and 0.24 per cent produce were consume at home, given as gift to relative and losses in storage and transport respectively. While remaining 98.96 per cent of white onion produce was marketable surplus.

Table 1. Per farm disposal of white onion

Sr.No	Particulars	Small group	Medium group	Large group	Overall
		Quantity in qtl	Quantity in qtl	Quantity in qtl	Quantity in qtl
1	Production	19.96 (100.00)	29.63 (100.00)	43.07 (100.00)	28.86 (100.00)
2	Disposal				
	i. Home consumption	0.12 (0.60)	0.13 (0.44)	0.15 (0.35)	0.13 (0.45)
	ii. Gifts to relatives	0.08 (0.40)	0.10 (0.34)	0.11 (0.26)	0.10 (0.35)
	iii. Marketed surplus	19.70 (98.70)	29.33 (98.99)	42.73 (99.21)	28.56 (98.96)
3	Total	19.90 (99.70)	29.56 (99.76)	42.99 (99.81)	28.79 (99.76)
4	Loss in storage and transport	0.06 (0.30)	0.07 (0.24)	0.08 (0.19)	0.07 (0.24)

(Figures in parentheses indicate percentage to total)

At small farm size group, it is observed that, the per farm total production of white onion was recorded to 19.96 quintal out of which 0.60 per cent, 0.40 per cent and 0.30 per cent produce were consume at home, given as gift to relative and losses in storage and transport respectively. While remaining 98.70 per cent of white onion produce was marketable surplus.

In case of medium size group, it is observed that, the per farm total production of white onion was found out to be 29.63 quintal out of which 0.44 per cent, 0.34 per cent and 0.24 per cent produce were consume at home, given as gift to relative and losses

in storage and transport respectively. While remaining 99.21 per cent of white onion produce was marketable surplus.

It was observed that losses in storage and transport for small, medium and large size group were 0.30 per cent, 0.24 per cent and 0.19 per cent respectively. For overall level it was 0.24 per cent. This indicated that the post-harvest losses decrease as size of farm increases.

Agency-wise white onion quantity handled

The agency wise white onion quantity dispose off and quantity handled were presented in the Table 2.

Table 2. Agency wise disposal of white onion

Sr. No	Agency	Small		Medium		Large		Overall	
		Qty (qtl)	No.	Qty (qtl)	No.	Qty (qtl)	No.	Qty (qtl)	No.
1.	Consumer	2.35	6 (12.77)	5.68	9 (19.57)	-	-	3.10	15 (12.50)
2.	Retailer	6.28	15 (31.91)	4.26	7 (15.22)	-	-	4.09	22 (18.33)
3.	Village trader	8.00	19 (40.43)	6.86	11 (23.91)	17.18	11 (40.74)	9.62	41 (34.17)
4.	Wholesaler	3.07	7 (14.89)	12.53	19 (41.30)	25.55	16 (59.26)	11.75	42 (35.00)
	Total	19.70	47 (100.00)	29.33	46 (100.00)	42.73	27 (100.00)	28.56	120 (100.00)

(Figures in parentheses indicate percentage to total)

It is observed from the Table 2 that, at overall level average total quantity of white onion sold by the sample farmer was worked out to 28.56 quintal and 42 (35.00Per cent) farmers dispose off their produce through wholesaler accounting to 11.75 quintal per farmer. However out of total quantity dispose off, 9.62 quintal was sold through village traders. 34.17 per cent of farmers (41 farmers) sold their produce through village traders. Similarly, out

of total quantity dispose off, 4.09 quintal and 3.10 quintal were sold through retailer and directly to consumer. 15 and 22 farmers were selling their produce directly to consumer and retailers respectively.

Channel wise marketing of white onion:

The channel wise marketing of white onion is given in Table 3.

Table 3. Channel wise marketing of white onion

Sr. No.	Channel	No. of growers	Total quantity marketed (qtl)
1.	Producer-Consumer	15	371.9 (10.85)
2.	Producer-Retailer-Consumer	22	491.16 (14.33)
3.	Producer-Village Trader-Retailer-Consumer	41	1155.12 (33.70)
4.	Producer-Wholesaler-Retailer-Consumer	42	1409.56 (41.12)
	Total	120	3427.74 (100.00)

It is revealed from the Table 3 that, the total quantity of white onion marketed by 120 sample growers were accounted to 3427.74 quintal. Out of four marketing channels highest quantity of white onion was marketed through Channel-IV (41.12Per cent), where white onion were sold through wholesaler followed by Channel-III (33.70Per cent)

where produce was sold through village trader, Channel-II (14.33Per cent) sold through retailer and Channel-I (10.85Per cent) directly sold to consumer.

Marketing expenses incurred by different agencies

The per quintal marketing cost of white onion incurred by different agencies is given in Table 4.

Table 4. Per quintal marketing cost incurred by different agencies in white onion

(Figures in Rs./ q)

Sr. No.	Item of cost	Producer	Village trader	Wholesaler	Retailer
1.	Assembling	-	1.58	2.6	1.5
2.	Grading	1.5	2.37	2.3	2.47
3.	Transport	34.52	25.4	28.5	21.8
4.	Storage losses	1.5	15.41	23.43	10.35
5.	Others	2	13.42	28.6	27.21
	Total	39.52	58.18	85.43	63.33

It is seen from the Table 4 that, the marketing costs per quintal of white onion were accounted for the producer, village trader, wholesaler and retailer were, Rs.39.52, Rs.58.18, Rs.85.43 and Rs.63.33 respectively. The highest expense at the producer level was determined to be transportation (Rs.34.52), which was followed by other costs (Rs.2.00), grading (Rs.1.50) and storage losses (Rs.1.50). However, at village trader level it was observed that per quintal marketing cost was maximum for transportation (Rs.25.40) followed by losses (Rs.15.41), other costs (Rs.13.42), grading (Rs.2.37) and assembling (Rs.1.58).

In case of wholesaler per quintal marketing cost was found to be maximum for other costs (Rs.28.60) followed by transportation cost (Rs.28.50), storage losses (Rs.23.43), assembling (Rs.2.60) and grading (Rs.2.30). Similarly in case of retailer per quintal marketing cost was accounted maximum for other costs (Rs.27.21), followed by transportation cost (Rs.21.80), storage losses (Rs.10.35), grading (Rs.2.47) and assembling (Rs.1.50).

Price spread and marketing efficiency:

Price paid by consumer and producer's share in consumer's rupee:

The price spread was estimated and presented in Table 5. It was seen from the Table 13

that, Net price received by producer in Channel-I, Channel-II, Channel-III and Channel-IV was Rs.3,463.98, Rs.2,984.06, Rs.2,760.06 and Rs.2,740.32 respectively. The producer's share in consumer rupees was maximum in Channel-I (98.97Per cent) which was followed by Channel-II (80.65Per cent), Channel-III (74.60Per cent) and Channel-IV (74.06Per cent).

Therefore, it is indicated that the producer's share of the consumer's rupee has significantly fallen as a result of the involvement of middlemen, particularly village traders, wholesalers and retailers. It is also revealed that the elimination of intermediaries benefited producers.

Table 5. Channel-wise per quintal price spread and marketing efficiency in marketing of white onion (Figures in Rs./q)

Sr. No.	Particulars	Channel-I	Channel-II	Channel-III	Channel-IV
1.	Net Price received by the producer	3463.98	2984.06	2760.29	2740.32
2.	Cost incurred by the producer	39.52 (1.13)	39.52 (1.07)	39.52 (1.07)	39.52 (1.07)
3.	Purchase price by Village trader	-	-	2799.81	-
4.	Cost incurred by the Village trader	-	-	58.18 (1.57)	-
5.	Marketing margin by Village trader	-	-	249.48 (6.74)	-
6.	Purchase price by Wholesaler	-	-	-	2779.84
7.	Cost incurred by the Wholesaler	-	-	-	85.43 (2.31)
8.	Marketing margin by Wholesaler	-	-	-	288.80 (7.81)
9.	Purchase price by Retailer	-	3023.58	3107.47	3154.07
10.	Cost incurred by the Retailer	-	63.33 (1.71)	63.33 (1.71)	63.33 (1.71)
11.	Marketing margin by Retailer	-	613.09	529.20	482.60 (13.04)
12.	Total marketing cost	39.52 (1.13)	102.85 (2.78)	161.03 (4.35)	188.28 (5.09)
13.	Total marketing margin	0	613.09 (16.57)	778.68 (21.05)	771.4 (20.85)
14.	Consumers purchase price	3500	3700	3700	3700
15.	Producer's share in consumers rupees (Per cent)	98.97	80.65	74.60	74.06
16.	Marketing efficiency (Per cent)	88.56	35.97	22.98	19.65

It is also observed that per quintal marketing cost was highest in Channel-IV (Rs.188.28) incurred by the producer and other agencies followed by Channel-III (Rs.161.03), Channel-II (Rs.102.85) and Channel-I (Rs.39.52). However, the total marketing margin of all intermediaries was highest in Channel-III (21.05Per cent) followed by Channel-IV (20.85Per cent) and Channel-II (16.57Per cent).

Marketing efficiency:

In essence, the level of market performance is marketing efficiency. It is regarded as a benchmark or measure for comparing or evaluating the efficiency of an alternative marketing channel or system.

It was observed from the Table 6 that, marketing efficiency in Channel-I was found to be 88.56Per cent, for Channel-II it was 35.97Per cent, for Channel III it was 22.98Per cent and for Channel-IV it was 19.65Per cent. This revealed that higher

marketing margin in Channel II, III and IV resulted in lower marketing efficiency in white onion. This indicated that Channel-I (Producer-Consumer) was the most efficient channel of marketing of white onion followed by Channel II, Channel-III and Channel-IV.

CONCLUSIONS

For marketing of white onion in Raigad district four marketing channels were identified namely, Channel-I (Producer – Consumer), Channel-II (Producer – Retailer – Consumer), Channel-III (Producer – Village trader – Retailer – Consumer) and Channel-IV (Producer – Wholesaler – Retailer – Consumer). The study on marketing cost of white onion indicated that per quintal marketing cost was highest for wholesaler (85.43 qtl) followed by village trader (58.18 qtl), retailer (63.33 qtl) and producer (39.52 qtl). The producer's share in consumer rupee was highest in Channel-I (98.97Per cent), which was followed by Channel-II (80.65Per cent), Channel-III (74.60Per cent) and Channel-IV (74.06Per cent). This further indicated that involvement of intermediaries decreased the producer's share in consumer rupee. The marketing efficiency was highest in Channel-I (88.56Per cent), followed by Channel-II (35.97Per cent), Channel-III 22.98Per cent and Channel-IV (19.65Per cent). This revealed that, marketing margin was taken away by market intermediaries, thus poor marketing efficiency in Channel-II, Channel-III and Channel-IV.

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Status of E-NAM in India and Farmers perception towards adoption of digital Agriculture

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ABSTRACT

The e-NAM (electronic National Agricultural Market) is a pioneering initiative aimed at integrating India's fragmented agricultural markets by connecting traditional APMC mandis into a cohesive national network. This study rigorously assesses e-NAM's impact and performance in Nagpur District, focusing on data collected from 80 farmers and 20 traders for the financial year 2023-24.

The compound annual growth rates (CAGR) for the traded quantity and value of food grains on the e-NAM platform are 9.39% and 21.71%, respectively. This suggests that the e-NAM platform has experienced comparatively higher growth in both the quantity and value of food grain trade since its inception. Similarly, the compound growth rates for oilseeds traded on the e-NAM platform are 42.35% for quantity and 41.67% for value. The analysis of fruit and vegetable trade on the e-NAM platform also reveals positive growth, with quantities increasing by 48.32% and values by 72.11% for fruits, and quantities increasing by 50.68% and values by 80.47% for vegetables from 2016-17 to 2019-20.

The analysis of barriers faced by farmers in selling their agricultural produce reveals a clear hierarchy of concerns based on the Likert scale mean scores. Transportation cost emerges as the most significant barrier, with a mean score of 3.78, placing it at the top of the list. This high ranking underscores the substantial burden that transportation expenses impose on farmers, affecting their profitability and limiting their access to markets. The results of Logit regression indicate that social category, age of the respondent, education, lending money to farmer and number of market function involved in APMC, affected the willing to adopt in e-NAM by traders. result indicates if the age was increased by one year among the respondent, then the probability to participate in e-NAM decreased by 1.96 times and if the education of the traders has increased then their willingness to participate in e-NAM was increased by 2.87 times. Similarly, when traders were more involved in the function of APMC the probability to participate in e-NAM increased by 27 times.

The study highlights the substantial potential of e-NAM to enhance market efficiency but also emphasizes the need for targeted improvements in infrastructure, education, and support systems to foster greater adoption and realize the full benefits of this transformative platform. There is a clear need for training programs aimed at enhancing the knowledge of e-NAM's features, particularly for older farmers and those with lower education levels. This could help bridge the gap in awareness and promote broader adoption. Addressing issues like inadequate grading/sorting facilities and transportation costs should be prioritized to enhance farmers' capacity to engage with e-NAM effectively. Outreach strategies should focus on younger farmers and those with higher educational backgrounds to maximize participation and leverage their enthusiasm for technology. Efforts should be made to simplify the online bidding and selling processes to mitigate perceived complexities. This could include user-friendly interfaces and step-by-step guides. Policymakers should consider providing subsidies or financial assistance for technological infrastructure improvements and transport costs, particularly for farmers in rural areas. Engaging community leaders and influencers in promoting e-NAM can help address resistance among older farmers and encourage a culture of innovation within farming communities. Improving market information flow and technological literacy among traders will be crucial for the successful adoption of e-NAM, as these factors significantly impact their operational efficiency. By implementing these strategies, e-NAM can potentially improve its reach and effectiveness, ultimately benefiting farmers and traders across the Nagpur District as well as across India.

INTRODUCTION

Agricultural marketing encompasses all processes involved in moving agricultural products from farmers to end consumers. It helps reveal market prices based on commodity quality, improves supply chain efficiency, and creates opportunities for value chain expansion. These marketing systems provide real-time information to farmers about new market opportunities, guiding them to adjust production according to market demands for quantity, quality, and variety, and connecting markets through virtual networks to develop effective marketing systems.

In the digital era, online markets have significantly enhanced farmers' ability to sell their produce efficiently. Online access facilitates the integration of agricultural markets at the national level. These online platforms, or 'e-markets,' function as virtual markets supported by physical markets, creating a nationwide network of mandis accessible online

e-NAM represents a significant advancement in agricultural marketing by providing farmers with digital access to numerous markets and buyers. This platform is part of the Government of India's initiative to 'Double Farmers' Income by 2022' by improving price realization and reducing intermediation costs through the creation of a 'One Nation, One Market' (Meena et al., 2019). It offers comprehensive information related to APMC, including commodity arrivals, price ranges, and trading offers, facilitating transparent transactions and enabling farmers and traders to buy and sell commodities at optimal prices nationwide.

The e-NAM initiative was introduced as a transformative solution aimed at modernizing agricultural marketing. By integrating digital technology with traditional market practices, e-NAM seeks to enhance transparency, streamline transactions, and reduce costs associated with agricultural produce trading. This platform allows for real-time price discovery, facilitates direct market access for farmers, and minimizes the role of intermediaries. Evaluating the performance of e-

NAM in Nagpur District is therefore crucial to understanding how well it addresses these issues on the ground. It helps to assess whether the platform meets its goals of improving market efficiency and fairness, and if there are specific areas where adjustments are needed to maximize its benefits for both farmers and traders.

METHODOLOGY

By considering the commercial importance of trade, Nagpur district was selected purposively for this study. The data was collected for this project was from two sources primary and secondary. From Nagpur district 4 tehsils were selected on the basis of location wise north, south, east, west they are Ramtek, Umred, Kuhi, Katol. From each tehsil 2 villages were selected from each village 10 farmers were selected. Thus, in all total 80 farmers were selected for present study and from Nagpur district 20 traders were selected from Nagpur APMC market.

To achieve objectives of the study, simple descriptive statistics like Percentage, Average, etc were tabulated. However following statistical measures were used for the study.

Likert Scale and Guttman Scaling Technique

To achieve third objective, to access the selling of produce by farmer, information regarding crop and crop selling were completed using percentage and tables. The acreage and land size used, the current system of selling agricultural produce by registered farmers in APMC. Selling point of agricultural produce and constraints faced in selling agricultural output was obtained from farmer by personal interview method.

For this Likert scale (1- Highly disagree to 5- Highly agree) were used. Each constraint was tested statistically of its mean score to be significant with the help of t-test. Further these constraints were ranked according to their mean score. Table 1 represents the constraints faced by the farmers in selling their produce.

Table 1: Constraints Faced by Farmers in Selling their Produce.

Sr. No.	Constraints
1.	Produce lot size is not economical to transport
2.	High transportation cost
3.	High numbers of middlemen in Marketing
4.	Price decided for produce is sufficient i.e. MSP
5.	Market information is available properly?
6.	Farmers have to sell their produce in distress mostly
7.	Traders tend to have monopolistic behaviour.
8.	No facilities for grading and sorting in APMC.
9.	Arhtiya provides financial help most of the time.
10.	Ware housing facility is either not available or poor

Guttman scaling was developed by Louis Guttman (1944) and was first used as part of the classic work on the American soldiers. Guttman scaling is applied to a set of binary questions answered by a set of subjects.

Guttman Scaling is also sometimes known as cumulative scaling or Scalogram Analysis. Here in the analysis, the awareness level among the farmers and traders were recognized using Guttman scale. A single dimensional set of question/statement were prepared, these questions were asked regarding working of e-NAM completely

Logit Regression:

To fulfil the fourth objective, Logit regression analysis was attempted to understand the willingness of farmers and traders to predict the probability of an event happening for an individual.

The logistic regression equation can be represented as: -

Logit (p)= $\ln \frac{p}{1-p} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_q x_q$
 β_0 = Constant/Intercept,
 β_1 and β_q = Coefficient of q Explanatory variables
 (X1 X2) p = probability of event occurring e.g. willingness participate in e-NAM or not
 $\frac{p}{1-p}$ = odd ratio

If probabilities of the event of interest happening for individuals are needed, the logistic regression equation can be written as (Nitesh, 2018).

$$\frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_q x_q)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_q x_q)}$$

$$P = 0 < p < 1$$

$$1 - \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_q x_q)$$

Table 2 shows the distribution of the dependent and the independent variables used for the logit model.

Table 2: Explanatory Variables for Logit Model

Dependent variables: Willingness to participate in e-NAM (i.e. Yes/No)		
Sr. No.	Independent variables	Explanation
1.	Social category	(1= Gen, 2= OBC, 3= SC/ST)
2.	Highest education in family	(1= illiterate, 2= primary, 3= Secondary, 4= U.G, 5= P.G)
3.	Distance from APMC	Distance in Kilometres
4.	Buyer of produce	Produce sold to person (1=village traders; 2=APMC arhatiya)
5.	Age of respondent	Age of respondent in years
6.	Business Turnover	In rupees
7.	farmers money lending	Yes/No
8.	Number of function involvement in APMC	1-7

*Categorization of farmers is done based on S.D. ± mean basis

Garrett Ranking Technique:

To achieve the fifth objective, Garrett ranking technique was used to identify the most significant constraints that influence the e-NAM adoption. According to this method, respondents were asked to rank all the constraints and the results of that ranking were converted into score value using following formula

$$\text{Percent Position} = \frac{100 (R_{ij} - 0.50)}{N}$$

Where,

R_{ij} = Rank given for the i th factor by the j th individual

N = Number of factors ranked by the j th individual

Once the percentage position was determined the percentage position of each rank was

converted to scores using the table provided by Garret and Woodsworth (1969). The score for each factor was then averaged across the number of sample farmers who ranked that factor. Total scores were obtained in this manner for each of the reason, and mean score were calculated by dividing the total score by the number of respondents who provided ranks. Finally, the overall ranking of the ten reason was determined by assigning rank 1, 2, 3.....,10 in descending order of mean scores.

RESULTS AND DISCUSSION**The Performance of e-NAM in India**

With the aim of promoting uniformity in Agricultural Marketing in India, 1,389 APMC's have been integrated across 23 states and 4 Union Territories. The details of APMC's covered under e-NAM are depicted in the table 3 and figure 2.

Table 3: e-NAM Markets Across India.

Sr. No	State	Total APMC's
1	Andaman and Nicobar Islands (UT)	1 (0.07)
2	Andhra Pradesh	33 (2.38)
3	Assam	3 (0.22)
4	Bihar	20 (1.44)
5	Chandigarh (UT)	01 (0.07)
6	Chhattisgarh	20 (1.44)
7	Goa	7 (0.50)
8	Gujarat	144 (10.37)
9	Haryana	108 (7.78)
10	Himachal Pradesh	38 (2.74)
11	Jammu and Kashmir (UT)	17 (1.22)
12	Jharkhand	19 (1.37)
13	Karnataka	05 (0.36)
14	Kerala	06 (0.44)
15	Madhya Pradesh	139 (10.01)
16	Maharashtra	133 (9.58)
18	Odisha	66 (4.75)
19	Puducherry (UT)	02 (0.14)
20	Punjab	79 (5.69)
21	Rajasthan	145 (10.44)
22	Tamil Nadu	157 (11.30)
23	Telangana	57 (4.10)
24	Tripura	07 (0.50)
25	Uttar Pradesh	125 (9.00)
26	Uttarakhand	20 (1.44)
27	West Bengal	18 (1.30)
Total APMC's in India		1389 (98.63)

(Source: <https://e-NAM.gov.in/NAM/home/mandis.html>)

(Figure in parenthesis indicate percentage)

Commodities traded under e-NAM: e-NAM provides a virtual platform to farmers and traders to perform commerce and trade across the states with one nation one market approach. 175 Commodities including food grains, oilseeds, fruits and vegetables, spices etc. are listed in the e-NAM

Table 4: Commodities Covered under E-NAM

Commodities group	Total Number
Food Grains / Cereals	35 (15.98)
Oilseeds	14 (6.39)
Fruits	45 (20.55)
Vegetables	59 (26.94)
Spices	16 (7.31)
Miscellaneous	50 (22.83)
Total	219 (100)

(Source: <https://e-NAM.gov.in/web/commodity/commodity-list>)

(Figure in parenthesis indicate percentage)

Table 4 outlines the distribution of various commodities into distinct groups, highlighting their respective totals and percentages within the overall dataset. The total number of commodities recorded is 219, which has been classified into six primary groups.

Vegetables make up the largest share, accounting for 59 commodities, which represents 26.94% of the total. Fruits follow with 45 commodities, comprising 20.55% of the overall figure. The miscellaneous category is close behind with 50 commodities, contributing 22.83% to the total. Food grains and cereals form a significant portion as well, with 35 commodities, representing

market. Till the 30th June 2020, agricultural produce having total volume of 3.54 crore MT with value of 1,02,529 crores has been traded through e-NAM portal. Table 4 shows the breakup of total 175 commodities traded under e-NAM.

15.98%. Oilseeds account for 14 commodities, which is 6.39% of the total, and spices include 16 commodities, constituting 7.31%.

This categorization offers a clear perspective on the distribution of agricultural commodities, emphasizing the dominance of vegetables and fruits in the overall composition.

Trade Performance in e-NAM Platform:

Trade performance of e-NAM was analyzed in terms of Quantity and value of commodity traded in the e-NAM platform to understand the acceptance of e-NAM among participants.

Table 5: Quantity of Commodity Traded in e-NAM Platform from 2016 -17 To 2019-20

Quantity: Metric Tons

Year	Food Grains	Oilseeds	Fruits	Vegetables	Spices	Miscellaneous
2016-17	4247151.72	326332.8	36008.73	274885.19	111472.16	5576.73
2017-18	6797886.89	787654.52	161714.88	713327.1	590019.81	674156.04
2018-19	4754556.4	958727.75	137674.81	944103.63	763995.3	711643.93
2019-20	6453645.99	991645.07	141366.57	981917.94	743672.09	1227013
Absolute Change	2206494.27	665312.27	105357.84	707032.75	632199.93	1221436.3
Relative Change (percent)	52	204	293	257	567	21902
CAGR (percent)	9.39	42.35	48.32	50.68	81.34	407.11
C.V. (percent)	22.51	40.01	47.36	44.60	55.04	76.51

(Source: <https://e-NAM.gov.in/>)

Table 5 indicates quantity of commodities traded under various heads through e-NAM platform from

2016-17 to 2019-20 and corresponding Compound Annual Growth Rate (CAGR) of the same.

Table 6: Value of Commodity Traded in e-NAM Platform from 2016-17 To 2019-20

Value: Rs. in crores

Year	Food Grains	Oilseeds	Fruits	Vegetables	Spices	Miscellaneous
2016-17	8203.22	1325.81	55.22	171.50	816.00	10571.75
2017-18	14032.82	2932.49	358.48	721.13	4078.68	22123.60
2018-19	12502.25	3570.41	377.42	766.83	5473.89	22690.80
2019-20	16411.35	3964.59	331.65	1202.51	6672.78	28582.88
Absolute Change	8208.13	2638.78	276.43	1031.01	5856.78	18011.13
Relative Change (percent)	100	199	501	601	718	170
CAGR (percent)	21.71	41.67	72.11	80.47	93.45	35.11
C.V. (percent)	27.01	39.42	53.97	59.06	59.36	35.90

(Source: <https://e-NAM.gov.in/>)

Similarly, Table 6 exhibits value of commodity traded in various subheads in e-NAM platform from 2016-17 to 2019-20 and their corresponding Compound Annual Growth Rates (CAGR) in the online marketplace i.e. e-NAM platform.

Tables 5 and 6 indicate that the compound annual growth rates (CAGR) for the traded quantity and value of food grains on the e-NAM platform are 9.39% and 21.71%, respectively. This suggests that the e-NAM platform has experienced comparatively higher growth in both the quantity and value of food grain trade since its inception. Similarly, the compound growth rates for oilseeds traded on the e-NAM platform are 42.35% for quantity and 41.67% for value. This reflects substantial positive growth in oilseed trade during the study period.

The analysis of fruit and vegetable trade on the e-NAM platform also reveals positive growth, with quantities increasing by 48.32% and values by 72.11% for fruits, and quantities increasing by 50.68% and values by 80.47% for vegetables from 2016-17 to 2019-20.

Furthermore, the trade of spices has shown remarkable positive growth, with an 81.34% increase in quantity and a 93.45% increase in value during the study period. For miscellaneous commodities, which are not classified into specific groups, the e-NAM platform has demonstrated exceptional growth. Specifically, there has been a 407.10% increase in traded quantity and a 35.11% increase in traded value from 2016-17 to 2019-20.

The overall analysis suggests that e-NAM is making significant strides in transforming the traditional trading practices within primary

agricultural markets into a modern, online trading system. This progress is attributed to the continuous efforts by the government to advance digital platforms nationwide, promote the system through stakeholder engagement programs, and enhance transparency in existing processes through digital operations. These initiatives have contributed to the gradual changes and positive growth observed in recent years.

Distribution of Farmers According to Level of Awareness about e-NAM

Eight questions were raised to farmers in succession to assess their level of awareness. The survey results regarding awareness of e-NAM indicate that all respondents (100%) are familiar with the e-NAM platform and acknowledge the necessity of registration before presenting their produce at the APMC. Furthermore, all respondents (100%) report having comprehensive knowledge about e-NAM. However, awareness regarding specific processes within e-NAM varies. Most respondents (78.25%) understand that a Lot ID is assigned to their produce and are aware that assaying follows the generation of this Lot ID. In contrast, 21.75% lack knowledge about these aspects. Awareness about the online circulation of Lot information for bidding is held by 70% of respondents, while 30% are not informed. National online bidding is less widely known, with only 28.75% of respondents aware that bidding occurs across the nation, leaving 71.25% unaware of this process. Additionally, 51.25% of respondents are knowledgeable that payment from the highest bidder is transferred to their account via NEFT, whereas 48.75% are not aware of this payment mechanism.

Table 7: Distribution of Farmers According to the Level of Awareness About e-NAM

Sr. No.	Questions on Guttman scale	Awareness (n=80)	
		Yes	No
1	Have you heard about e-NAM?	80 (100)	0 (0)
2	Do you have complete knowledge about e-NAM?	80 (100)	0 (0)
3	Do you know that you have to register before taking your produce in APMC for e-NAM?	80 (100)	0 (0)
4	Do you know that a Lot ID was generated for your produce?	63 (78.25)	17 (21.75)
5	Are you aware that after your Lot ID has been generated, assaying takes place?	63 (78.25)	17 (21.75)
6	Do you know that your Lot information was circulated online for bidding?	56 (70)	24 (30)
7	Do you know that bidding takes place online across nation?	23 (28.75)	57(71.25)
8	Do you know that highest bidder payment amount was transferred your account through NEFT?	41 (51.25)	39 (48.75)

(Figure in parenthesis indicate percentage)

Distribution of Traders According to Level of Awareness About e-NAM

Similarly, nine questions were asked to traders in succession to assess their level of awareness. All 20 respondents (100%) are aware of e-NAM and have a basic understanding of its purpose. They are also uniformly aware that participation requires registration and that a license is necessary for trading. Additionally, all respondents recognize that the license is valid only within a single state. Knowledge about specific features of e-NAM varies significantly. Only 35% of respondents know that online bidding occurs via Smartphone or PC, while 65% are unaware of this aspect. Similarly, 35%

understand that logistics are associated with e-NAM for procured entities, whereas 65% do not. Awareness of payment and receipt processes is relatively high. 80% of respondents are aware that the highest bidder pays to e-NAM, and 90% know that the highest bidder receives an online receipt for their procurement.

Overall, while the basic and procedural aspects of e-NAM are well understood, there are notable gaps in awareness regarding online bidding and logistical arrangements. In Figure 1, Green colour shows positive response, and red colour shows negative response.

Table 8: Distribution of Traders on the Basis of the Level of Awareness About e-NAM

Sr. No.	Question on Guttman scale	Awareness (n=20)	
		Yes	No
1	Have you heard about e-NAM?	20 (100)	0(0)
2	Do you any idea about e-NAM?	20 (100)	0 (0)
3	Do you know that you have to register before taking part in e- NAM?	20 (100)	0 (0)
4	Do you know that a license needs to be made for trading?	20 (100)	0 (0)
5	Do you know that license was valid in one state only?	20 (100)	0 (0)
6	Do you know that online bidding takes place via Smartphone/PC?	7 (35)	13 (65)
7	Do you know that highest bidder will pay to e-NAM?	16 (80)	4 (20)
8	Do you know about highest bidder will get online receipt for his procurement?	18 (90)	2 (10)
9	Do you know that logistics were associated to e-NAM for procured entity?	7 (35)	13 (65)

(Figure in parenthesis indicate percentage)

Distribution of cultivated land owned by different size groups of sample farms revealed that 4.22 percent of cultivated land was owned by 7 marginal sized farmers, whereas 27.37 and 68.40 percent of this area was owned by 31 small and 38 medium size farmers.

Constraints Faced in Selling Agricultural Output in Present System

The data in table 9 represents the analysis of barriers faced by farmers in selling their agricultural produce reveals a clear hierarchy of concerns based on the Likert scale mean scores. Transportation cost emerges as the most significant barrier, with a mean score of 3.78, placing it at the top of the list. This high ranking underscores the substantial burden that transportation expenses impose on farmers, affecting their profitability and limiting their access to markets.

Following closely, facilities for grading and sorting in APMC received a mean score of 3.74, ranking second. This indicates a significant concern regarding the adequacy of these facilities, which are essential for ensuring produce quality and achieving better market prices. The Minimum Support Price (MSP) sufficiency, with a mean score of 3.70, ranks third, reflecting widespread dissatisfaction with the current MSP levels. Distress sales by farmers, with a mean score of 3.69, are ranked fourth. This indicates that farmers frequently encounter situations where they must sell their produce under unfavourable

conditions due to market saturation or inadequate storage facilities. The involvement of middlemen in the marketing process, with a mean score of 3.68, ranks fifth. This high score reveals dissatisfaction with intermediaries who can affect pricing and diminish farmers' profits.

Warehousing facility availability and quality, ranked sixth with a mean score of 3.65, indicates that existing warehousing facilities are either inadequate or poorly maintained. Monopolistic behaviour among traders, with a mean score of 3.63, ranks seventh. This score highlights concerns about the concentration of market power among a few traders, which can lead to unfair pricing and market manipulation. Economical produce lot size for transportation, with a mean score of 3.60, ranks eighth. This score reflects logistical challenges related to the size of produce lots, which can affect transportation efficiency and costs. Market information availability, with a mean score of 3.54, ranks ninth. This indicates concerns about the accessibility and quality of market data, which is crucial for informed decision-making by farmers. Finally, financial help from arhtiyas (commission agents), with a mean score of 3.49, ranks tenth. This low score suggests that financial support from commission agents is infrequent, potentially impacting farmers' ability to manage cash flow effectively. Improving financial assistance from arhtiyas could provide crucial support during critical periods.

Table 9: Problems Faced in Selling Agricultural Output in Present System

Sr. No.	Problem Statements (through Likert scale)	Mean score	Rank based on Mean score
1.	Is transportation cost was too high?	3.78	I
2.	Whether facilities for grading and sorting in APMC were available?	3.74	II
3.	MSP announced was sufficient?	3.70	III
4.	Farmers have to sell their produce in distress mostly?	3.69	IV
5.	Middlemen involved in marketing?	3.68	V
6.	Whether warehousing facility is either not available or poor?	3.65	VI
7.	Traders tend to have monopolistic behavior?	3.63	VII
8.	Whether produce lot size was economical to transport?	3.60	VIII
9.	Whether market information was available?	3.54	IX
10.	Whether arhtiya provides financial help most of the time?	3.49	X

Overall, the data highlights that high transportation costs, inadequate grading and sorting facilities, and insufficient MSP are the most pressing issues faced by farmers. Addressing these barriers, along with concerns related to middlemen, warehousing, and market dynamics, is essential for enhancing the agricultural marketing system and supporting farmers' livelihoods.

Logit Regression of Willingness to Adopt e-NAM by Farmers

The results of Logit regression indicate that social category, age of respondent, education of respondent and distance from the APMC significantly affected the willingness to participate in e-NAM to sell their agricultural produce.

Table 10: Factors Affecting Willingness of Farmers to Adopt e-NAM

Sr. No.	Independent Variable	Parameter Estimate	Standard Error
1	Social category	0.271**	0.678
2	Education	1.292**	0.462
3	Distance from Road APMC	1.779**	0.222
4	Total Family Size	0.824	0.251
5	Age of respondent	0.877**	0.050
6	Income	1.000	4.042

** Indicate statistically significant at the 5 % level of significance

Table 10 indicates that if the age was increased by one year among the respondent, then the probability to participate in e-NAM decreased by 0.87 times. If the education of the farmer has increased then their willingness to participate in e-NAM was increased by 1.29 times.

Independent variables those had significant positive influence on willingness to participate in e-NAM were farmer's social category, age of the respondent, education. Variables those were statistically significant as well as negatively influencing willingness to participate in e-NAM for farmers were age and distance from the APMC.

Logit Regression of Willingness to Adopt e-NAM by Traders

Table 11: Factors Affecting Willingness of Traders to Adopt e-NAM

Sr. No.	Independent Variable	Parameter Estimate	Standard Error
1	Social category	6.009**	1.73
2	Education	2.867**	0.21
3	Age of respondent	1.963**	0.53
4	Business turnover	1.003	4.43
5	Lend money of farmers	23.096**	2.34
6	No. Of market function involved	27.173**	3.21

** Indicate statistically significant at the 5 % level of significance

The results of Logit regression indicate that social category, age of the respondent, education, lending money to farmer and number of market function involved in APMC, affected the willing to adopt in e-NAM by traders. Table 28 indicates if the age was increased by one year among the respondent,

then the probability to participate in e-NAM decreased by 1.96 times and if the education of the traders has increased then their willingness to participate in e-NAM was increased by 2.87 times. Similarly, when traders were more involved in the

function of APMC the probability to participate in e-NAM increased by 27 times.

Independent variables those had significant positive influence on willingness to participate in e-NAM by trader's were social category, education, lending money to farmer and number of functions involved. Business profits were non-significant parameter because traders were afraid that their income will be known.

Constraints Perceived in the Adoption of e-NAM by Farmers

Farmers perceive several constraints in adopting e-NAM. The complexity of the sale process is the most significant issue, with a mean score of 72.10. This is followed by inadequate basic

infrastructure (mean of 71.51) and difficulties in price realization (mean of 69.78). Challenges in online payment processes also stand out, with a mean of 59.31. Insufficient information transmission (mean of 57.23) and issues with bidding and unsold lots (mean of 46.65) are notable concerns. Preferences for physical presence (mean of 46.21) and shortages of computer operators (mean of 46.05) are also significant, alongside the need for cash payments (mean of 46.05). Managing perishable produce (mean of 42.16) and discomfort with technology (mean of 41.14) are additional barriers. Less critical issues include digital payment barriers (mean of 37.39), lack of assaying laboratories (mean of 36.61), and problems with payment trust (mean of 35.43).

Table 12: Constraints Perceived in the Adoption of e-NAM by Farmers

Sr. No.	Constraints	Sum of Garrett Value	Mean	Rank
1.	Lack of proper information transmission.	4578	57.23	V
2.	e- auction takes much longer than conventional process	3472	43.40	X
3.	Bidding may be not satisfactory and problems regarding unsold lots	3732	46.65	VI
4.	Insufficient number of computer operator	3562	46.05	VIII
5.	Strong trust in physical presence for selling	3697	46.21	VII
6.	Management of perishable produce, especially storage in APMC	3373	42.16	XI
7.	Digital payments were barrier in repayment of informal loans taken	2991	37.39	XIII
8.	No proper assaying laboratory	2929	36.61	XIV
9.	Farmers were uncomfortable using technology/computers	3291	41.14	XII
10.	Problems regarding receiving payments for produce and lack of faith on online transaction	2834	35.43	XV
11.	Difficulties in online payment process	4745	59.31	IV
12.	Lack of basic infrastructure for cleaning, weighing etc.	5721	71.51	II
13.	Sale process was complicated	5768	72.10	I
14.	Price realization was difficult	5582	69.78	III
15.	Farmers need cash payment to meet immediate expenses	3684	46.05	VIII

These findings indicate that issues related to the sale process complexity, infrastructure, and payment difficulties are the primary barriers to e-NAM adoption among farmers.

Constraints Perceived in the Adoption of e-NAM by Traders

The constraints perceived in the adoption of e-NAM by traders are detailed in Table 13 indicate that High Transportation Cost (Garrett score 76.95) emerged as the most significant constraint, followed by Technological Illiteracy (Garrett score 68) and Poor Flow of Market Information (Garrett score

66.1). Other major constraints include Lack of Internet Facility (Garrett score 62.5) and Management Problems of Produce Unsold (Garrett score 50). Additionally, Difficulty in Getting License (Garrett score 45) and Invasion by Capital Corporate Houses (Garrett score 41) were also notable concerns. Constraints such as Insufficient Number of Computer Operators (Garrett score 35), Complaint Settlement (Garrett score 28), and the Impact on Small Traders (Garrett score 17) were perceived as less critical. Overall, high transportation costs and technological challenges had the greatest impact on the adoption of e-NAM among traders.

Table 13: Constraints Perceived in the Adoption of e-NAM by Traders

Sr. No.	Constraints	Sum of Garrett Value	Mean	Rank
1.	High Transportation cost	1539	76.95	I
2.	Safeness of Insurance for the product sold in the market or warehouse	1229	61.45	V
3.	Complaint settlement maybe awkward	560	28	X
4.	Poor flow of market information	1322	66.1	III
5.	Business of small traders badly affected	340	17	XI
6.	Invasion by Capital Corporate Houses	820	41	VIII
7.	Lack of internet facility	1250	62.5	IV
8.	Technological illiteracy	1360	68	II
9.	Management problems of produce unsold	1000	50	VI
10.	Insufficient number of computer operator	700	35	IX
11.	Difficulty in getting license	900	45	VII

CONCLUSION

- Significant Growth in e-NAM Usage. The platform has experienced remarkable growth across various categories, particularly in "Miscellaneous" and "Spices," indicating a growing acceptance and utilization among farmers and traders.
- Awareness Levels. While basic awareness of e-NAM is high among farmers and traders, detailed knowledge—especially concerning online bidding—remains limited, highlighting a gap in comprehensive understanding.
- Selling Practices. The traditional selling channels, primarily through APMC Arhtiyas, dominate, suggesting that existing structures still play a critical role in the market dynamics despite e-NAM's introduction.
- Barriers to Adoption. Major concerns among farmers include high transportation costs and

inadequate facilities for grading/sorting, which could hinder their participation in e-NAM.

- Demographic Trends. Younger farmers show a significantly higher willingness to adopt e-NAM, while older farmers display more resistance, suggesting a generational divide in technology acceptance.
- Education and Willingness. Higher education levels correlate positively with willingness to engage with e-NAM, indicating that education is a critical factor in the adoption of new technologies.
- Income and Family Size Effects. While willingness to participate in e-NAM is high across various income levels, smaller family sizes are associated with slightly greater willingness, hinting at potential lifestyle factors influencing adoption.

- Constraints to Adoption. Complexity in the sales process and technological barriers are significant constraints for both farmers and traders, underscoring the need for more accessible and user-friendly systems.

These findings underscore the need for targeted interventions to enhance e-NAM's effectiveness, ensuring that it meets the diverse needs of farmers and traders while fostering a more inclusive agricultural market.

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Economic Analysis of Production and Value Chain of Millet in Maharashtra

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ABSTRACT

Finger millet (*Eleusine coracana*), commonly known as ragi or nachni, is a nutritionally rich millet valued for its high calcium content and climate resilience. India, being the largest producer, primarily cultivates it in Karnataka, Maharashtra, and Tamil Nadu. This study, conducted in Nashik district of Maharashtra, explores the cost, returns, and profitability of finger millet production and its value-added products, employing a multistage sampling method. Data from 120 respondents, including 90 farmers and 30 value addition processors, was analyzed using budgeting and tabular analysis techniques.

Findings reveal that the current finger millet production system is not profitable, with a Benefit-Cost (B:C) ratio of 0.94 due to high labor and input costs. However, value-added products like biscuits, papads, and satv exhibit strong profitability, with B:C ratios of 1.77, 1.82, and 2.03, respectively, underscoring the economic potential of value addition. Strategies such as cost optimization, mechanization, and effective resource management can improve production viability.

The study highlights the importance of focusing on value addition, branding, and market linkages, particularly through Farmer Producer Organizations (FPOs), to enhance farmer incomes and meet the rising demand for gluten-free, health-conscious products. Emphasizing sustainable farming practices and government support can further bolster the economic viability of finger millet cultivation and its products, ensuring long-term benefits for farmers and rural economies.

Keywords: Finger millet, value-added products, cost, returns, and profitability

INTRODUCTION

Finger millet (*Eleusine coracana*), commonly known as nachni or ragi, is a nutritionally rich millet that plays a vital role in global food security, especially in arid and semi-arid regions. With one of the highest calcium contents among all cereals (344 mg per 100 grams), it is a crucial source of nutrition, particularly for women and children. India is the largest producer of finger millets, contributing around 40 per cent of the world's production, with states like Karnataka, Maharashtra, and Tamil Nadu being the major growers. Due to its drought tolerance and low input requirements, finger millet is a climate-resilient crop, making it an important player in sustainable agriculture. The rising demand for gluten-free and nutritious food has further boosted its importance, leading to increasing value-added products like finger millet flour, biscuits, and health drinks, contributing to both rural economies and global health trends.

Value addition in millets involves transforming raw millet grains into processed products, which enhances their market value, improves shelf life, and increases consumer demand. Finger millet (*Eleusine coracana*), also known as ragi or nachni, holds significant importance within the larger millet family due to its nutritional, economic, and environmental benefits. Finger millet stands out within the millet family due to its superior nutritional profile, resilience in harsh climates, and growing importance in both traditional diets and modern health-conscious markets. It is increasingly becoming a focal point in the promotion of millets as a solution to health, environmental, and food security challenges. Hence for the study purpose Finger Millet was considered

Role in Millet Revival

1. Focus on Millets: With international initiatives like the *International Year of Millets 2023* and government policies promoting millet

consumption, finger millet is playing a key role in reviving traditional millets and diversifying agriculture.

2. **Food Security:** Finger millet contributes to food security due to its adaptability to difficult growing conditions and its high nutritional value.

Economic Importance

1. **Staple Food:** Finger millet is a staple for many rural populations, particularly in parts of India and Africa.
2. **Income Source for Farmers:** Finger millet cultivation provides livelihood to small and marginal farmers, especially in drought-prone areas.
3. **Value Addition:** There's growing demand for value-added products like finger millet flour, biscuits, health drinks, and snacks, opening up markets for farmers and entrepreneurs.
4. **Export Potential:** With the rising global demand for nutritious, gluten-free, and health-conscious food, finger millet has significant export potential.

In view of importance of Finger Millet in balanced diet and farmers economy, it become imperative to study Value addition of Millet in Maharashtra. Objectives of the study are

- i) To study cost, returns and profitability in Finger Millet production
- ii) To study Economics of value addition in different Finger Millet Products

Methodology

The study employed a multistage sampling technique to select farmers based on finger millet production during the Kharif season in Maharashtra. The Western Maharashtra region, specifically Nashik district, was purposively chosen due to its significant contribution to the production and value addition of finger millet. Within Nashik, three talukas viz. Sargana, Dindori, and Peth were selected based on the highest area under finger millet cultivation. From each taluka, two villages were randomly selected, and from each village, 15 Finger Millet growing farmers were chosen using simple random sampling, resulting in a sample size of 90 farmers. Additionally, data on value-added products were collected from 10 respondents involved in the value addition process for each product, giving a total sample size of 30 respondents for three value-added products. Hence, the overall sample size for the study was 120 respondents.

Nature and Source of Data

The study is based on primary data collected through personal interviews with the sample farmers using a specially designed and pre-tested interview schedule. Information was gathered on the quantity and value of various inputs used in finger millet cultivation and the corresponding yields obtained. Additionally, data related to the preparation and marketing of value-added finger millet products were collected.

Analytical tools Applied

Budgeting Technique: This method was employed to estimate the costs and returns associated with both the production and value addition of finger millet.

Tabular Analysis: This approach, utilizing averages and percentages, was applied to examine the marketing aspects of finger millet and its value-added products, as well as to identify the constraints related to production, value addition, and marketing of millet and its products

RESULTS AND DISCUSSION

I. Per hectare cost of cultivation of Finger Millet in Western Maharashtra

Cost of Production: The cost of cultivating millets includes expenses on seeds, fertilizers, labor, water, and other inputs. Millets are drought-resistant and can grow in marginal soils, making their production cost relatively lower compared to other cereals.

Supply Chain: Farmers generally supply millets to processors or traders. The value chain includes post-harvest activities like cleaning, grading, and storage, which increase the quality and marketability of the product.

It can be seen from table 1 that the per hectare costs and returns for cultivating a Finger Millet in the 2023-24, offering a detailed perspective on the overall profitability and efficiency of the cultivation process.

The per hectare cost 'C' was worked out to ₹.68203.44. In this total cost, the share of working capital, cost 'A' and cost 'B' are ₹ 28804.66 (42.23%), ₹ 31033.54 (45.50 %) and ₹ 42093.95 (61.72 %), respectively. Among the different items of cost total human labour (56.12 %), bullock Power (16.00 %) and rental value of land (15.49 %) were the major items. The other important items of cost were the machine power (3.03 %), manures (2.60 %) and incidental charges (1.52 %). The share of cost incurred in respect of land revenue and taxes, fertilizers and repairs of farm implements were negligible in the cost of cultivation. The average per hectare productivity was 17.59 quintals and the cost

required for the production of one quintal of finger millet was ₹. 3558.70

Cost Structure

1. Direct Costs (Cost A):

Labor Costs: Hired labour is divided into male and female workdays, amounting to ₹4,205.37 for male labour and ₹7,956.80 for female labor. Labour remains one of the most significant inputs due to high wage rates per day.

Animal and machine power: Bullock power is used for tasks like ploughing, costing ₹10,915.30, while machine power (e.g., tractors) costs ₹2,065.33 for 2.29 hours of operation. Both animal and machine power is essential for timely land preparation and management.

Input Costs: Essential inputs include seeds (₹178.71), manure (₹1,770.28), and chemical fertilizers like nitrogen and phosphorus (₹398.42 and ₹136.88, respectively). Together, these inputs ensure the crop's growth and productivity.

Incidental Charges: Other small but necessary expenses, such as incidental charges (₹1,034.55) and maintenance of farm implements (₹143.01), contribute to overall expenses.

Adding up these expenses, the **Cost A** is ₹31,033.54. This represents the direct investment needed to bring the crop to harvest readiness.

Table 1. Per hectare cost of cultivation of Finger Millet in Western Maharashtra

Sr. No	Cost Item	Quantity	Rate (₹)	Value (₹)	Per Cent
1	Hired Human Labour (Days)				
	Male	18.56	226.59	4205.37	6.17
	Female	37.51	212.11	7956.80	11.67
2	Bullock Power (Days)	8.15	1339.30	10915.30	16.00
3	Machine Power (Hrs.)	2.29	901.89	2065.33	3.03
4	Seed (Kg)	3.65	48.96	178.71	0.26
5	Manure (Qtl.)	11.06	160	1770.28	2.60
6	Fertilizer (Kg)				
	Nitrogen (N)	30.00	13.28	398.42	0.58
	Phosphorous (P)	2.36	58.00	136.88	0.20
	Potash (K)	0.00	0.00	0.00	0.00
7	Incidental Charges (₹)			1034.55	1.52
8	Repairs on Farm Implements			143.01	0.21
9	Working Capital (1 to 9)			28804.66	42.23
10	Interest on Working capital (₹.)@6 %			1728.28	2.53
11	Depreciation on farm implements (Rs.)			457.50	0.67
12	Land revenue and other taxes (₹)			43.10	0.06
13	COST – 'A' Rs. (1 to 12)			31033.54	45.50
14	Rental value of Land (₹.)			10565.77	15.49
15	Interest on Fixed Capital (₹)			494.64	0.73
16	COST – 'B' (13 to 15)			42093.95	61.72
17	Family Labour (Days)				
	Male	48.07	267.27	12847.63	18.84
	Female	58.72	225.85	13261.85	19.44
18	COST – 'C' (16 to 18)			68203.44	100.00
19	Output (Qtl.)				
	a) Main Produce	17.59	3299.60	58047.31	
	b) By Produce	12.59	445.37	5605.90	
20	COST – 'C' Net of by Produce Rs. (18- 19b)			62597.54	
21	Per Quintal Cost Rs. (20/19b)			3558.70	

2. Fixed and Additional Costs (Cost B):

Rental value of Land: Since land is a primary resource, its rental value is considered a fixed cost at ₹10,565.77. For farmers leasing land, this represents a cash outflow, while for owners, it accounts for the opportunity cost of land use.

Interest on Fixed Capital: Interest on fixed capital, such as equipment and structures, is calculated at ₹494.64, ensuring a more comprehensive estimate of costs.

Together, these bring the total fixed and additional expenses to **Cost B**, or ₹42,093.95.

3. Total Cost Including Family Labour (Cost C):

Many farming families contribute labour directly, which is monetized for analysis. Family labour costs include 48.07 days of male labour (₹12,847.63) and 58.72 days of female labour (₹13,261.85). Including family labour, the **Total Cost (Cost C)** rises to ₹68,203.44.

Revenue and Profitability

- Main Produce:** A yield of 17.59 quintals valued at ₹3,299.60 per quintal provides revenue of ₹58,047.31.
- By-Product:** Additional by-products are valued at ₹5,605.90, offering supplementary income.

Combined, the total revenue from main and by-produce reaches ₹63,653.21.

Profit Analysis and Benefit-Cost (B:C) Ratio

To evaluate profitability, we calculate the **Net Cost** by subtracting the revenue from by-products from the total cost, resulting in ₹62,597.54. The **per-quintal production cost** is then calculated at ₹3,558.70, reflecting how much it costs to produce each quintal. Finally, the **Benefit-Cost Ratio** compares total revenue to total cost. Here, the B : C ratio is approximately **0.93** (₹63,653.21 / ₹68,203.44), meaning that for every rupee invested, the farmer recovers only 0.94 paise. Since a ratio above 1 indicates profitability, this value below 1 suggests a small loss, as total costs exceed revenues by a slight margin. This insight is crucial for making adjustments, such as optimizing input use or reducing labour costs, to enhance profitability in future seasons.

II. Final Cost and Profit Analysis for Finger Millet Biscuits

From the table 2. outlines the cost structure for processing 1 kg of raw finger millet (ragi) into flour. It includes the purchase cost of raw millet at ₹47 per kg, transportation at ₹1 per kg, labor charges for cleaning and drying at ₹5 per kg, and grinding costs at ₹10 per kg, totaling ₹63. To this, a profit margin of ₹7 is added, bringing the final cost of processed millet flour to ₹70 per kg. This breakdown provides a clear understanding of the expenses involved in value addition, facilitating pricing strategies for further use in products like biscuits or other value-added items.

Table 2. Raw Material and Processing Costs

Sr. No.	Cost Head/Ingredient	Quantity (kg/unit)	Rate (₹/kg/unit)	Amount (₹)
1	Raw Finger Millet (Ragi)	1.000	47.00	47.00
2	Transport cost	1.000	1.00	1.00
3	Labor costs (Cleaning, Drying)	1.000	5.00	5.00
4	Grinding Cost	1.000	10.00	10.00
	Subtotal		63.00	
	Profit margin (Raw Millet)		7.00	
	Total (Raw Finger Millet Processing)		70.00	

The table 3 Presents the raw material costs for producing biscuits using finger millet (ragi) flour as a key ingredient. The recipe requires 0.3 kg of ragi flour at ₹70 per kg (₹21), 0.7 kg of refined flour (maida) at ₹40 per kg (₹28), 0.5 kg of hydrogenated oil (vanaspati) at ₹145 per kg (₹72.50), and 0.5 kg of sugar at ₹40 per kg (₹20). Additionally, 0.005 kg

each of ammonium bicarbonate and sodium bicarbonate, costing ₹60 and ₹90 per kg respectively, contribute ₹0.30 and ₹0.45. Packaging costs, including 0.03 kg of printed plastic bags at ₹185 per kg, add ₹5.55. Altogether, the subtotal for raw material costs amounts to ₹147.80, providing a detailed breakdown for pricing and production planning.

Table 3. Production and Packaging Costs (Variable Cost) in finger millet Biscuit

Sr. No.	Cost Head/Ingredient	Quantity (kg/unit)	Rate (₹/kg/unit)	Amount (₹)
1	Finger Millet (Ragi) Flour	0.300	70.00	21.00
2	Refined Flour (Maida)	0.700	40.00	28.00
3	Hydrogenated Oil (Vanaspati)	0.500	145.00	72.50
4	Sugar	0.500	40.00	20.00
5	Ammonium Bicarbonate	0.005	60.00	0.30
6	Sodium Bicarbonate	0.005	90.00	0.45
7	Printed Plastic Bag	0.030	185.00	5.55
	Subtotal (Raw Material Costs)			147.80

Table 4 summarizes the calculation of overhead charges, profit margin, and final cost for producing biscuits. Overhead charges, which include labour, fuel, electricity, supervision, sales management, machinery depreciation, and interest on capital, are calculated at 60 per cent of raw material

costs (₹147.80), amounting to ₹88.68. Adding this to the raw material costs brings the total production cost to ₹236.48. A profit margin of 25 per cent on the total cost is applied, contributing ₹59.12. The final cost, inclusive of all expenses and profit, is ₹295.60 providing a comprehensive cost structure for the product.

Table 4. Overhead charges and Profit in finger millet Biscuit

Overhead Charges	Rate (%)	Amount (₹)
60% of Raw Material Costs (Cost A)	--	88.68
Total Cost (Including Overheads)	--	236.48
Profit Margin (25%)	--	59.12
Final Cost	--	295.60

This table provides an analysis of the production and profitability of biscuits made from finger millet (ragi). From 1 kg of raw millet flour, 1.8 kg of finished biscuits are produced, sold at ₹200 per kg, generating a total revenue of ₹360. The cost of producing 1 kg of finished biscuits, including raw

materials, overheads, and other expenses, is ₹236.48. This results in a profit margin of ₹123.52 per kg. The benefit-cost (B:C) ratio for the raw millet used in production is calculated to be 1.77, indicating that the revenue generated is more than double the production costs, demonstrating significant profitability.

Table 5. Selling Price and Profit Margin in finger millet Biscuit

Details	Quantity (kg)	Rate (₹/kg)	Amount (₹)
Production from 1 kg Raw Millet	1.800	200.00	360.00
Cost for Finished Product	1.800		295.60
Profit Margin (25%)	--	--	59.12
Total Selling Price			419.12
B:C Ratio of Raw Millet	--	--	1.77

The analysis covers the production cost and profitability of biscuits made from finger millet (ragi). Processing 1 kg of raw millet into flour costs ₹70, including procurement, transport, labour, grinding, and a profit margin. The raw material costs for the biscuits total ₹147.80, incorporating ingredients like ragi flour, refined flour, hydrogenated oil, sugar, and packaging. Overheads, calculated at 60

per cent of raw material costs, add ₹88.68, making the total production cost ₹236.48. With a 25 per cent profit margin, the final cost is ₹295.60 per kg. From 1 kg of processed millet, 1.8 kg of biscuits are produced, generating revenue of ₹360 at a selling price of ₹200 per kg, yielding a profit of ₹123.52 per kg and a B:C ratio of 1.77, showcasing strong profitability and cost efficiency.

III. Final Cost and Profit Analysis for Finger Millet Papad

Table 6. Production and Packaging Costs (Variable Cost) for finger Millet Papad

Sr. No.	Cost Head/Ingredient	Quantity (kg/unit)	Rate (₹/kg/unit)	Amount (₹)
1	Finger Millet (Ragi) Flour	1.000	70.00	70.00
2	Papad Khar	0.025	200	5.00
3	Salt	0.025	24	0.60
4	Seasamum	0.012	200	2.40
5	fennel	0.012	220	2.64
6	ova	0.012	600	7.20
7	oil	0.025	150	3.75
8	Water	1.500	1	1.50
9	Sabudana	0.025	80	2.00
	Subtotal (Raw Material Costs)			95.09

From the table 6 outlines the cost breakdown for producing Finger Millet Papad, detailing the quantities, rates, and total amounts for each ingredient. The primary ingredient, Finger Millet (Ragi) Flour, is used in the highest quantity (1 kg) at a rate of ₹70/kg, contributing ₹70.00 to the total cost. Other key ingredients include Papad Khar (0.025 kg at ₹200/kg, ₹5.00), salt (0.025 kg at ₹24/kg, ₹0.60), sesame (0.012 kg at ₹200/kg, ₹2.40), funnel (0.012 kg at ₹220/kg, ₹2.64), and ova (0.012 kg at ₹600/kg, ₹7.20). Additionally, oil (0.025 kg at ₹150/kg, ₹ 3.75), water (1.5 kg at ₹1/kg, ₹1.50), and sabudana (0.025 kg at ₹80/kg, ₹2.00) are included, bringing the total raw material cost to ₹95.09. This table provides

a precise breakdown of costs essential for analyzing production expenses.

The table 7 presents the overhead charges and profit margin calculations for producing Finger Millet Papad. Overhead costs are calculated at 60 per cent of the raw material costs, amounting to ₹ 57.05. Adding this to the raw material cost of ₹ 95.09 results in a total production cost, including overheads, of ₹ 152.14. A profit margin of 25 per cent on the total cost is then applied, equating to ₹ 38.03. Consequently, the final cost of producing the papad, incorporating both costs and profit, amounts to ₹ 190.17. This comprehensive breakdown ensures transparency and aids in pricing decisions.

Table. 7 Overhead charges and Profit for finger Millet Papad

Overhead Charges	Rate (%)	Amount (₹)
60% of Raw Material Costs	--	57.05
Total Cost (Including Overheads)	--	152.14
Profit Margin (25%)	--	38.03
Final Cost	--	190.17

The table 8 illustrates the production yield, selling price, and benefit-cost analysis for Finger Millet Papad. From 1 kg of raw millet, 0.8 kg of papad is produced, which is sold at a rate of ₹ 300/kg, generating revenue of ₹ 240.00. After accounting for the profit margin of ₹ 38.03, the total proceeds

amount to ₹ 278.03. The benefit-cost (B: C) ratio is calculated at 1.82, indicating that for every rupee spent on production, ₹1.82 is earned, demonstrating the economic viability and profitability of the papad production process.

Table 8. Selling Price and Profit Margin in Finger Millet Papad

Details	Quantity (kg)	Rate (₹/kg)	Amount (₹)
Production from 1 kg Raw Millet	0.800	300.00	240.00
Profit Margin	--	--	38.03
Total	--	--	278.03
B:C Ratio of Papad			1.82

The production of Finger Millet Papad involves several cost components, with raw material costs totaling ₹95.09, including ingredients such as Finger Millet Flour, Papad Khar, salt, sesame, and others. Overhead charges, calculated at 60 per cent of the raw material costs, add ₹ 57.05, bringing the total production cost to ₹ 152.14. A 25 per cent profit margin, amounting to ₹ 38.03, results in a final production cost of ₹ 190.17 per kg. From 1 kg of raw millet, 0.8 kg of papad is produced, which is sold at ₹ 300/kg, generating ₹ 240 in revenue. Including the profit margin, the total revenue reaches ₹ 278.03, with a benefit-cost (B:C) ratio of 1.82, indicating good profitability and economic viability of the papad production.

IV. Cost and Profit Analysis for Finger Millet Satv

The table 9 provides a comprehensive cost and profit analysis for producing Finger Millet Satv. It begins with the primary ingredient, Finger Millet Flour, used in a quantity of 1.5 kg at a rate of ₹ 70/kg, totaling ₹ 105.00 as the raw material cost. Overheads are calculated at 60% of the raw material cost, adding ₹ 63.00, bringing the total cost, including overheads, to ₹168.00. A profit margin of 25% (₹42.00) is applied, resulting in a final cost of ₹ 210.00. The production yield from 1 kg of raw millet is 0.7 kg of Satv, sold at ₹ 300/kg, generating a total revenue of ₹ 240.00 and a profit margin of ₹ 42.00, leading to a total selling price of ₹ 282.00. The analysis concludes with a benefit-cost (B:C) ratio of 2.03, demonstrating the economic viability and profitability of the production process.

Table 9. Cost and Profit Analysis for Finger Millet Satv

Sr. No.	Details	Quantity (kg/unit)	Rate (₹/kg/unit)	Amount (₹)
1	Finger Millet (Ragi) Flour	1.500	70.00	105.00
	Subtotal (Raw Material Costs)			105.00
2	Overhead Charges			
	60% of Raw Material Costs			63.00
3	Total Cost (Including Overheads)			168.00
4	Profit Margin (25%)			42.00
5	Final Cost			210.00
6	Selling Price and Profit Margin Details			
	Production from 1 kg millet Satv	1.000	300.00	300.00
	Profit Margin			42.00
7	Total Selling Price			342.00
8	Benefit-to-Cost Ratio (B:C Ratio)			2.03

CONCLUSIONS

1. The per-hectare cost of cultivating finger millet (₹ 68,203.44) surpasses the total revenue generated (₹ 63,653.21), resulting in a Benefit-Cost (B:C) ratio of 0.94. This indicates that the current production system is not profitable, as costs slightly exceed returns. Key cost components, such as human labor (56.12%), bullock power (16.00%), and rental value of land (15.49%), are significant contributors to the overall expenses, highlighting the need for cost optimization strategies to improve financial outcomes.
2. The inclusion of by-products (valued at ₹ 5,605.90) contributes significantly to total revenue, demonstrating the potential for

income diversification through effective utilization of all outputs. However, the high cost per quintal of production (₹ 3,558.25) indicates the necessity to enhance resource productivity, streamline input use, and explore mechanization or alternative labor strategies to reduce dependency on expensive human labor and bullock power.

3. The production of biscuits using finger millet (ragi) as a key ingredient demonstrates strong profitability and cost efficiency, with a Benefit-Cost (B:C) ratio of 1.77. This indicates that the revenue generated is more than double the production cost. The process effectively adds value to raw millet, transforming it into a high-margin product. By leveraging

efficient cost management and value addition, the final product achieves a profit margin of ₹ 123.52 per kg, highlighting the potential of ragi-based biscuits as a lucrative and sustainable business opportunity in the value-added food segment.

4. The production of Finger Millet Papad is a profitable and economically viable venture, as evidenced by a Benefit-Cost (B:C) ratio of 1.82. This indicates that for every rupee invested in production; ₹ 1.82 is earned, reflecting substantial returns. The process effectively utilizes raw materials and overhead management to achieve a total production cost of ₹152.14 per kg and a selling price of ₹300 per kg, generating a profit margin of ₹38.03. This analysis highlights the potential of Finger Millet Papad as a lucrative value-added product in the food processing sector.
5. The production of Finger Millet Satv is economically viable and profitable, with a Benefit-Cost (B : C) ratio of 2.03, indicating that every rupee invested in the production yields ₹ 1.03 in returns. By efficiently managing raw material costs (₹105.00) and overheads (₹63.00), the total production cost is maintained at ₹168.00, while a 25% profit margin ensures a competitive final cost of ₹ 210.00. With a selling price of ₹ 300 per kg and a revenue of ₹240.00 from 0.7 kg of Satv produced per kg of raw millet, the process demonstrates a strong potential for profitability and sustainability in the value-added food product market.

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Economic Analysis of Integrated Farming System for Doubling Farmers Income in Western Maharashtra

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ABSTRACT

Integrated farming is defined as a biologically integrated system, which integrates natural resources in a regulated mechanism into farming activities to achieve maximum replacement of off-farm inputs and sustain farm income. The productivity of a diversified cropping system always tends to increase when it is integrated with dairy, horticulture components. The present investigation on economics of integrated farming systems for doubling farmer's income in Western Maharashtra helps farmers to achieve maximum returns and income from different integrated components, thereby improving their standard of living. The primary data were collected from 12 Villages of Kolhapur, Pune and Nashik district. The total sample size for the study was 180 farmers. The finding of study observed that among the identified integrated farming system, crop + dairy + horticulture (C+D+H) farming system was profitable as indicate from the B:C ratio i.e. 1.68, followed by crop + dairy (C+D) i.e. 1.40 followed by crop only i.e. 1.25. Also the IBCR of crop + dairy + horticulture (C+D+H) farming system was 1.93 followed by crop + dairy (C+D) i.e. 1.53 Therefore, It was concluded that farm income from the farming system i.e. crop + dairy + horticulture (C+D+H) was more than the crops only in the study area. So that, intensification of Integrated farming system with crop, dairy and horticulture, should be popularized among the farmers on a larger scale, as it provides scope for higher returns.

INTRODUCTION

Agriculture is one of the most fundamental activities that supports human life, providing food, raw materials, and other products that are essential to societies around the world. The agriculture continually faces challenges due to environmental changes, population growth, fragmentation of agricultural land, market fluctuations, and the pursuit of improved livelihoods. In response, integrated farming systems (IFS) have emerged as a promising strategy to address these multifaceted challenges in agriculture. "Integrated Farming Systems defined as an output from one subsystem in an integrated farming system, which otherwise may have been wasted, becomes an input to another subsystem resulting in a greater efficiency of output of desired products from the land/water area under a farmer's control". (FAO 2008) Integrated farming is a farming system that involves the integration of multiple components of agriculture, such as crop cultivation, livestock rearing, aquaculture, agroforestry, and other allied activities, in a single farm unit.

Integrated farming emphasizes the use of natural processes and ecological principles to enhance productivity and sustainability. In an integrated farming system, the waste products of one component are utilized as inputs for another, resulting in a closed-loop system that minimizes waste and promotes efficiency. For example, livestock waste can be used as fertilizer for crops, and crop residues can be used as feed for livestock. Integrated farming can help farmers to improve their income and livelihoods, as well as promote food security and environmental sustainability. Integrated farming can also help to conserve natural resources and promote biodiversity, as it involves the integration of different farming practices that utilize the land and its resources in a more efficient and sustainable manner.

Keeping above fact in view, the present study was designed to estimate the economics of integrated farming system adopters in order to understand economic potential of integrated farming system.

METHODOLOGY

'Western Maharashtra' region was selected for present study on the basis of diversification in farming system. The main aim of this study was to analyze the selected farming systems economically. Three major farming systems adopted in the region considered for the present study was F.S.-I (Crops only), F. S.-II (Crops + Dairy) and F. S. - III (Crops + Dairy + Horticulture).

Three districts viz; Kolhapur, Pune and Nashik were purposively selected on the basis of livestock population density, presence of both irrigated as well as rainfed area, regional diversity etc. The most representative Tahsils, one irrigated and one rainfed Tahsils were selected from each district. Thus, three irrigated and three rainfed Tahsils were selected from all three districts. Two villages were selected randomly from each Tahsil. In all 12 villages (6 irrigated and 6 rainfed) were selected. From each village, 15 farmers were selected purposively in such a way that, 5 farmers from each farming system were selected out of three selected farming systems in that district. As such total 180 sample farmers were selected randomly for the study.

The data were collected through the personal interview. The collected data were processed and statistically analyzed by using statistical technique like computation of mean and percentage,. Standard costs concept generally used in farm management study i.e. Cost A, Cost B and Cost C employed for estimation of economics of farming system.

RESULTS AND DISCUSSION

Per farm costs and returns of irrigated and rainfed region of all the three selected farming systems are presented in the Table 1.

The analysis of the cost and returns from farming systems I, II, and III reveals significant differences in profitability and productivity across irrigated and rainfed regions.

Farming System I: The average cost per farm in irrigated regions was ₹ 2,47,288, while in rainfed regions it was ₹ 1,78,049. The higher input costs in irrigated regions made farming more expensive, although the gross returns were not explicitly highlighted for this system. The output-input ratio was 1.25, indicating modest efficiency.

Farming System II: The average cost per farm in irrigated and rainfed regions was ₹ 5,27,808 and ₹ 3,89,434, respectively. Gross returns were significantly higher in irrigated regions (₹ 8,10,891) compared to rainfed ones (₹ 4,70,025), suggesting greater productivity. The system's overall output-input ratio stood at 1.40, with net returns of ₹ 1,81,837, making it moderately profitable.

Farming System III: This system demonstrated the highest gross returns, with ₹ 21,21,671 in irrigated regions and ₹ 11,99,360 in rainfed ones. The average cost per farm was also highest at ₹ 11,22,679 in irrigated regions and ₹ 8,51,282 in rainfed ones. The output-input ratio (1.68) and IBCR (1.93) indicate exceptional profitability, with net returns reaching ₹ 6,73,535, marking it as the most advantageous farming system.

Conclusion

The study indicated that In conclusion, **farming system III** emerged as the most productive and profitable system, particularly in irrigated regions, due to its superior gross and net returns and higher output-input ratio. These findings underline the critical role of irrigation in enhancing agricultural productivity and profitability across diverse farming systems.

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Table 1. Per farm cost and return structure of selected Farming Systems

(Rs/farm)

Sr. No.	Particulars	Farming system I (Crop only)			Farming system II (Crops +Dairy)			Farming system III (Crops+ Dairy +Horticulture)		
		Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall	Irrigated	Rainfed	Overall
1	Gross Returns	328466	201476	264971	810891	470025	640458	2121671	1199360	1660515
2	Cost A	128270	82734	105502	222514	178460	200487	445791	386518	416155
3	Cost B	230125	163276	196700	444260	309391	376825	928433	711548	819990
4	Cost C	247288	178049	212669	527808	389434	458621	1122679	851282	986980
7	Net Return	81178	23427	52302	283083	80591	181837	998992	348078	673535
10	Output-Input Ratio at Cost C	1.33	1.13	1.25	1.54	1.21	1.40	1.89	1.41	1.68
11	Added Cost	-	-	-	280519	211385	245952	594871	461848	528359
12	Added Return	-	-	-	482425	268549	375487	1310780	729335	1020057
13	IBCR	-	-	-	1.72	1.27	1.53	2.20	1.58	1.93

Economic Analysis of Production and Value Chain of Millet in Maharashtra

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ABSTRACT

Finger millet (*Eleusine coracana*), commonly known as ragi or nachni, is a nutritionally rich millet valued for its high calcium content and climate resilience. India, being the largest producer, primarily cultivates it in Karnataka, Maharashtra, and Tamil Nadu. This study, conducted in Nashik district of Maharashtra, explores the cost, returns, and profitability of finger millet production and its value-added products, employing a multistage sampling method. Data from 120 respondents, including 90 farmers and 30 value addition processors, was analyzed using budgeting and tabular analysis techniques.

Findings reveal that the current finger millet production system is not profitable, with a Benefit-Cost (B:C) ratio of 0.94 due to high labor and input costs. However, value-added products like biscuits, papads, and satv exhibit strong profitability, with B:C ratios of 1.77, 1.82, and 2.03, respectively, underscoring the economic potential of value addition. Strategies such as cost optimization, mechanization, and effective resource management can improve production viability.

The study highlights the importance of focusing on value addition, branding, and market linkages, particularly through Farmer Producer Organizations (FPOs), to enhance farmer incomes and meet the rising demand for gluten-free, health-conscious products. Emphasizing sustainable farming practices and government support can further bolster the economic viability of finger millet cultivation and its products, ensuring long-term benefits for farmers and rural economies.

Keywords: Finger millet, value-added products, cost, returns, and profitability

INTRODUCTION

Finger millet (*Eleusine coracana*), commonly known as nachni or ragi, is a nutritionally rich millet that plays a vital role in global food security, especially in arid and semi-arid regions. With one of the highest calcium contents among all cereals (344 mg per 100 grams), it is a crucial source of nutrition, particularly for women and children. India is the largest producer of finger millets, contributing around 40 per cent of the world's production, with states like Karnataka, Maharashtra, and Tamil Nadu being the major growers. Due to its drought tolerance and low input requirements, finger millet is a climate-resilient crop, making it an important player in sustainable agriculture. The rising demand for gluten-free and nutritious food has further boosted its importance, leading to increasing value-added products like finger millet flour, biscuits, and

health drinks, contributing to both rural economies and global health trends.

Value addition in millets involves transforming raw millet grains into processed products, which enhances their market value, improves shelf life, and increases consumer demand. Finger millet (*Eleusine coracana*), also known as ragi or nachni, holds significant importance within the larger millet family due to its nutritional, economic, and environmental benefits. Finger millet stands out within the millet family due to its superior nutritional profile, resilience in harsh climates, and growing importance in both traditional diets and modern health-conscious markets. It is increasingly becoming a focal point in the promotion of millets as a solution to health, environmental, and food security challenges. Hence for the study purpose Finger Millet was considered

Role in Millet Revival

3. **Focus on Millets:** With international initiatives like the *International Year of Millets 2023* and government policies promoting millet consumption, finger millet is playing a key role in reviving traditional millets and diversifying agriculture.
4. **Food Security:** Finger millet contributes to food security due to its adaptability to difficult growing conditions and its high nutritional value.

Economic Importance

5. **Staple Food:** Finger millet is a staple for many rural populations, particularly in parts of India and Africa.
6. **Income Source for Farmers:** Finger millet cultivation provides livelihood to small and marginal farmers, especially in drought-prone areas.
7. **Value Addition:** There's growing demand for value-added products like finger millet flour, biscuits, health drinks, and snacks, opening up markets for farmers and entrepreneurs.
8. **Export Potential:** With the rising global demand for nutritious, gluten-free, and health-conscious food, finger millet has significant export potential.

In view of importance of Finger Millet in balanced diet and farmers economy, it become imperative to study Value addition of Millet in Maharashtra. Objectives of the study are

- i) To study cost, returns and profitability in Finger Millet production
- ii) To study Economics of value addition in different Finger Millet Products

Methodology

The study employed a multistage sampling technique to select farmers based on finger millet production during the Kharif season in Maharashtra. The Western Maharashtra region, specifically Nashik district, was purposively chosen due to its significant contribution to the production and value addition of finger millet. Within Nashik, three talukas viz. Surgana, Dindori, and Peth were selected based on the highest area under finger millet cultivation. From each taluka, two villages were randomly selected, and from each village, 15 Finger Millet growing farmers were chosen using simple random sampling, resulting in a sample size of 90 farmers. Additionally, data on value-added products were collected from 10 respondents involved in the value addition process for

each product, giving a total sample size of 30 respondents for three value-added products. Hence, the overall sample size for the study was 120 respondents.

Nature and Source of Data

The study is based on primary data collected through personal interviews with the sample farmers using a specially designed and pre-tested interview schedule. Information was gathered on the quantity and value of various inputs used in finger millet cultivation and the corresponding yields obtained. Additionally, data related to the preparation and marketing of value-added finger millet products were collected.

Analytical tools Applied

Budgeting Technique: This method was employed to estimate the costs and returns associated with both the production and value addition of finger millet.

Tabular Analysis: This approach, utilizing averages and percentages, was applied to examine the marketing aspects of finger millet and its value-added products, as well as to identify the constraints related to production, value addition, and marketing of millet and its products

RESULTS AND DISCUSSION

V. Per hectare cost of cultivation of Finger Millet in Western Maharashtra

Cost of Production: The cost of cultivating millets includes expenses on seeds, fertilizers, labor, water, and other inputs. Millets are drought-resistant and can grow in marginal soils, making their production cost relatively lower compared to other cereals.

Supply Chain: Farmers generally supply millets to processors or traders. The value chain includes post-harvest activities like cleaning, grading, and storage, which increase the quality and marketability of the product.

It can be seen from table 1 that the per-hectare costs and returns for cultivating a Finger Millet in the 2023-24, offering a detailed perspective on the overall profitability and efficiency of the cultivation process.

The per hectare cost 'C' was worked out to ₹.68203.44. In this total cost, the share of working capital, cost 'A' and cost 'B' are ₹ 28804.66 (42.23%), ₹ 31033.54 (45.50 %) and ₹ 42093.95 (61.72 %), respectively. Among the different items of cost total human labour (56.12 %), bullock Power (16.00 %) and rental value of land (15.49 %) were the major items. The other important items of cost were the machine power (3.03 %), manures (2.60 %) and

incidental charges (1.52 %). The share of cost incurred in respect of land revenue and taxes, fertilizers and repairs of farm implements were negligible in the cost of cultivation. The average per hectare productivity was 17.59 quintals and the cost required for the production of one quintal of finger millet was ₹. 3558.70

Cost Structure

4. Direct Costs (Cost A):

Labor Costs: Hired labour is divided into male and female workdays, amounting to ₹4,205.37 for male labour and ₹7,956.80 for female labor. Labour remains one of the most significant inputs due to high wage rates per day.

Animal and machine power: Bullock power is used for tasks like ploughing, costing ₹10,915.30, while machine power (e.g., tractors) costs ₹2,065.33 for 2.29 hours of

operation. Both animal and machine power is essential for timely land preparation and management.

Input Costs: Essential inputs include seeds (₹178.71), manure (₹1,770.28), and chemical fertilizers like nitrogen and phosphorus (₹398.42 and ₹136.88, respectively). Together, these inputs ensure the crop's growth and productivity.

Incidental Charges: Other small but necessary expenses, such as incidental charges (₹1,034.55) and maintenance of farm implements (₹143.01), contribute to overall expenses.

Adding up these expenses, the **Cost A** is ₹31,033.54. This represents the direct investment needed to bring the crop to harvest readiness.

Table 1. Per hectare cost of cultivation of Finger Millet in Western Maharashtra

Sr.No	Cost Item	Quantity	Rate (₹)	Value (₹)	Per Cent
1	Hired Human Labour (Days)				
	Male	18.56	226.59	4205.37	6.17
	Female	37.51	212.11	7956.80	11.67
2	Bullock Power (Days)	8.15	1339.30	10915.30	16.00
3	Machine Power (Hrs.)	2.29	901.89	2065.33	3.03
4	Seed (Kg)	3.65	48.96	178.71	0.26
5	Manure (Qtl.)	11.06	160	1770.28	2.60
6	Fertilizer (Kg)				
	Nitrogen (N)	30.00	13.28	398.42	0.58
	Phosphorous (P)	2.36	58.00	136.88	0.20
	Potash (K)	0.00	0.00	0.00	0.00
7	Incidental Charges (₹)			1034.55	1.52
8	Repairs on Farm Implements			143.01	0.21
9	Working Capital (1 to 9)			28804.66	42.23
10	Interest on Working capital (₹.)@6 %			1728.28	2.53
11	Depreciation on farm implements (Rs.)			457.50	0.67
12	Land revenue and other taxes (₹)			43.10	0.06
13	COST – 'A' Rs. (1 to 12)			31033.54	45.50
14	Rental value of Land (₹.)			10565.77	15.49
15	Interest on Fixed Capital (₹)			494.64	0.73
16	COST – 'B' (13 to 15)			42093.95	61.72
17	Family Labour (Days)				
	Male	48.07	267.27	12847.63	18.84
	Female	58.72	225.85	13261.85	19.44
18	COST – 'C' (16 to 18)			68203.44	100.00
19	Output (Qtl.)				
	a) Main Produce	17.59	3299.60	58047.31	
	b) By Produce	12.59	445.37	5605.90	
20	COST – 'C' Net of by Produce Rs. (18- 19b)			62597.54	
21	Per Quintal Cost Rs. (20/19b)			3558.70	

5. Fixed and Additional Costs (Cost B):

Rental value of Land: Since land is a primary resource, its rental value is considered a fixed cost at ₹10,565.77. For farmers leasing land, this represents a cash outflow, while for owners, it accounts for the opportunity cost of land use.

Interest on Fixed Capital: Interest on fixed capital, such as equipment and structures, is calculated at ₹494.64, ensuring a more comprehensive estimate of costs.

Together, these bring the total fixed and additional expenses to **Cost B**, or ₹42,093.95.

6. Total Cost Including Family Labour (Cost C):

Many farming families contribute labour directly, which is monetized for analysis. Family labour costs include 48.07 days of male labour (₹12,847.63) and 58.72 days of female labour (₹13,261.85). Including family labour, the **Total Cost (Cost C)** rises to ₹68,203.44.

Revenue and Profitability

3. **Main Produce:** A yield of 17.59 quintals valued at ₹3,299.60 per quintal provides revenue of ₹58,047.31.

4. **By-Produce:** Additional by-products are valued at ₹5,605.90, offering supplementary income.

Combined, the total revenue from main and by-produce reaches ₹63,653.21.

Profit Analysis and Benefit-Cost (B:C) Ratio

To evaluate profitability, we calculate the **Net Cost** by subtracting the revenue from by-products from the total cost, resulting in ₹62,597.54. The **per-quintal production cost** is then calculated at ₹3,558.70, reflecting how much it costs to produce each quintal. Finally, the **Benefit-Cost Ratio** compares total revenue to total cost. Here, the B : C ratio is approximately **0.93** (₹63,653.21 / ₹68,203.44), meaning that for every rupee invested, the farmer recovers only 0.94 paise. Since a ratio above 1 indicates profitability, this value below 1 suggests a small loss, as total costs exceed revenues by a slight margin. This insight is crucial for making adjustments, such as optimizing input use or reducing labour costs, to enhance profitability in future seasons.

VI. Final Cost and Profit Analysis for Finger Millet Biscuits

From the table 2. outlines the cost structure for processing 1 kg of raw finger millet (ragi) into flour. It includes the purchase cost of raw millet at ₹47 per kg, transportation at ₹1 per kg, labor charges for cleaning and drying at ₹5 per kg, and grinding costs at ₹10 per kg, totaling ₹63. To this, a profit margin of ₹7 is added, bringing the final cost of processed millet flour to ₹70 per kg. This breakdown provides a clear understanding of the expenses involved in value addition, facilitating pricing strategies for further use in products like biscuits or other value-added items.

Table 2. Raw Material and Processing Costs

Sr. No.	Cost Head/Ingredient	Quantity (kg/unit)	Rate (₹/kg/unit)	Amount (₹)
1	Raw Finger Millet (Ragi)	1.000	47.00	47.00
2	Transport cost	1.000	1.00	1.00
3	Labor costs (Cleaning, Drying)	1.000	5.00	5.00
4	Grinding Cost	1.000	10.00	10.00
	Subtotal		63.00	
	Profit margin (Raw Millet)		7.00	
	Total (Raw Finger Millet Processing)		70.00	

The table 3 Presents the raw material costs for producing biscuits using finger millet (ragi) flour as a key ingredient. The recipe requires 0.3 kg of ragi flour at ₹70 per kg (₹21), 0.7 kg of refined flour (maida) at ₹40 per kg (₹28), 0.5 kg of hydrogenated oil (vanaspati) at ₹145 per kg (₹72.50), and 0.5 kg of sugar at ₹40 per kg (₹20). Additionally, 0.005 kg

each of ammonium bicarbonate and sodium bicarbonate, costing ₹60 and ₹90 per kg respectively, contribute ₹0.30 and ₹0.45. Packaging costs, including 0.03 kg of printed plastic bags at ₹185 per kg, add ₹5.55. Altogether, the subtotal for raw material costs amounts to ₹147.80, providing a detailed breakdown for pricing and production planning.

Table 3. Production and Packaging Costs (Variable Cost) in finger millet Biscuit

Sr. No.	Cost Head/Ingredient	Quantity (kg/unit)	Rate (₹/kg/unit)	Amount (₹)
1	Finger Millet (Ragi) Flour	0.300	70.00	21.00
2	Refined Flour (Maida)	0.700	40.00	28.00
3	Hydrogenated Oil (Vanaspati)	0.500	145.00	72.50
4	Sugar	0.500	40.00	20.00
5	Ammonium Bicarbonate	0.005	60.00	0.30
6	Sodium Bicarbonate	0.005	90.00	0.45
7	Printed Plastic Bag	0.030	185.00	5.55
	Subtotal (Raw Material Costs)			147.80

Table 4 summarizes the calculation of overhead charges, profit margin, and final cost for producing biscuits. Overhead charges, which include labour, fuel, electricity, supervision, sales management, machinery depreciation, and interest on capital, are calculated at 60 per cent of raw material

costs (₹147.80), amounting to ₹88.68. Adding this to the raw material costs brings the total production cost to ₹236.48. A profit margin of 25 per cent on the total cost is applied, contributing ₹59.12. The final cost, inclusive of all expenses and profit, is ₹295.60 providing a comprehensive cost structure for the product.

Table 4. Overhead charges and Profit in finger millet Biscuit

Overhead Charges	Rate (%)	Amount (₹)
60% of Raw Material Costs (Cost A)	--	88.68
Total Cost (Including Overheads)	--	236.48
Profit Margin (25%)	--	59.12
Final Cost	--	295.60

This table provides an analysis of the production and profitability of biscuits made from finger millet (ragi). From 1 kg of raw millet flour, 1.8 kg of finished biscuits are produced, sold at ₹200 per kg, generating a total revenue of ₹360. The cost of producing 1 kg of finished biscuits, including raw

materials, overheads, and other expenses, is ₹236.48. This results in a profit margin of ₹123.52 per kg. The benefit-cost (B:C) ratio for the raw millet used in production is calculated to be 1.77, indicating that the revenue generated is more than double the production costs, demonstrating significant profitability.

Table 5. Selling Price and Profit Margin in finger millet Biscuit

Details	Quantity (kg)	Rate (₹/kg)	Amount (₹)
Production from 1 kg Raw Millet	1.800	200.00	360.00
Cost for Finished Product	1.800		295.60
Profit Margin (25%)	--	--	59.12
Total Selling Price			419.12
B:C Ratio of Raw Millet	--	--	1.77

The analysis covers the production cost and profitability of biscuits made from finger millet (ragi). Processing 1 kg of raw millet into flour costs ₹70, including procurement, transport, labour, grinding, and a profit margin. The raw material costs for the biscuits total ₹147.80, incorporating ingredients like ragi flour, refined flour, hydrogenated oil, sugar, and packaging. Overheads, calculated at 60

per cent of raw material costs, add ₹88.68, making the total production cost ₹236.48. With a 25 per cent profit margin, the final cost is ₹295.60 per kg. From 1 kg of processed millet, 1.8 kg of biscuits are produced, generating revenue of ₹360 at a selling price of ₹200 per kg, yielding a profit of ₹123.52 per kg and a B:C ratio of 1.77, showcasing strong profitability and cost efficiency.

VII. Final Cost and Profit Analysis for Finger Millet Papad

Table 6. Production and Packaging Costs (Variable Cost) for finger Millet Papad

Sr. No.	Cost Head/Ingredient	Quantity (kg/unit)	Rate (₹/kg/unit)	Amount (₹)
1	Finger Millet (Ragi) Flour	1.000	70.00	70.00
2	Papad Khar	0.025	200	5.00
3	Salt	0.025	24	0.60
4	Seasamum	0.012	200	2.40
5	fennel	0.012	220	2.64
6	ova	0.012	600	7.20
7	oil	0.025	150	3.75
8	Water	1.500	1	1.50
9	Sabudana	0.025	80	2.00
Subtotal (Raw Material Costs)				95.09

From the table 6 outlines the cost breakdown for producing Finger Millet Papad, detailing the quantities, rates, and total amounts for each ingredient. The primary ingredient, Finger Millet (Ragi) Flour, is used in the highest quantity (1 kg) at a rate of ₹70/kg, contributing ₹70.00 to the total cost. Other key ingredients include Papad Khar (0.025 kg at ₹200/kg, ₹5.00), salt (0.025 kg at ₹24/kg, ₹0.60), sesame (0.012 kg at ₹200/kg, ₹2.40), funnel (0.012 kg at ₹220/kg, ₹2.64), and ova (0.012 kg at ₹600/kg, ₹7.20). Additionally, oil (0.025 kg at ₹150/kg, ₹ 3.75), water (1.5 kg at ₹1/kg, ₹1.50), and sabudana (0.025 kg at ₹80/kg, ₹2.00) are included, bringing the total raw material cost to ₹95.09. This table provides

a precise breakdown of costs essential for analyzing production expenses.

The table 7 presents the overhead charges and profit margin calculations for producing Finger Millet Papad. Overhead costs are calculated at 60 per cent of the raw material costs, amounting to ₹ 57.05. Adding this to the raw material cost of ₹ 95.09 results in a total production cost, including overheads, of ₹ 152.14. A profit margin of 25 per cent on the total cost is then applied, equating to ₹ 38.03. Consequently, the final cost of producing the papad, incorporating both costs and profit, amounts to ₹ 190.17. This comprehensive breakdown ensures transparency and aids in pricing decisions.

Table 7 Overhead charges and Profit for finger Millet Papad

Overhead Charges	Rate (%)	Amount (₹)
60% of Raw Material Costs	--	57.05
Total Cost (Including Overheads)	--	152.14
Profit Margin (25%)	--	38.03
Final Cost	--	190.17

The table 8 illustrates the production yield, selling price, and benefit-cost analysis for Finger Millet Papad. From 1 kg of raw millet, 0.8 kg of papad is produced, which is sold at a rate of ₹ 300/kg, generating revenue of ₹ 240.00. After accounting for the profit margin of ₹ 38.03, the total proceeds

amount to ₹ 278.03. The benefit-cost (B: C) ratio is calculated at 1.82, indicating that for every rupee spent on production, ₹1.82 is earned, demonstrating the economic viability and profitability of the papad production process.

Table 8. Selling Price and Profit Margin in Finger Millet Papad

Details	Quantity (kg)	Rate (₹/kg)	Amount (₹)
Production from 1 kg Raw Millet	0.800	300.00	240.00
Profit Margin	--	--	38.03
Total	--	--	278.03
B:C Ratio of Papad			1.82

The production of Finger Millet Papad involves several cost components, with raw material costs totaling ₹95.09, including ingredients such as Finger Millet Flour, Papad Khar, salt, sesame, and

others. Overhead charges, calculated at 60 per cent of the raw material costs, add ₹ 57.05, bringing the total production cost to ₹ 152.14. A 25 per cent profit margin, amounting to ₹ 38.03, results in a final

production cost of ₹ 190.17 per kg. From 1 kg of raw millet, 0.8 kg of papad is produced, which is sold at ₹ 300/kg, generating ₹ 240 in revenue. Including the profit margin, the total revenue reaches ₹ 278.03, with a benefit-cost (B:C) ratio of 1.82, indicating good profitability and economic viability of the papad production.

VIII. Cost and Profit Analysis for Finger Millet Satv

The table 9 provides a comprehensive cost and profit analysis for producing Finger Millet Satv. It begins with the primary ingredient, Finger Millet

Flour, used in a quantity of 1.5 kg at a rate of ₹ 70/kg, totaling ₹ 105.00 as the raw material cost. Overheads are calculated at 60% of the raw material cost, adding ₹ 63.00, bringing the total cost, including overheads, to ₹168.00. A profit margin of 25% (₹42.00) is applied, resulting in a final cost of ₹ 210.00. The production yield from 1 kg of raw millet is 0.7 kg of Satv, sold at ₹ 300/kg, generating a total revenue of ₹ 240.00 and a profit margin of ₹ 42.00, leading to a total selling price of ₹ 282.00. The analysis concludes with a benefit-cost (B:C) ratio of 2.03, demonstrating the economic viability and profitability of the production process.

Table 9. Cost and Profit Analysis for Finger Millet Satv

Sr. No.	Details	Quantity (kg/unit)	Rate (₹/kg/unit)	Amount (₹)
1	Finger Millet (Ragi) Flour	1.500	70.00	105.00
	Subtotal (Raw Material Costs)			105.00
2	Overhead Charges			
	60% of Raw Material Costs			63.00
3	Total Cost (Including Overheads)			168.00
4	Profit Margin (25%)			42.00
5	Final Cost			210.00
6	Selling Price and Profit Margin Details			
	Production from 1 kg millet Satv	1.000	300.00	300.00
	Profit Margin			42.00
7	Total Selling Price			342.00
8	Benefit-to-Cost Ratio (B:C Ratio)			2.03

CONCLUSIONS

1. The per-hectare cost of cultivating finger millet (₹ 68,203.44) surpasses the total revenue generated (₹ 63,653.21), resulting in a Benefit-Cost (B:C) ratio of 0.94. This indicates that the current production system is not profitable, as costs slightly exceed returns. Key cost components, such as human labor (56.12%), bullock power (16.00%), and rental value of land (15.49%), are significant contributors to the overall expenses, highlighting the need for cost optimization strategies to improve financial outcomes.
2. The inclusion of by-products (valued at ₹ 5,605.90) contributes significantly to total revenue, demonstrating the potential for income diversification through effective utilization of all outputs. However, the high cost per quintal of

production (₹ 3,558.25) indicates the necessity to enhance resource productivity, streamline input use, and explore mechanization or alternative labor strategies to reduce dependency on expensive human labor and bullock power.

3. The production of biscuits using finger millet (ragi) as a key ingredient demonstrates strong profitability and cost efficiency, with a Benefit-Cost (B:C) ratio of 1.77. This indicates that the revenue generated is more than double the production cost. The process effectively adds value to raw millet, transforming it into a high-margin product. By leveraging efficient cost management and value addition, the final product achieves a profit margin of ₹ 123.52 per kg, highlighting the potential of ragi-based biscuits

as a lucrative and sustainable business opportunity in the value-added food segment.

4. The production of Finger Millet Papad is a profitable and economically viable venture, as evidenced by a Benefit-Cost (B:C) ratio of 1.82. This indicates that for every rupee invested in production; ₹ 1.82 is earned, reflecting substantial returns. The process effectively utilizes raw materials and overhead management to achieve a total production cost of ₹152.14 per kg and a selling price of ₹300 per kg, generating a profit margin of ₹38.03. This analysis highlights the potential of Finger Millet Papad as a lucrative value-added product in the food processing sector.
5. The production of Finger Millet Satv is economically viable and profitable, with a Benefit-Cost (B : C) ratio of 2.03, indicating that every rupee invested in the production yields ₹ 1.03 in returns. By efficiently managing raw material costs (₹105.00) and overheads (₹63.00), the total production cost is maintained at ₹168.00, while a 25% profit margin ensures a competitive final cost of ₹ 210.00. With a selling price of ₹ 300 per kg and a revenue of ₹240.00 from 0.7 kg of Satv produced per kg of raw millet, the process demonstrates a strong potential for profitability and sustainability in the value-added food product market.

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Study on Disposal Pattern of Chengalikodan Nendran Banana (GI tag variety) in Thrissur district of Kerala

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ABSTRACT

This paper has analysed the disposal pattern, marketing channels, marketing strategies and the constraints in marketing of Chengalikodan Nendran banana (GI Tag variety). The primary data was collected from 90 sample farmers in Thrissur district of Kerala and they were classified in to three groups namely, small, medium and large. The primary data pertained to the year 2022-23. The study analyses the production and disposal patterns of Chengalikodan Nendran banana across different farm sizes. Small, medium and large farms produce 45.86 quintals, 86.05 quintals and 296.60 quintal of banana fruits per farm respectively. Out of which 97 per cent of the total production available for the market. The main marketing channel is through commission agents and wholesalers, representing 80.17 per cent of the marketable surplus. Cent per cent farmers participate in sales during the Onam season, whereas very less (13.33%) only a small percentage engage in value-added activities. Key challenges in marketing includes fluctuation in market prices (86.67%), misuse of GI Tag (74.44%), high marketing costs and delays in harvesting due to climate change (68.89%) respectively.

Keywords: GI Tag, Chengalikodan Nendran banana, Disposal, Marketing Channel, Constraints

INTRODUCTION

Banana cultivation holds a significant place in global agriculture, being one of the most widely grown and consumed fruits worldwide. Native to Southeast Asia, bananas have been cultivated for thousands of years, spreading to tropical and subtropical regions across the globe. This fruit is not only a staple food for millions but also a vital source of income for many smallholder farmers and large-scale producers.

"Chengalikodan" the most well-liked and traditional Nendran cultivar in the Thrissur area of Kerala, South India, also referred to as the "Chengazhikode" banana. It is thought that the Chengalikodan banana, got its name from the Chengazhikode location in the Thrissur District, where this cultivar originated. The locality known as Chengazhikode got its name from the local land lords of the time, known as the "Chengazhi Nambiyars". This variety of Nendran banana is well-known for its distinct flavour, form of the bunch, and colour of the fruit. Fruits have a shelf life of 7-9 days and a sugar content of 26–30 per cent, which makes them

particularly sweet. The fruits are long (21–25 cm), with a rind that is golden yellow in colour with red borders or patches known as "Kara" (which means boundary in Malayalam). An attempt has been made in this study to examine the disposal pattern of Chengalikodan Nendran banana.

METHODOLOGY

Kunnamkulam and Thalappally tahsils in Thrissur district were specifically chosen based on the area under cultivation of Chengalikodan Nendran banana in each tahsil. The Wadakkanchery River and its tributaries that run through the agriculture regions make the ground fertile and rich in organic matter, which enhances the attractiveness and taste of the fruits. The Wadakkanchery river, which originates in the Vazhani forest, supplies rich organic matter to its riverbeds, making Chengalikodan Nendran farming more popular.

A list of banana growers was compiled from documents kept at the respective Krishi Bhavans. The study included 15 farmers picked at random from each village. As a result, the final sample includes one district, two tahsils, six villages, and a total of 90

ChengalikodanNendran banana farmers. This multi-stage sampling strategy ensures a complete picture of ChengalikodanNendran banana cultivation in the Thrissur area. The present study used both primary and secondary data. The primary data were acquired from several farmers via personal interviews using a specially developed schedule. Secondary information for the specific variety is gathered from the Geographical Indications Registry.

RESULT AND DISCUSSION

3.1 Disposal pattern of Chengalikoda Nendran Banana

Disposal of ChengalikodanNendran banana included total quantity sold, quantity used for home

consumption, quantity given as kind wages, quantity given to relatives and damage and losses.

3.1.1 Per farm production and disposal of Chengalikodan Nendran banana

The final quantity of farm produce marketed after meeting other requirements of the farmer, the per farm disposal pattern of Chengalikodan Nendran banana was studied and the results of the same are presented in Table 1. It is seen from the Table 1 that the total production of banana at the overall level is 109.64 quintal. Out of which home consumption accounts for 0.83 per cent, followed by damage and losses (0.67 %), gift to relatives (0.38 %) and kind wages (0.34 %). The marketable surplus was 97.78 per cent of the total production.

Table 1 Per farm disposal pattern of ChengalikodanNendran banana (Qty. in quintal)

Sr. No.	Particulars	Small (N=31)	Medium (N=43)	Large (N=16)	Overall (N=90)
1.	Total Production (quintal)	45.86 (100.00)	86.05 (100.00)	296.60 (100.00)	109.64 (100.00)
2.	Disposal (quintal)				
	a. Home consumption	0.34 (0.76)	1.02 (1.19)	1.72 (0.58)	0.91 (0.83)
	b. Kind wages	0.29 (0.65)	0.29 (0.34)	0.74 (0.25)	0.37 (0.34)
	c. Gift to relatives	0.25 (0.54)	0.36 (0.42)	0.89 (0.30)	0.42 (0.38)
	d. Damage and losses	0.22 (0.48)	0.55 (0.64)	2.25 (0.76)	0.74 (0.67)
	Total	1.11 (2.43)	2.29 (2.59)	5.61 (1.89)	2.43 (2.22)
3.	Marketable surplus (quintal)	44.75 (97.57)	83.82 (97.41)	290.99 (98.11)	107.21 (97.78)

(Figures in parenthesis indicate percentage to total)

The disposal pattern of small farmers shows that out of total production (45.86qtls) of banana the marketable surplus was 44.75 quintal (97.57 %) followed by home consumption of 0.34 quintal (0.76 %), kind wages 0.29 quintal (0.65 per cent), gift to relatives (0.54 %) and damage and losses (0.48 %). The total production was 45.86 quintal per farm.

For the medium farmers, the total production was 86.05 quintal per farm. Out of which, marketable surplus was 97.41 per cent followed by home consumption of 1.19 per cent, damage and losses of 0.64 per cent, gift to relatives of 0.42 per cent and 0.34 per cent of kind wages.

The large farmers have a production of 296.60 quintal per farm. The disposal pattern followed include marketable surplus (98.11 %),

damage and losses (0.76 %), home consumption (0.58 %), gift to relatives (0.30 %) and kind wages (0.25 %). Thus, large farmers usually sold more per cent of their produce in the market whereas, small and medium farmers have a higher per cent of home consumption.

The above analysis indicates that the marketable surplus for the produce is higher in all the three groups which is a major reason for profitability of banana farmers in the study area. The findings of the study are in line with the studies of Hande (2012) for banana production in Sindhudurg district of Maharashtra.

3.1.2 Disposal of marketable surplus

Three main marketing channels were identified for the distribution of marketable surplus of Chengalikodan Nendran banana.

Channel I: Producer → Consumer

Channel II: Producer → Retailer → Consumer

Channel III: Producer → Commission agent cum Wholesaler → Retailer → Consumer

These channels wise distribution of marketable surplus is given in the Table 2

Table 2 Channel wise distribution of marketable surplus

Sr. No.	Identified marketing channels	Average quantity marketed (quintal)
1.	Producer → Consumer	7.04 (6.57)
2.	Producer → Retailer → Consumer	14.22 (13.26)
3.	Producer → Commission agent cum Wholesaler → Retailer → Consumer	85.95 (80.17)
	Total	107.21 (100.00)

(Figures in parenthesis indicate percentage to total)

It is seen from Table 2 that, more than three fourth of the marketable surplus is distributed through the third channel i.e., Producer → Commission agent cum Wholesaler → Retailer → Consumer (80.17 %), followed by second channel i.e., Producer → Retailer → Consumer (13.26 %) and the first channel i.e., Producer → Consumer (6.57 %). Farmers usually encourage direct sale on own farm to the commission agent or wholesalers in order to avoid the high transportation cost to obtain better share in consumer rupee.

3.2 Marketing practices followed by farmers

In general, the demand for Nendran shoots up in Onam season and to meet the demand merchants directly purchase the bunches from the farmers' fields. Very often deals are made prior to the harvest. Before obtaining the GI tag, the Chengalikodan bunches were sold at Rs. 50- 55 per kg during Onam season but after obtaining the GI tag,

farmers obtain Rs. 75-90 per kg during the Onam season. Farmers selling 'Kazchakula' (gift bunches) will get a fancy price of Rs 1500-3000 per bunch according to the demand and beauty of the bunches. Covering of bunches, 20 -25 days after emergence, is very important in 'Kazchakula' production. In bunches meant for 'Kazchakula', male inflorescence will be retained without removal. 'Theeta' (rolls of dry leaves) are kept between hands and fruits to improve orientation of hands and thus, to enhance the beauty of the bunch. Some farmers even slightly massage fruits to make them more attractive. The best 'Kazchakula' will have great demand to offer in temples and to be given as special gift to dignitaries or friends.

The documentation of the marketing practices followed by the sample farmers were given in Table 3.

Table 3 Documentation of the marketing practices followed by farmers

Sr. No.	Marketing Practices	Number of respondents (N = 90)
1	Sale during Onam season	90 (100.00)
2	Sale of suckers	78 (86.67)
3	Sale during off season	32 (35.56)
4	Care and Sale of Kaazhchakula (Gift bunches)	18 (20.00)
5	Value addition	12 (13.33)

(Figures in parentheses indicates percentage to total)

It is observed from Table 3 that; all the farmers sell their produce during Onam festival season in order to obtain premium price for their produce. Sale during off season is done by 35.56 per cent of sample farmers due to replanting of the damaged suckers and variation in the time of maturity among different plants. Most of the farmers still follows traditional practices of cultivation so, there are chances that few bunches may not be mature during the Onam season. 'Kazhakula' sale is done by 20 per cent of the sample farmers. Since, farmers follow traditional methods of production, suckers are not produced through methods like tissue culture propagation. Therefore, sale of suckers generates

Table 4 Constraints faced by sample banana farmers

Sr. No.	Constraints	Number of respondents (N = 90)
1	Fluctuating market prices and lack of price stability	78 (86.67)
2	Misuse use of GI tag	67 (74.44)
3	High marketing cost and losses during harvesting	62 (68.89)
4	Delay in harvesting due to climate change issues	54 (60.00)
5	Inadequate number of processing industries for value addition	46 (51.11)

(Figures in parentheses indicates percentage to total)

It is seen from the Table 4 that the main reason for the fluctuating market prices and lack of price stability are due to decrease in demand during the off season. This banana variety fetches premium price mainly during the Onam festival season. The price decreases rapidly after the Onam season. Another major constraint is the misuse of GI tag name. Certain shopkeepers utilise the brand name of this variety in order to deceive consumers who are not well aware about the differences between ChengalikodanNendran banana (GI tag variety) and common Nendran cultivars. Setting up of processing industries can help farmers to obtain stable price throughout the year.

CONCLUSION

The study reveals the disposal pattern of ChengalikodanNendran banana (GI Tag variety) production across small, medium, and large farms. The overall production per farm averaged 109.64 quintals. A small amount of the production goes towards domestic consumption, kind wages, gifts to

good returns. Among the sample farmers, 78 farmers sell suckers. Value addition to the produce is done by 13.33 per cent of farmers.

3.3 Constraints faced by farmers during marketing

It is revealed from Table 4 that, the major marketing constraints are fluctuating market price and lack of price stability (86.67 %), misuse of GI tag (74.44 %), high marketing cost and losses during harvesting (68.89 %), delay in harvesting due to climate change issues (60.00 %) and inadequate number of processing industries for value addition (51.11 %).

relatives and damage and losses. This accounts for 2.22% of the whole total. In case of channel-wise distribution of marketable surplus the largest share was through the Producer → Commission Agent cum Wholesaler → Retailer → Consumer channel, with 85.95 quintals, representing 80.17%. The total quantity marketed across all channels was 107.21 quintals. The study of the marketing practices adopted by farmers revealed that all respondents (100%) participated in the sales during the Onam season, while 86.67% engaged in the sale of suckers. The majority of respondents (86.67%) cited fluctuating market prices and lack of price stability as the main challenge, followed by 67 farmers (74.44%) who reported misuse of the GI tag. High marketing costs and losses during harvesting affected 68.89% of farmers, while 60% experienced delays in harvesting due to climate change. Additionally, 51.11% faced difficulties due to the inadequate number of processing industries for value addition.

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Seasonality Analysis of Sorghum Prices and Arrivals in Maharashtra

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ABSTRACT

Sorghum (Sorghum bicolor L.) contributes to more than 60% of millets produced globally. In India, Maharashtra state is the largest producer of sorghum over the period of time. The present study was aimed to estimate the seasonal variation and trends of arrival and prices and price volatility by using advanced time series analysis. The time series data on monthly arrivals and prices of sorghum were collected from the major six number of APMCs markets of Maharashtra. The seasonality of arrivals and prices were analyzed by estimating seasonal arrival and prices indexes and intra year variability. Data used were pertaining to the period of 20 years i.e., 2004-2024. Seasonality analysis of data indicated that all of the selected markets seasonal arrival indices of sorghum were higher than the price indices. The clear pattern of maximum and minimum arrivals and prices were noticed in most of the market. The peak arrivals of sorghum were noticed from the month march to June and the peak prices were seen from November to December with few exceptions. The estimated historical price and arrival patterns, fluctuations, and trends of sorghum revealed that there is need of appropriate policy measures to ensure fair prices to farmers in order to increase the potential area and production of sorghum in the Maharashtra.

Keywords: Sorghum, Trend, Seasonal indices, intra year variability, Arrivals

INTRODUCTION

Sorghum (*Sorghum bicolor L.*) is grown in nearly 100 countries, and contributes to more than 60% of millets produced globally. It is the world's fifth major cereal food crop in terms of production and acreage after rice, wheat, maize and barley. In India, major sorghum growing regions are north-western, western and central India, Southern peninsula and some parts of north-eastern states. In India, Maharashtra state contributes maximum area and production of sorghum over the period of time. The area, production and productivity of sorghum were 1.65 million ha., 1.71 million tonnes and 1038 qtl./ha respectively in the Maharashtra during the year 2021-2022. Sorghum crop has inherent drought tolerant characteristics but less tolerant to low temperatures. The grains of sorghum have other industrial uses such as bioethanol production and potable alcohol production. It is also recognized as nutritive and healthy food among all the cereals and millets as it is rich in protein, fibre, thiamine, riboflavin, folic acid, and carotene.

Agricultural prices are an important signal of marketing system and have enormous economic implications. These prices play an important role in bringing market equilibrium between demand and supply. The variations of market arrival largely responsible for price instability of agricultural commodities. In order to devise the appropriate ways and means for reducing the price fluctuation of agricultural commodities, there is need to have a thorough understanding of the price behavior of agricultural commodities over time. The estimation of seasonal arrival and price indexes and intra year variability of sorghum would be insightful to all stakeholders including farmers to understand the market dynamics that influence the prices.

METHODOLOGY

The time series data on monthly arrivals and prices of sorghum were collected from the major APMCs markets of Maharashtra for the period of 20 years i.e., 2004-2023. Selection of markets were decided on the

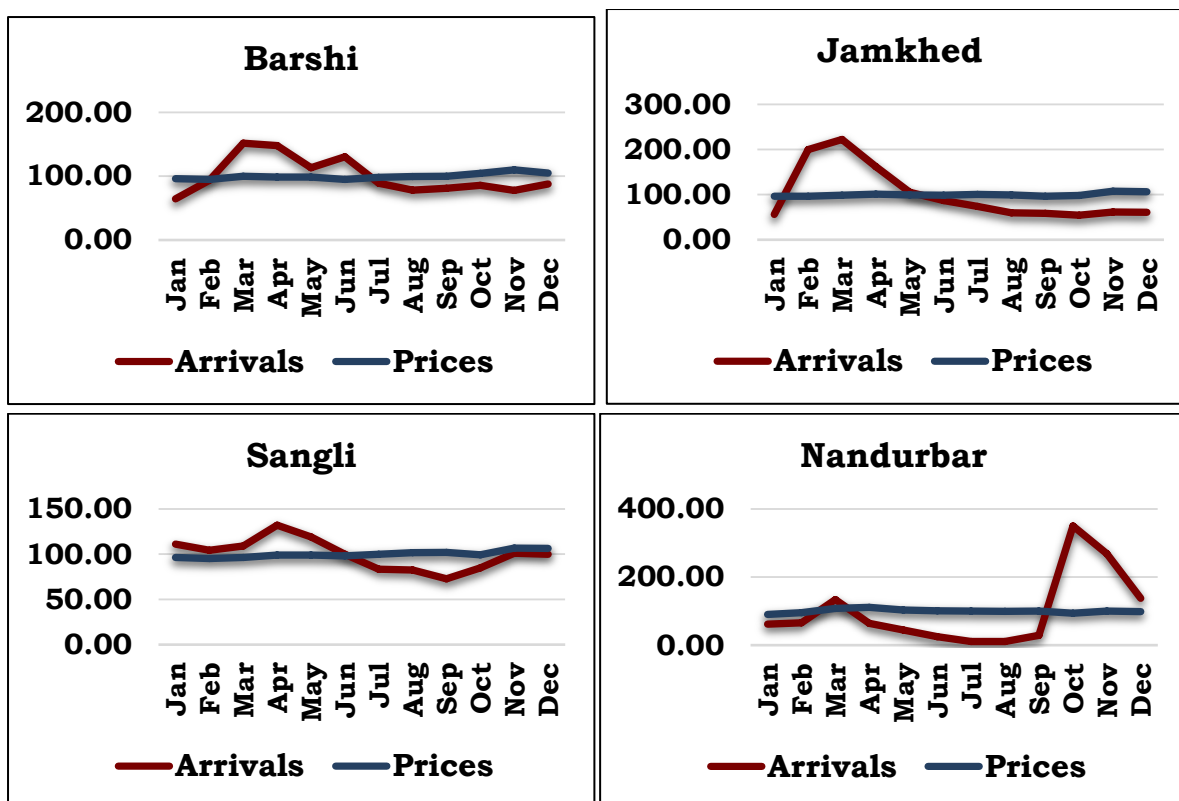


Fig. 1: Seasonal Indices of arrivals and prices of sorghum in Western Maharashtra

Seasonal Indices of arrivals and prices of sorghum in Marathwada and Vidarbha region

The seasonal indices of monthly arrivals and prices of sorghum for the period of last 20 years (2004 to 2023) in Jalna markets of Marathwada region and Khamgaon market of vidarbha region were calculated and the results are presented in Table 2.

It could be noticed from the table 2. that, the maximum indices of arrivals of sorghum in the Jalna market of Marathwada region and Khamgaon market of vidarbha region were 163 per cent (April) and 254.90 (November) per cent respectively. The highest price indices of sorghum in the same markets market were in the month December as 109.30 per cent and 106.74 per cent in the Jalna and Khamgaon markets

respectively. On the contrary, the lowest arrivals indices were recorded in the months of January, i.e. 42.44 per cent and 54 per cent in the month of September in the Jalna and Khamgaon markets respectively. In case of lowest indices per unit prices of sorghum were 95.44 per cent (June) and 93.55 per cent (February) in the Jalna and Khamgaon markets respectively.

The maximum arrival indexes in Jalna market were from the month March to June and November to December in the Jalna market of Marathwada region and Khamgaon market of vidarbha region respectively. In Jalna and Khamgaon market, the per quintal price indexes were above the 100 in the month of January, November and December.

Table 2. Seasonal indices of arrivals and prices of Sorghum in Marathwada and vidarbha region (2004 to 2023)

Month	Jalna		Khamgaon	
	Arrivals Indices	Prices Indices	Arrivals Indices	Prices Indices
Jan	42.44	102.17	107.27	94.58
Feb	73.40	98.45	78.79	93.55
Mar	152.10	97.66	69.70	93.97
Apr	163.00	99.12	88.50	99.62
May	145.15	95.53	72.67	94.80
Jun	125.04	95.44	63.11	96.95
Jul	87.58	99.08	65.24	106.26
Aug	92.58	99.45	68.87	106.04
Sep	109.36	96.35	54.00	104.69
Oct	87.51	98.35	72.03	99.09
Nov	67.68	109.12	254.90	103.73
Dec	54.15	109.30	204.91	106.74
Total	1200	1200	1200	1200

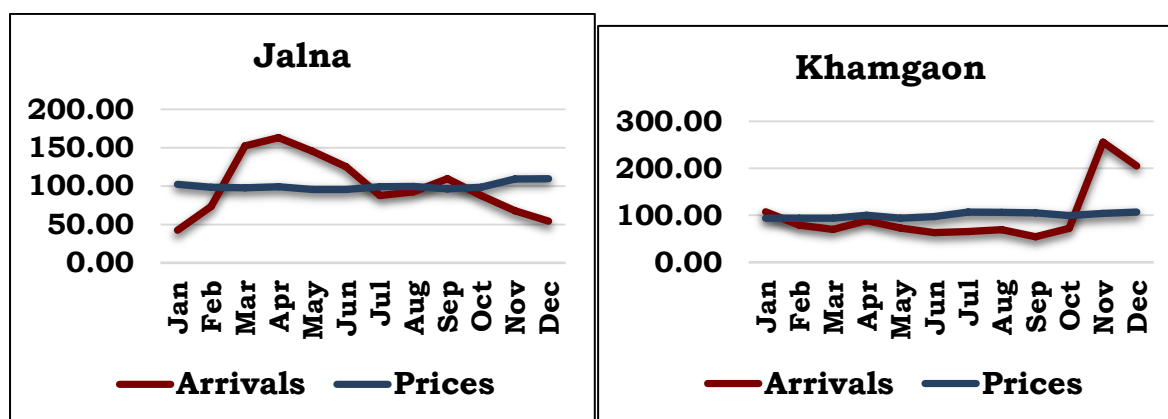


Fig. 2: Seasonal Indices of arrivals and prices of sorghum in Marathwada and Vidarbha region

Overall, it was found that in all of the selected markets seasonal arrival indices of sorghum were higher than the price indices. The clear pattern of maximum and minimum arrivals and prices were also noticed in most of the market. The peak arrivals of sorghum were noticed from the month march to June and the peak prices were seen from November to December with few exceptions.

Intra-year variations in arrivals and prices of sorghum in Maharashtra

The coefficient of variation measure is used to estimate the intra-year variability of selected major millets from the year 2004 to 2023. The region wise results of sorghum are presented in table 3. respectively.

A. Western Maharashtra Region

The intra-year variability in the arrivals and prices of sorghum in Barshi, Jamkhed, Nandurbar and Sangli markets over 20 years are presented in Table 3. and graphically depicted in fig. 3.

The overall variation in sorghum arrivals and prices was 80.38 percent and 50.87 percent in Barshi market, 60.39 percent and 47.13 percent in Jamkhed market, 68.83 percent and 49.69 percent in Sangli market, and 66.26 percent and 44.51 percent in Nandurbar market respectively. It was observed that in all the four of the selected markets, the variation in arrivals was greater than the variation in prices. The greatest overall variation in arrivals and prices was observed in barshi market

Table 3. Intra-year coefficient of variations in arrivals and prices of Sorghum in Western Maharashtra (WM) (2004-2023)

Month	Barshi		Jamkhed		Sangali		Nandurbar	
	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices
Jan	99.93	52.32	73.73	47.29	67.16	48.72	79.74	45.63
Feb	72.20	51.73	54.45	47.60	56.32	48.67	56.79	42.18
Mar	70.48	50.44	66.05	45.71	52.15	49.57	39.06	47.13
Apr	82.30	50.55	59.23	43.94	67.12	48.82	55.15	43.11
May	78.46	49.12	55.15	44.93	67.39	48.85	70.20	40.71
Jun	81.73	47.38	46.50	44.87	91.69	48.63	82.56	43.66
Jul	67.82	49.68	55.67	45.35	81.60	49.92	66.26	42.56
Aug	73.40	48.03	48.86	47.12	75.50	49.72	72.42	42.03
Sep	73.32	50.99	62.42	50.03	56.71	49.35	86.33	42.38
Oct	90.51	51.44	59.91	48.79	71.92	50.29	61.57	46.71
Nov	83.87	55.69	74.12	50.65	74.36	52.28	59.44	50.31
Dec	90.48	53.05	68.59	49.25	64.02	51.52	65.55	47.77
Mean	80.38	50.87	60.39	47.13	68.83	49.69	66.26	44.51

In Barshi market, estimates of the monthly variability over the period of 20 years (2004-2023) revealed that, variation in arrivals and prices of sorghum were ranged between 67.82 percent (July) to 99.93 percent (January) and 47.38 percent (June) to 55.69 percent (November) respectively. In case of Jamkhed market, variation in arrivals and prices of sorghum were ranged between 46.50 percent (June) to 74.12percent (November) and 43.94percent (April) to 55.65percent (November) respectively. Similarly,

in Sangli market variation in arrivals were ranged between 52.15 percent (March) to 91.69percent (June) and variation in prices were ranged between 48.63percent (June) to 52.28 percent (November) respectively. Moreover, in Nandurbar market, variation in arrivals were ranged between 39.06 percent (March) to 86.33 percent (September) while variation in prices were ranged between 40.71 percent (May) to 50.31 percent (November) respectively.

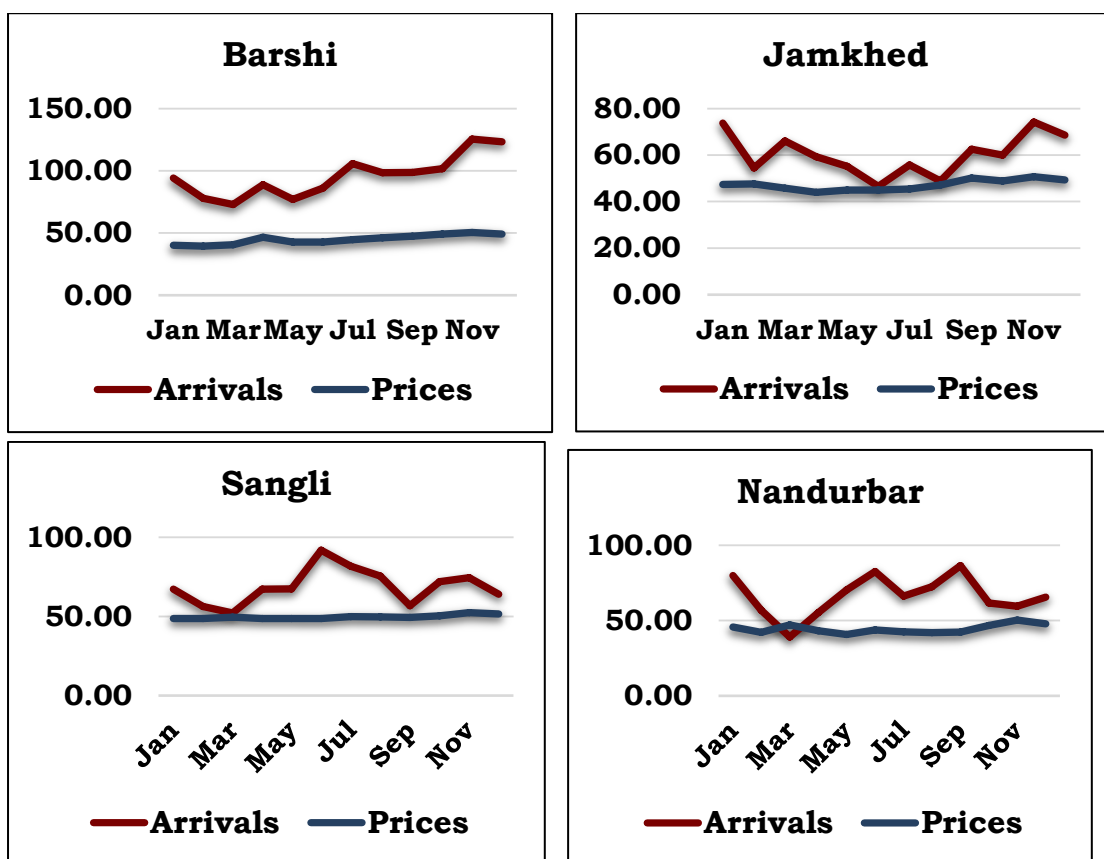


Fig. 3: Intra-year coefficient of variations in arrivals and prices of Sorghum in Western Maharashtra (WM) (2004-2023)

B. Marathwada and Vidarbha Region

The intra-year variation in the arrivals and prices of sorghum in Jalna market of Marathwada region and Khamgaon market of vidarbha region over a period of 20 years (2004-2023) are given in table 4. and graphically illustrated in fig 4.

From the table 4., it is observed that, the overall variation in arrivals of sorghum in Jalna market of Marathwada region and Khamgaon market of vidarbha region are 53.89 percent and 95.76 percent respectively, while variation in prices were 47.55

percent and 44.91 percent respectively. The month wise analysis shows that, the estimates of arrivals were varied between 41.72 percent (September) to 96.71 percent (February) in Jalna market of Marathwada region, while variation in prices were ranged between 41.60 percent (May) to 52.57 percent (January). In case of Khamgaon market of vidarbha region, the variation in arrivals ranged between 72.87percent (March) to 125.32 percent (November) and variation in prices were ranged between 39.45 percent (February) to 50.47 percent (November).

Table 4. Intra-year coefficient of variations in arrivals and prices of Sorghum in Marathwada and Vidarbha region (2004-2023)

Month	Jalna		Khamgaon	
	Arrivals	Prices	Arrivals	Prices
Jan	55.83	52.57	94.00	40.10
Feb	96.71	50.26	77.77	39.45
Mar	64.33	46.43	72.87	40.60
Apr	53.17	42.99	88.71	46.66
May	42.77	41.60	76.94	42.70
Jun	42.64	45.20	85.97	42.61
Jul	43.66	44.86	105.72	44.60
Aug	42.79	46.59	98.42	46.12
Sep	41.72	48.19	98.58	47.36
Oct	48.39	49.57	101.52	49.09
Nov	56.00	51.77	125.32	50.47
Dec	58.71	50.62	123.29	49.13
Mean	53.89	47.55	95.76	44.91

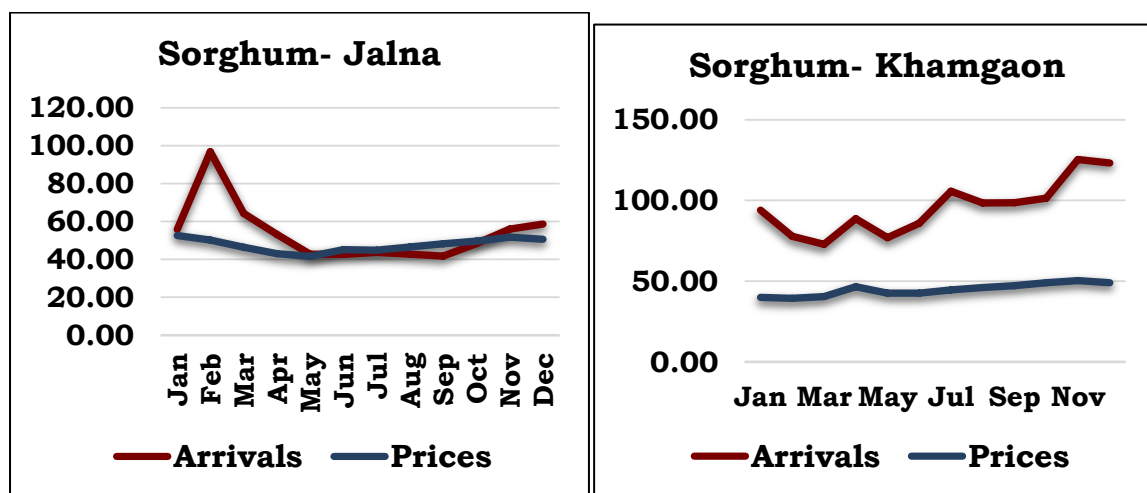


Fig. 4: Intra-year coefficient of variations in arrivals and prices of Sorghum in Marathwada and Vidarbha region (2004-2023)

CONCLUSION AND RECOMMENDATIONS

Maharashtra state has potential to increase the production of sorghum because of suitable climatic

conditions. Government is also taking various initiatives on the awareness of millets consumption for their nutritional and health benefits. However,

there is need to increase the area, production and productivity of sorghum. The fair and stable prices to the farmers and other stakeholders such as processors and exporters helpful to increase the area and production of sorghum. Seasonality analysis of arrival and prices of sorghum revealed that, high volume of arrivals immediate to harvesting season brings instability in prices. The policy measures such as maintaining the buffer stock by the government, creation of warehousing facilities in order to maintain optimum balance between price support to the millet farmers and price stabilization measures for the consumers.

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Agri-startups and rural enterprises: A case study of private horticulture nurseries enterprise in Navsari District of Gujarat

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ABSTRACT

The Southern/ Deccan region of Gujarat state offers enormous opportunities for small scale nurseries enterprise development owing to the increasing demand for the horticultural ornamental plants. It also opens a new self-employment avenue to the youngsters and farmers. Moreover, the institutional support coupled by Navsari Agricultural University and various NGO has led to development of these enterprises. However, local varieties, improper input-mix and traditional practices characterize the present status of agricultural technology in the region. In this background, the study was undertaken for economic profitability of the nursery enterprise in Navsari District. The study was based on the 75 nurseries/ growers selected from Navsari, Gandevi and Vansda taluks. The adequacy and experience of the owners regarding nursery enterprise are quite acceptable which is shown with the probability of the business with an annual Rate on Return over Investment of 15 percent. All the nurseries were found to generate a substantial number of employment and income for the owners. The study suggests that plant nursery enterprise should be promoted as a major agribusiness in this region for employment generation and adequate support in form of training and credit should be provided to the nursery enterprises.

INTRODUCTION

Nurseries have the common goal of producing plant material for improving sites. They are established to produce seedlings, grown under favorable conditions at germination and early growth stage before transplanting to the field for planting purpose. Plant nurseries can be an informal, small-scaled arrangement or a large commercial enterprise that vary in size, facilities (supplies, tools, equipment, etc.), types of seedlings produced, and operations (Larinde and Ruth, 2014). High quality seedlings are fundamental to the successful establishment of orchards and plantations, both for timber production and reforestation of degraded land/environments. Recently, the production of both cut flowers and home plants has continued to increase steadily in most urban and metropolises. The importance of ornamental plants in human life cannot be over-emphasized. Ornamental plants are not only sources of medicinal herbs (Fakayode et al., 2008). Ornamental plants also serve as environmental stimulants that trigger pleasant memories. These

plants also play crucial role in cooling the atmosphere through the evapo-transpiration process on their leaves and other parts thereby preventing health hazards (Omokhua, et al, 2002). People are increasingly realizing the need for planting trees, shrubs and grasses for different purposes, especially in the urban and metropolises. Plant seedling nurseries provide employment opportunity for the urban youths. The job including skilled-labour such as green-house and nursery managers and jobs for individuals involved in the cultivation and marketing of the ornamental plants (Fakayode et al., 2008).

Nursery is a site used for experimentally managing, producing and growing seedlings under favorable conditions until they are ready for final planting. A plant nursery plays a major role in many agricultural development programs. A plant nursery can be an informal, small scaled arrangement or a large commercial enterprise. Nurseries vary in size, facilities supplies, tools, equipment, etc., types of seedlings produced, and operations (World Agro Forestry Centre 2010). They also differ significantly

in quantity and quality of planting stocks produced. Nursery establishments can generally be grouped into private and public depending on the ownership, size and ultimate goal of their establishments. Plant nurseries may often provide income generating opportunities for the operators and enhance the social capital, technical capacity and leadership skills of communities. With the emerging urbanization, the demand for the small-scale (or small holder) nurseries is tremendously increasing. Small-scale enterprises certainly play an important role in the production of goods and services and in the generation of substantial employment and income in almost all countries, both developing and developed. In a country like India where more than half of the population derive their livelihood from agriculture, there is need for studies that create awareness for people in prospecting the hidden opportunities in the agriculture sector in order to ease the pressure on the government for the provision of jobs and create awareness on how people could become self-employed. The plant nursery enterprise is a form of self-employment opportunity that generates income with relatively low investment expenditure, and thereby possesses the potential of enhancing the socio-economic aspects of the ground root level (Kharlukhi and Jha, 2021, Bhaskar et al, 2020a, 2020b). While a small scale enterprise is a business that is privately owned and operated, with a small number of employees and relatively low volume of sales plays a key role in national development.

The Southern/ Deccan region of Gujarat state offers enormous opportunities for small scale nurseries development owing to the increasing demand for the horticultural ornamental plants. It also opens a new self-employment avenue to the farmers. Moreover, the institutional support coupled by Navsari Agricultural University and various NGO has led to development of these enterprises. However, local varieties, improper input-mix and traditional practices characterize the present status of agricultural technology in the region. The nurseries are maintained in every pocket of the region without any organized back up of production and marketing. The region also suffers from poor accessibility to technology, incidence of small and fragmented landholdings and low investment capacity of farmers (Khandave et al, 2017; Patel and Vyas, 2015; and Ramrao, 2020) . All this act as bottlenecks in development of the enterprise. Therefore, keeping all these problems into consideration the present study is

proposed for assessing the economics of private nurseries in Navsari district.

Objective:

1. To assess the socio-economic status of the nursery owners
2. To assess the economic profitability of the nursery enterprise
3. To determine the constraints faced by Private Horticulture Nurseries

METHODOLOGY

The Navsari district of South Gujarat was selected for the present study as the district has major institutional support for the technicality of conducive growth of the nurseries in the region. The multistage sampling technique was employed for selection of nurseries enterprises. At first stage Navsari district was purposively selected. The Second stage was for selection of 3 taluka namely, Navsari, Gandevi and Vandsa based on probability of maximum nurseries in the region. At last stage, 25 nurseries from each taluka were selected randomly in consultation with the personals of the Government of Gujarat offices. Thus, the study was based on the 75 nurseries/ growers of the study area.

The information was gathered through primary sources (questionnaire survey, personal observations and interviews). A structured questionnaire administered to the nursery operators which contained questions on the demographic characteristics of the nursery owners, the capital used in starting the business, the equipment and materials they use and the cost of purchasing them and their weekly, monthly and yearly income. Information on the yearly cost of production and income of ornamental, horticultural, forestry, medicinal and agricultural seedlings were obtained through this questionnaire.

The cost or investment incurred on working capital for financial year was obtained by directly surveying the nursery owner while cost incurred on fixed capital assets was collected from the records and by enquiring the corresponding nursery owners. In order to arrive at the cost of poly-period fixed capital assets for current financial year amortized cost concept was employed using straight-line depreciation method. The cost analysis for poly-period fixed capital assets excludes land cost. Thus,

total cost was arrived by adding the working capital cost and depreciation cost.

The analytical tools that was employed for the study comprises of descriptive statistical tool which include frequency, mean, tables and percentages. The profitability of the enterprise was calculated using the formula below

Profitability analysis:

Profit = TR - TC

RORI = (TR - TC) / TC * 100

Where: TR is the Total Revenue

TC is the Total Cost

RORI is the Rate of Return over Investment

RESULTS AND DISCUSSION

The socio-economic status of the surveyed nursery owners shows that the average family size of nursery owners was 4.87. The family of the surveyed households composed of adult male, female, and children constituted 33.46 percent, 19.01 percent, and

32.88 percent respectively. The obtained results shows that 26.67 percent of the plant nursery owners had secondary level of education, 23.33 percent had higher secondary level of education and the rest (50 percent) owners had college level of education. The higher education of the nursery owners provide a opportunity to adopt to the new innovation in the sector. It was found that 63.38 percent of the respondent's principal and sole occupation was nursery business and 36.62 percent respondents depended on nursery business along with other agricultural activities (Table 1). It was found the twenty six percent of the nursery owners have experience of up to 10 years while around three fourth of the survey respondent are in the nursery business for more than 10 years showing that the enterprise is slowly entering in second generation. In the case of ownership pattern of nursery land, 66.68 percent nursery owners started business on their owned lands, 12.66 percent on leased in land and 20.66 percent nursery owners mentioned both owned as well as leased in land.

Table 1. Socio-economic Status of surveyed Nursery owners

Particulars	Unit in Numbers/ Percentage
Family size (Numbers/Nursery)	4.87 (100 %)
Adult male	1.70 (33.46 %)
Adult-female	1.83(19.01 %)
Children (below 13 years)	1.73(32.88 %)
Education level (%)	100.00
Primary	0.00
Secondary	26.67
Higher Secondary	23.33
College	50.00
Occupation (%)	100.00
Nursery (sole)	63.38
Nursery + other agricultural activity	36.62
Nursery + service	0.00
Source of income (%)	100.00
Nursery (sole)	63.38
Nursery + other agricultural activity	36.62
Nursery + service	0.00
Length of nursery business (%)	100.00
Up to 5 years	13.33
6 to 10 years	13.33
11 to 20 years	40.00
Above 20 years	33.34
Ownership of nursery land (%)	100.00
Owned	66.68
Leased in land	12.66
Owned as well leased in land	20.66

Table 2. Land distribution pattern of plant nursery owners

Types of land	Area (ha/nursery)
Owned cultivated land	0.87 (44.17)
Fallow land	--
Leased in land	0.28 (14.21)
Land under plant nursery	0.82 (41.62)
Total land	1.97 (100.00)

Note: Figures in parenthesis shows percentage to total

Economic Profitability of Nursery Enterprise

Plant Nurseries have a very varied product mix and produce a large number of plant varieties with varied costs and returns. In the present study, input use pattern and cost calculation has been made for surveyed nurseries producing. All calculations have been made based on information collected from plant nursery owners.

Fixed Capital Assets / Nursery Equipment and Materials

In the establishment and production of seedlings in a nursery, some equipment and materials are used for longer period of time which are termed as fixed assets. The detailed information on these items along with their cost and expected life is discussed in table 3. The table shows that except Borewell/ submersible majority of other equipment are used for two years. The expected life (year) and the annual depreciation of the fixed cost item is arrived using straight line method of depreciation. The annual total depreciation cost comes out to be Rs. 42079.03.

Table 3. Average cost values of fixed cost items

Items	Quantity	Unit Cost	Total cost	Expected life	Annual Depreciation
Spade	19.25	233.33	4492	2	2246.22
Purring Shear Cutter	18.03	150.67	2716	3	905.34
Seedling tray	82.77	78.67	6512	1	6511.50
Garden tiller	16.05	147.33	2365	2	1182.60
Shovel	15.73	136.00	2140	2	1069.87
Hoe	7.52	159.73	1201	2	600.60
Digging fork	12.00	157.60	1891	2	945.60
Rake	7.15	148.00	1058	2	528.85
Hand fork	20.00	144.40	2888	2	1444.00
Trowel	40.00	68.93	2757	2	1378.67
Wheelbarrow	5.28	2546.67	13446	7	1732.34
Watering can	27.25	200.00	5451	2	2725.33
Nursery bench	80.00	1120.67	89653	5	14730.67
Plastic bucket	40	144.00	5760	2	2880.00
Borewell/submersible	0.96	33306.67	31974	10	3197.44
Total					42079.03

Note:

1. The expected life (year) and the annual depreciation of the fixed cost item using straight line method of depreciation
2. The Junk Value of per Nursery bench is Rs. 200 and wheel barrow is Rs. 250

The total cost for a year is arrived as a sum of fixed cost discussed in previous and other working cost.

The total cost and the revenue generated are herewith illustrated in table 4. The total cost of the surveyed

nursery was computed to be Rs. 4180467 which included the working capital (cost of hired human labour, seedlings/cuttings/plantlets, organic manures, chemical fertilizers, soil, polythene, irrigation, and insecticides) and depreciation cost.

Profitability of nursery enterprise

The revenue generated by surveyed plant nursery owners from selling of saplings/seedlings was found to Rs. 4807980 (Table 4). It was inferred that the

surveyed nurseries owners incur a seedling fatality of five to fifteen percent. Thus in our analysis of estimation of revenue a fatality of 10 percent is considered. The profit for the surveyed year is estimated to be Rs. 627513. The enterprise was found to generate an annual return of fifteen indicating that the nursery business is a profitable venture and also a good source of employment.

Table 4. Input use pattern and Economics of Surveyed Nursery Enterprise

Sr. No.	Items	Physical Unit	Monetary Unit	Total Value (Rs.)	
1	Human labour (in Mandays)				
	Family labour	763.20	208.27	158949.12	
	Hired labour	1435.20	208.27	298904.32	
2	Seedlings/Sapling /Planting material/rootstock				
	Owned	Floriculture/ Ornamental	8453.33	6.81	57595.38
		Fruits	9866.67	93.47	922204.44
	Purchased	Floriculture/ Ornamental	4466.67	6.81	30432.89
		Fruits	22733.33	93.47	2124808.89
3	Manure				
	Cow dung (in Tons)	50.53		136417.50	
	Vermicompost (in 50 kg bags)	31.27		7816.67	
4	Chemical Fertilizer				
	Urea			33940.00	
	DAP			101573.33	
	MOP			14141.67	
5	Electric cost / annum			33706.67	
6	Cost of soil			56900.00	
7	Packing material			89764.67	
8	Insecticides/Pesticides			71232.79	
9	Depreciation			42079.03	
10	Total cost			4180467.36	
11	Sale of Seedlings/Sapling /Planting material/rootstock				
	Floriculture/ Ornamental	12920	35	406980	
	Fruits	32600	150	4401000	
12	Total Return	45520		4807980	
13	Profit			627512.64	
14	Rate on Return over Investment			15.01	

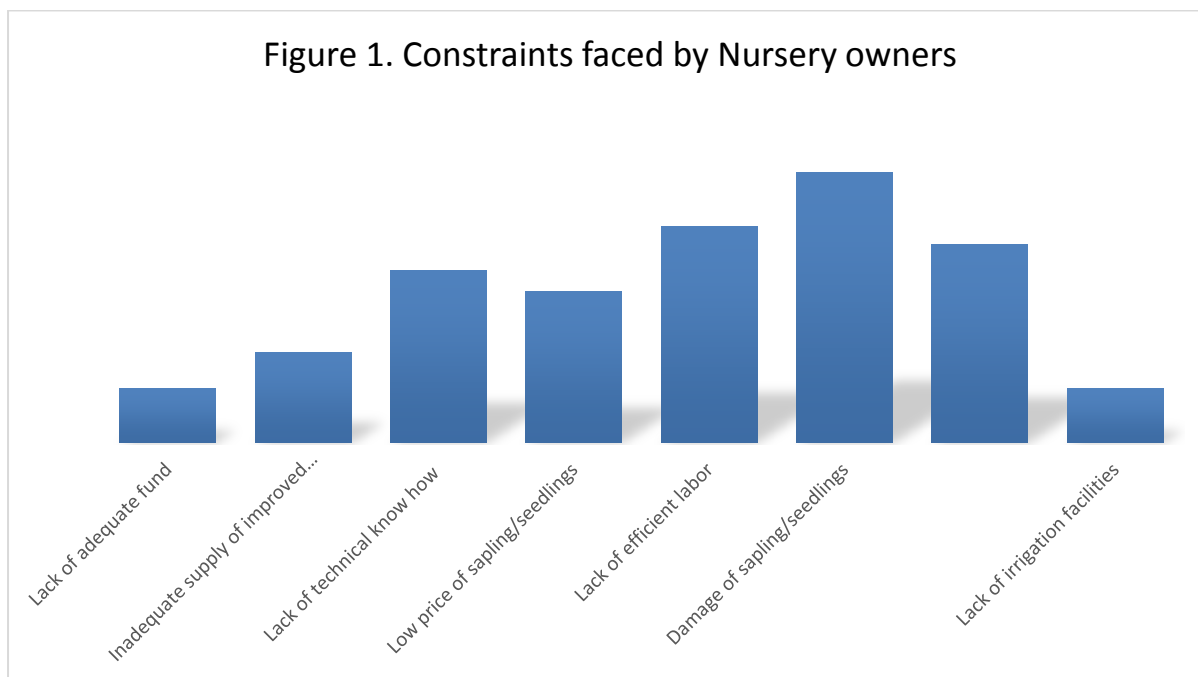
Constraints

The respondents were asked to regarding the problems/ constraints faced in plant nursery business. In this respect, respondents expressed more than one

opinion which is shown in the figure 1. The study revealed that all the respondent are facing the constraint of damage of sapling/seedlings in the study areas and consider it as a manor constraint followed

by lack of efficient labor. The other problems of nursery business were Infestation of insect pest and diseases, Lack of technical know how, Low price of

sapling/seedlings, Inadequate supply of improved seed/seedlings, lack of adequate fund and irrigation facilities.



CONCLUSION

The study on horticulture nurseries reveals that the adequacy and experience of the owners regarding nursery enterprise are quite acceptable which is shown with the probability of the business with an annual Rate on Return over Investment of 15 percent. All the nurseries were found to generate a substantial number of employment and income for the owners. The study suggests that plant nursery business should be promoted as a major agribusiness in this region for employment generation and adequate support in form of training and credit should be provided to the nursery enterprises.

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Growth and Instability in Export of Fresh Papaya from India

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ABSTRACT

Fruit plays an important role in India's agricultural economy and trade. Fruits produced in India are mainly mangoes, bananas, papayas, guavas, grapes, apples, oranges, etc. India ranks second in fruit production at global level. India is one of the largest producers of papaya in the world. The study examine India's papaya export performance in major countries, study also highlighted the growth and instability in export of fresh papaya. The study period was 20 years (2000-01 to 2019-20). Study utilized secondary data collected from government of India, Ministry of commerce and Industry, Department of Commerce. The compound annual growth rate was estimated with the help of exponential function and instability was assessed by employing Cuddy-Della Valle's instability index. The study revealed positive growth in export volumes, values in rupees and values in dollars for most countries during the overall study period, although sub-periods showed variations. Key destinations included UAE, Saudi Arabia and Nepal, with UAE accounting for the highest export share. Despite positive trends, the instability indices indicated moderate fluctuations in export performance due to factors like perishability and trade barriers. Efforts to stabilize exports could include better storage, packaging and market access strategies. The findings underline India's potential to enhance its export contribution through strategic interventions.

Keywords: Papaya, Growth, Instability, Export

INTRODUCTION

India has diverse agro climatic zones, highly favorable for growing variety of different agricultural and horticultural crops. The growing vitality of commercial horticultural crops is having unique importance as it is nationwide increase in the income. Papaya has significant importance in India and worldwide, demand for the fruit is increasing day by day nationwide and also in International markets, due to its availability throughout the year and cheap price that any common man can purchase and consume. Papaya production provides employment and income to many cultivators in India. Diverse agriculture provides opportunities to adopt and access to new technology and growing patterns of the crops. The objective of the study was to study growth and instability in export of fresh papaya from India.

Papayas are among the most traded tropical fruits following bananas, mangoes, and pineapples. Approximately, 75 percent of world's papayas are produced in only ten countries Brazil (25%), Nigeria (15%), India (12%), Mexico (11%), Indonesia (10%), Ethiopia (4%), Congo (4%), Peru (3%), Venezuela (3%) and China (2%). The area

under papaya cultivation in India was 148.13 thousand hectares with production 5304.28 thousand metric tons as per the third advanced estimates of Department of Agriculture and Farmers Welfare 2023-24. In India, about 24 states are growing papayas; the major producing states in India are Andhra Pradesh, Maharashtra, Chhattisgarh, West Bengal, Assam, Tamil Nadu and Jharkhand.

Maharashtra state has area of 17.38 thousand hectares area under papaya cultivation with production of 640.37 thousand tons (Source: Ministry of Agriculture and Farmers Welfare 2023-24). Hingoli district in Maharashtra leads in papaya production on commercial scale. Papaya is also cultivated in districts Solapur, Jalgaon, Dhule, Thane, Nanded, Ahmadnagar, Amravati, Dhule, Pune, Parbhani etc. of Maharashtra. Papaya has significant importance in India and worldwide, demand for the fruit is increasing day by day nationwide and also in International markets, due to its availability throughout the year and cheap price that any common man can purchase and consume. Papaya production provides employment and income to many cultivators in India. Diverse agriculture provides opportunities to adopt and access to new technology and growing

patterns of the crops. The study covers growth and instability analysis of fresh papaya in export from India. The advantage of this fruit is its availability round the year. It is reported to be grown in 60 countries all over the world with total production 13,290,320 metric tons, India accounting for 45 percent of global production and ranking second.

METHODOLOGY

The nature of data for study was mainly secondary collected from various sources such as, the data on export quantity and value were collected from Government of India, Ministry of Trade and Commerce, Directorate General of Commercial Intelligence and Statistics, Food and Agriculture Organization, National Horticulture Board, Agricultural Processed Food Product Export Development Authority.

Period of study

The data was collected for the period of 20 years period i.e. from 2000-01 to 2019-2020. For the purpose of comparison, the period of study was divided into different periods:

Period-I: 2000-01 to 2009-10

Period-II: 2010-11 to 2019-20

Overall Period: 2000-01 to 2019-20.

Analytical tools and techniques:

The data was analyzed with the help of tabular analysis, growth and Instability analysis.

Tabular Analysis

For meaningful interpretation of data, appropriate percentages and averages were worked out and presented in the form of tables.

Growth Analysis

To examine the growth in export of fresh papaya from India compound growth rate (CGR) was computed based on its fit using non-linear models, especially the exponential model. Conventionally, the compound growth rate were estimated after converting the growth model to semi-log form and estimated through Ordinary Least Square (OLS) technique assuming multiplicative errors term. However, there are several problems associated with this technique including the difficulty in estimating standard error of estimates of original parameters. Hence, a non-linear estimation technique for solving exponential model assuming additive error terms was used to estimate compound growth rate by using exponential growth function as given below:

$$Y_t = \text{constant} * (1 + \text{CGR}) + E_t$$

Where,

Y_t = time series data for export quantity/
export value for year t

t = Time trends for years of interest

E_t = error terms

CGR is compound growth rate for the period under consideration.

The Marquardt algorithm was used to estimate parameters of equation. The significance of regression coefficient was tested by applying standard 't' test procedure.

Instability analysis

Cuddy-Della Valle Instability Index was used to estimate the instability in export of fresh papaya data. This index is modification of coefficient of variation (CV) to accommodate for trend which is commonly present in time series economic data. It is superior over other scale dependent measure such as Standard Deviation or Root Mean Square of the residuals (RMSE) obtained from the fitted trend lines of raw data and hence suitable for cross comparison. The Cuddy-Della Valle Instability Index calculated as follows:

$$I_x = CV \sqrt{1 - R^2}$$

Where,

CV = Coefficient of Variation (σ/x)

R^2 = Adjusted coefficient of multiple determination

Where, ever trend in time series data is non-significant, instability of that particular was analyzed with the help of conventional statistical tool of instability i.e. coefficient of variation. The coefficient of variation was calculated by using formula,

$$\text{CV (\%)} = \frac{\text{Standard deviation (a)}}{\text{Mean (x)}} \times 100$$

RESULT AND DISCUSSION

Growth and instability of total fresh Papaya export from India

The growth and instability in export of fresh Papaya from India to all world was estimated to study the performance of fresh Papaya export for the year 2000-01 to 2019-20 i.e.20 years. The performance of fresh Papaya export was estimated in the sub-periods viz; period-I (2000-01 to 2009-2010) and period-II (2010-11 to 2019-20). The outcomes are presented in table 01. The growth rate and instability in fresh Papaya export was estimated for

three parameters viz; quantity, value in rupees and value in dollar.

The outcomes reported in the table 01 showed that, during period-I, the average quantity of fresh Papaya exported to all countries was 11928.26 thousand MT. The currency obtained from export of fresh Papaya to all total countries in rupees was 988.12 lacks and in dollar it was about 2.17 million dollar, respectively. In the period-II, export of fresh Papaya to total countries was increased in quantity and it was 12782.29 thousand MT; value in rupees obtained was about 3660.87 lacks and 5.97 in million dollar. In overall study period of export of fresh Papaya to total countries in quantity it was 12355.28 thousand MT, in currency rupees it was 2324.50 lacks and in dollar it was 4.07 million dollar.

The outcomes showed that, during period-I, the compound growth rate (CGR) in quantity of fresh Papaya export to total countries was 14.39 percent. The compound growth rate (CGR) measured for fresh Papaya export to total countries in rupees and dollar was 10.02 percent and 9.79 percent, respectively. The period-II (2010-11 to 2019-20), showed compound growth rate of total countries in quantity was -6.73 percent, in terms of value in rupees and dollar it was 7.43 percent and 3.72 percent, respectively. The study of overall period CGR showed that, export of fresh Papaya to total countries estimated in quantity was 4.86 percent, in rupees and dollar it was 11.35 percent and 8.76 percent, respectively. The growth rates in all the three periods showed ups and downs and significant at the

level of 1, 5 and 10 percent except in period-II the growth rate value showed non-significant. The level of significance in period-I in quantity was 1 percent while in rupees and dollar it was at 5 percent each. In period-II the values in quantity was insignificant but in rupees and dollars were significant at the level of 5 and 10 percent, respectively while in overall period the growth rate values were all significant at the level of 1 percent.

The instability in export of fresh Papaya was estimated with the help of coefficient of variation and Cuddy-Della Valle instability index and outcomes were presented in the table 01. The instability in export of fresh Papaya was measured in parameters viz; quantity, rupees and dollar.

The outcomes showed that, instability in fresh Papaya estimated in quantity during the second period of study was very less compared to period-I. The coefficient of variation and CDI value estimated in quantity was 0.77 and 0.60 in period-I and 0.27 and 0.15 in period-II. The estimated coefficient of variation and Cuddy-Della Valle index of fresh Papaya export in rupees in period-I was 0.76 and 0.69 and in period-II it was 0.31 and 0.29. The estimated results of CV and CDI of fresh Papaya export in dollar in period-I was 0.76 and 0.69 and in period-II it was 0.24 and 0.00. Whereas in overall period, instability in export of fresh Papaya with estimated CV and CDI was 0.58 and 0.48 in quantity, in rupees it was 0.80 and 0.44 while in the case of dollar it was 0.67 and 0.41, respectively.

Table 01: Growth and instability of total fresh Papaya export from India

Particulars		Period-I 2000-01 to 2009-10			Period-II 2010-11 to 2019-20			Overall 2001-02 to 2019-20		
		Qty	Rs.	US \$	Qty	Rs.	US \$	Qty	Rs.	US \$
Growth	Mean	11928.26	988.12	2.17	12782.29	3660.87	5.97	12355.28	2324.50	4.07
	CGR	14.93	10.02	9.79	-6.73	7.43	3.72	4.86	11.35	8.76
	SE	4.11	4.25	4.24	0.79	2.59	1.89	1.42	1.40	1.20
	“t” Value	3.50	2.35	2.31	-8.46	2.87	1.96	3.41	8.07	7.25
Instability	CV	0.77	0.76	0.76	0.27	0.31	0.24	0.58	0.80	0.67
	CDI	0.60	0.69	0.69	0.15	0.29	-	0.48	0.44	0.41

(Note: Quantity in thousand MT, Rupees in lakhs and Dollars in US million.)

Figure 01 concluded that the compound growth rate of fresh Papaya export from

India in terms of quantity. A figure shows that, maximum CGR was recorded in Oman followed by

Italy, Nepal. Least CGR was recorded in UK, and Belgium.

Figure 02 concluded that the compound growth rate of fresh Papaya export from

India in terms of rupees. A figure shows that, maximum CGR was recorded in Oman followed by Italy and Qatar. Least CGR was recorded in Belgium and Netherlands.

Table No. 02: Country wise (CGR) compound growth rate of fresh Papaya export from India during the period 2000-01 to 2019-20

Sr. No.	Countries	Quantity	Rupees	Dollar Million
1.	UAE	4.78	11.29	8.93
2.	Saudi Arabia	2.91	10.62	7.52
3.	Netherlands	6.81	2.90	2.67
4.	Qatar	4.54	16.94	12.89
5.	Kuwait	3.83	12.70	8.72
6.	Bahrain	4.23	11.35	8.36
7.	Nepal	13.06	15.90	13.08
8.	Oman	20.40	34.63	31.01
9.	USA	2.86	5.02	4.29
10.	Bangladesh	1.77	5.92	4.94
11.	UK	-9.33	8.42	-0.92
12.	Belgium	0.53	2.65	1.69
13.	Poland	1.55	8.07	7.28
14.	Italy	18.94	25.52	24.36
15.	Other	-0.73	-99.99	-3.46
16.	Total	4.86	11.35	8.76

(Note: Quantity in thousand MT, Rupees in lakhs and Dollars in US million.)

Figure 03 showed that the compound growth rate of fresh Papaya export from India in terms of dollar. A figure shows that, maximum CGR was recorded in Oman followed by Italy and Nepal. Least CGR was recorded in UK and Netherlands.

Figure 04 showed that the instability of fresh Papaya export from India measured in quantity. A figure shows that, maximum

instability was recorded in UK followed by Poland and Bangladesh. Least instability was recorded in Nepal, UAE, Saudi Arabia and Oman.

Figure 05 showed that the instability of fresh Papaya export from India value measured in rupees. A figure shows that, maximum instability was recorded in UK followed by USA and Bangladesh. Least instability was recorded in Bahrain, UAE and Kuwait.

Table 03: Country wise instability in export of fresh Papaya from India

Sr. No.	Country	Quantity	Rupees	Dollar
1.	UAE	0.58	0.54	0.47
2.	Saudi Arabia	0.71	0.57	0.60
3.	Netherlands	0.91	0.96	0.90
4.	Qatar	0.77	0.61	0.59
5.	Kuwait	0.83	0.54	0.53
6.	Bahrain	0.87	0.52	0.53
7.	Nepal	0.41	0.61	0.48
8.	Oman	0.71	1.06	0.95
9.	USA	1.87	2.01	2.14
10.	Bangladesh	1.92	1.82	1.98
11.	UK	3.55	4.40	1.10
12.	Belgium	1.69	1.42	1.52
13.	Poland	2.62	1.42	1.52
14.	Italy	1.58	1.21	1.17
15.	Other	0.78	-11.47	2.76
16.	Total	0.48	0.44	0.41

(Note: Quantity in thousand MT, Rupees in lakhs and Dollars in US million.)

Figure 06 showed that the instability of fresh Papaya export from India value measured in dollar. A figure shows that, maximum instability was recorded

in other countries followed by USA and Bangladesh. Least instability was recorded in UAE, Nepal, Kuwait and Bahrain.

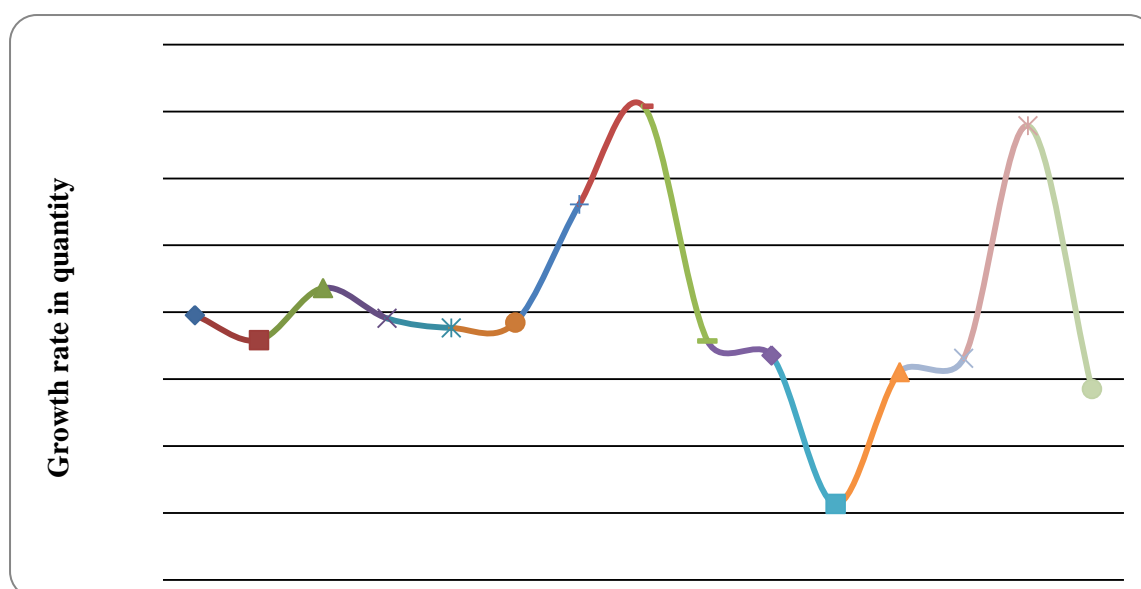


Figure 01: Compound Growth Rate of fresh Papaya Export from India in quantity

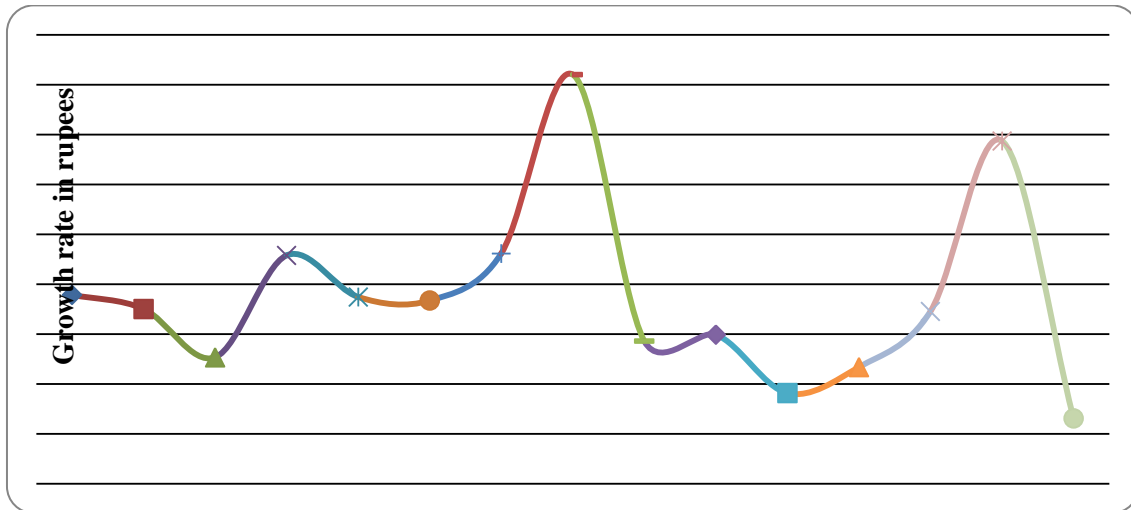


Figure 02: Compound Growth Rate of fresh Papaya Export from India in value rupees

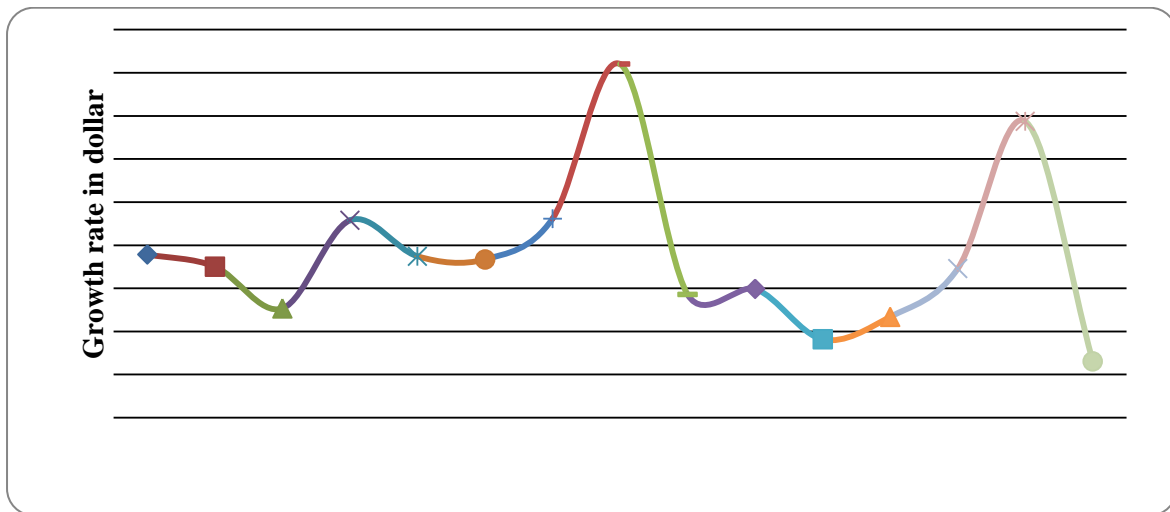


Figure 03: Compound Growth Rate of Fresh Papaya Export from India in value US dollars

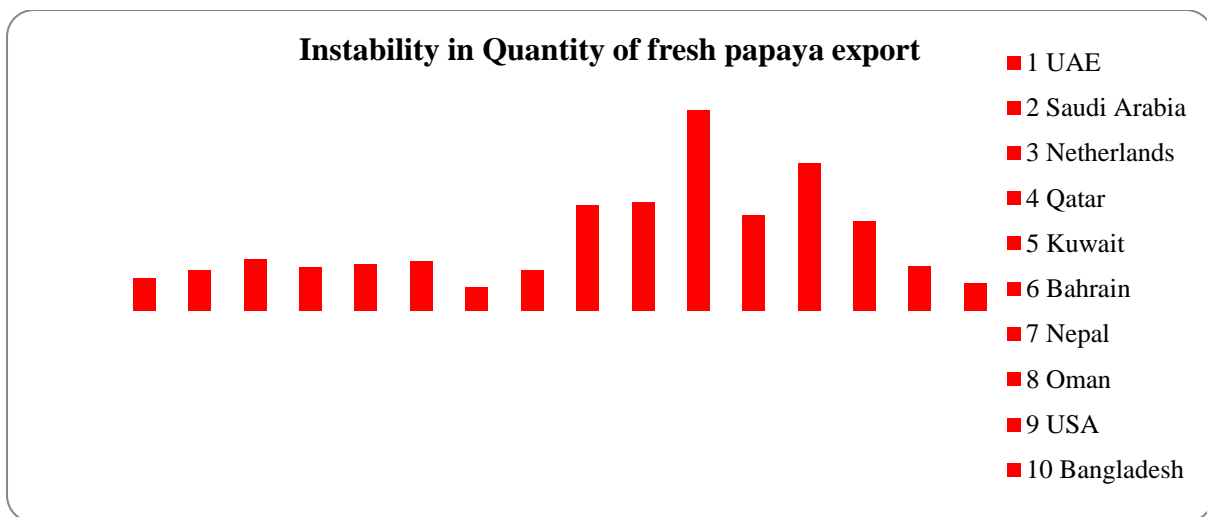


Figure 04: Instability in export of fresh Papaya from India measured in quantity

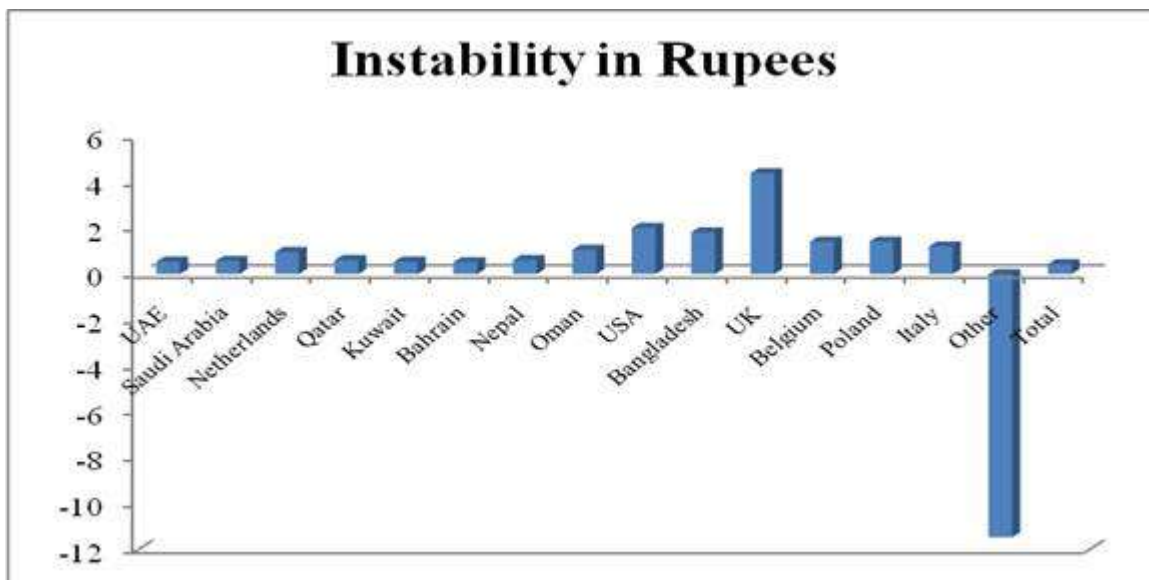


Figure 05: Instability in export of fresh Papaya from India value measured in rupees

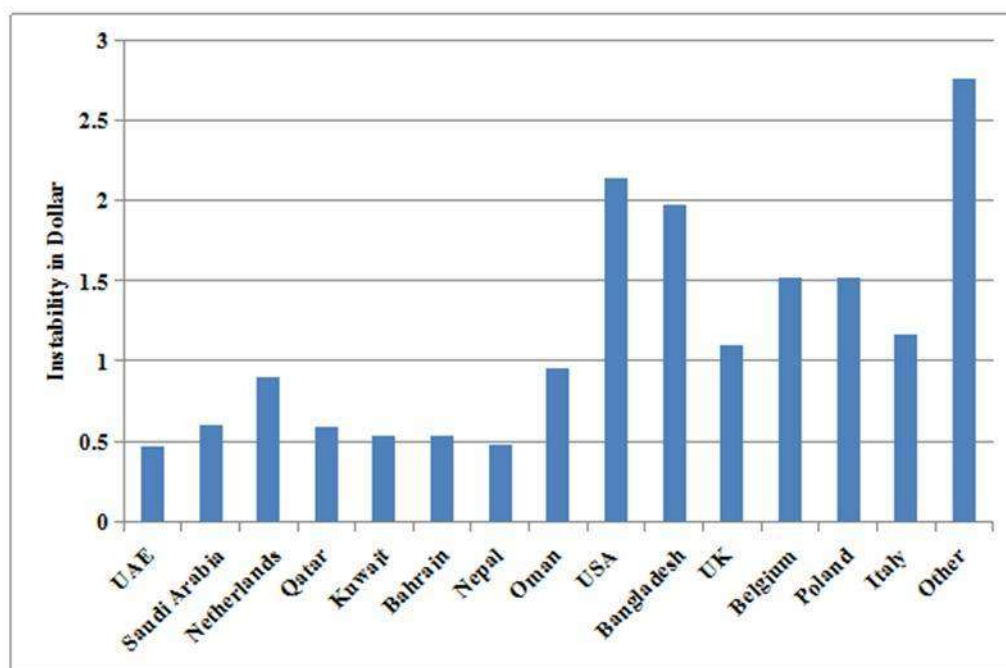


Figure 06: Instability in export of fresh Papaya from India (Value Measured in US dollar)

CONCLUSION

The analysis of the growth and instability of fresh papaya exports from India reveals significant insights into its performance over two distinct sub-periods. The Cuddy-Della Valle Instability Index (CDI) and Coefficient of Variation (CV) revealed that instability was higher. Oman exhibited the highest CGR for export quantity, rupees and dollars, while countries

like Italy and Nepal demonstrated strong growth. Conversely, the UK and Belgium showed negative or negligible growth in quantity. Instability in exports was highest in the UK, followed by Poland and Bangladesh, while countries like UAE, Nepal and Oman demonstrated the least instability.

Implications

The findings suggest that India's fresh papaya export market has grown overall, it experienced volatility in growth rates and export stability across different countries. Strategic export planning, market diversification and fostering stronger trade partnerships with high-growth, low-instability regions like Oman and Italy could help sustain and expand India's presence in the global papaya market.

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Price forecasting of Chickpea for Minimizing Price Risk in Maharashtra

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ABSTRACT

Chickpea is an important pulse crop occupying first position amongst pulse crops in India. The chickpea crop has 55.45 per cent share in total pulse production in Maharashtra during the year 2020-21. The fluctuations in prices are the greatest source of risk next only to weather in agricultural production system. Hence, price forecasting is necessary for the farmers in order to get good prices for their produce in the agricultural markets. Thus, present study was undertaken to forecast the prices of chickpea in ten major markets (Latur, Daryapur, Hinganghat, Amravati, Nagpur, Akola, Washim, Khamgaon, Murtizapur and Akot) of Maharashtra by using ARIMA (Box-Jenkins) model. The chickpea prices were predicted for the year 2023 by using 18 years monthly and yearly data from 2005 to 2022. On the basis of price forecasting analysis of chickpea, the prices of chickpea were highest in the month of December for majority of markets viz., Amravati (Rs.4367.28), Daryapur (Rs. 4717.94), Khamgaon (Rs. 4705.56), Murtizapur (Rs. 5030.04) and Nagpur (Rs. 4882.13) and comparatively highest in Latur market (Rs. 5510.88). Therefore, it was suggested that the farmers may sell their chickpea during the months of September to December, 2023 in ten major markets instead of immediate sell after harvest for better price realization to minimize the price risk. The forecasting of chickpea prices in the agricultural markets may be benefitted to the farmers in bringing the produce during the higher rates in terms of selling for better economic fulfillment.

Keywords: Chickpea, Forecasting, Prices, ARIMA, Maharashtra.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) commonly known as gram or Bengal gram, is an important and unique food legume. It is an important pulse crop of the country occupying first position amongst pulses. It is an important source of protein to the predominating vegetarian population of the country and used in variety of food products like sweets, condiments and vegetables. Bengal gram is widely appreciated as health food. It is a protein-rich supplement to cereal-based diets, especially to the poor in developing countries, where people are vegetarians or cannot afford animal protein. The pulse proteins are rich in lysine and have low sulfur containing amino acids. It offers the most practical means of eradicating protein malnutrition among vegetarian children and nursing mothers. Bengal gram has a very important role in human diet in our country. Among a dozen of different grain legumes under cultivation in India, gram is the leading crop and is grown in Rabi season.

In India chickpea is cultivated (2020-21) on 9995.92 thousand hectares, producing 11911.18 thousand tonnes with a productivity of 1192 kg/ha. Maharashtra ranks first in area with 2231.30 thousand hectares producing 2396.42 thousand tonnes with a productivity of 1074 kg/ha. The expansion in area in state as well country is due to increase in irrigated area, use of improved varieties and modern technology.

Fluctuations or instability in prices is the greatest source of risk next only to weather in agricultural production system and this fluctuating characteristic of agricultural prices enter directly in the decision frame of farmers, both in production and marketing (Naidu and Kala, 2016). For better economic development of agriculture, price forecasting is necessary that farmers get good prices of their produce in the agricultural markets. If there could be some forecast of arrivals and prices in the agricultural markets, the farmer may be benefitted in bringing the produce during the higher rates in terms

of selling for his/her better economic fulfillment. In view of this, present study was undertaken to forecast the prices of chickpea in major markets

METHODOLOGY

The time series data on monthly arrivals and prices of chickpea required for the study were collected from major APMCs of Maharashtra. Ten major markets were selected on the basis of maximum arrivals of chickpea. The monthly and yearly data on arrivals and prices of chickpea were collected from selected ten markets for the period of 18 years from 2005-06 to 2022-23.

Forecasting of prices

a) Forecasting of prices

The prices of chickpea in major markets of Maharashtra were forecasted with the help of ARIMA model which is also called as Box-Jenkins model. ARIMA models are generally denoted as ARIMA (p,d,q) where p is the order of autoregressive model, d is the degree of differencing and q is the order of moving-average model.

AR (Autoregression):

A model that uses the dependent relationship between an observation and some number of lagged observations.

I (Integrated):

The use of differencing of raw observations (e.g. subtracting an observation from an observation at the previous time step) in order to make the time series stationary.

MA (Moving Average):

A model that uses the dependency between an observation and a residual error from a moving average model applied to lagged observations.

ARIMA models use differencing to convert a non-stationary time series into a stationary one and then predict future values from historical data. Several criteria were used to choose the best fit model viz; highest R², lowest Root Mean Square Error, lowest Mean Absolute Percentage Error (MAPE), lowest Mean Absolute Error (MAE) criteria and Normalized BIC value.

RESULT AND DISCUSSION

By using 18 years data (2005-2022) on chickpea prices in ten major chickpea markets of Maharashtra, forecasting of chickpea prices were done upto December 2023 with the help of ARIMA model.

Table 1: Forecasting of chickpea prices in Akola and Amravati APMC

(Rupees/Q)

Year	Akola			Amravati		
	Actual price	Predicted price	Difference (%)	Actual price	Predicted price	Difference (%)
Jan-22	4197.83	4391.46	4.61	4296	4364.32	1.58
Feb-22	4316.39	4396.74	1.86	4483	4413.59	-1.54
Mar-22	5164.21	4526.20	-12.35	4531	4462.53	-1.50
Apr-22	5492.35	5190.96	-5.49	4489	4412.35	-1.71
May-22	4557.20	5273.32	15.71	4233	4444.78	5.01
Jun-22	4547.59	4324.91	-4.90	4139	4288.81	3.63
Jul-22	4883.45	4606.13	-5.68	4240	4255.18	0.36
Aug-22	4871.46	5141.71	5.55	4210	4287.77	1.85
Sep-22	4484.05	5058.45	12.81	4214	4124.26	-2.14
Oct-22	4312.62	5039.80	16.86	4169	4042.17	-3.05
Nov-22	4663.14	4865.00	4.33	4261	4071.20	-4.46
Dec-22	4487.17	4730.62	5.43	4329	4185.98	-3.30
Jan-23	4355.00	4778.62	9.73	4327	4257.58	-1.60
Feb-23	--	4963.40		--	4215.83	
Mar-23	--	5110.71		--	4132.26	
Apr-23	--	5096.30		--	4126.13	
May-23	--	4962.09		--	4216.57	

Jun-23	--	4862.54		--	4303.88	
Jul-23	--	4906.39		--	4296.84	
Aug-23	--	5055.12		--	4223.70	
Sep-23	--	5171.87		--	4192.12	
Oct-23	--	5161.50		--	4253.98	
Nov-23	--	5059.30		--	4344.63	
Dec-23	--	4986.56		--	4367.28	

The results presented in Table 1 to 5 revealed that there was less variation between actual and forecasted prices of chickpea which shows the suitability of fitted model. Majority of markets will have highest price per quintal in the month of December viz., Amravati (Rs. 4367.28), Daryapur (Rs. 4717.94), Khamgaon (Rs. 4705.56), Murtizapur (Rs. 5030.04) and Nagpur (Rs. 4882.13). The forecasted prices of chickpea will be higher in August for Akola (Rs. 5171.87) and September for Hinganghat market (Rs. 4543.42). However, prices of chickpea will be higher in the month of November in

Washim (Rs. 4740.55) and Latur market (Rs. 5510.88).

In contrary, the lowest price of chickpea will be obtained in January for Akola (Rs. 4778.62) and Hinganghat market (Rs. 4381.26). The prices will be low in the month of February for Khamgaon (Rs. 4552.71), Latur (Rs. 5138.63) and Washim market (Rs. 4557.57). The prices of chickpea will be low in the month of April for Amravati (Rs. 4126.13) and Nagpur market (Rs. 4633.29) and May for Murtizapur market (Rs. 4851.52).

Table 2: Forecasting of chickpea prices in Daryapur and Hinganghat APMC (Rupees/Q)

Year	Daryapur			Hinganghat		
	Actual price	Predicted price	Difference (%)	Actual price	Predicted price	Difference (%)
Jan-22	4082.69	3942.66	-3.43	4156.75	4102.94	-1.29
Feb-22	4554.41	4366.62	-4.12	4309.05	4157.67	-3.51
Mar-22	4649.33	4700.94	1.11	4518.33	4407.38	-2.46
Apr-22	4573.53	4521.14	-1.15	4437.86	4527.33	2.02
May-22	4361.58	4504.69	3.28	4121.07	4464.01	8.32
Jun-22	4318.42	4388.64	1.63	4217.73	4216.65	-0.03
Jul-22	4621.25	4529.37	-1.99	4466.58	4219.36	-5.53
Aug-22	4620.83	4694.41	1.59	4294.41	4391.88	2.27
Sep-22	4238.57	4503.40	6.25	4040.59	4360.53	7.92
Oct-22	4195.63	4453.40	6.14	4108.16	4397.64	7.05
Nov-22	4253.75	4423.49	3.99	4234.47	4360.22	2.97
Dec-22	4215.83	4512.71	7.04	4316.46	4320.16	0.09
Jan-23	4237.5	4609.22	8.77	4185.83	4381.26	4.67
Feb-23	--	4599.24		--	4412.38	
Mar-23	--	4583.43		--	4392.87	
Apr-23	--	4591.50		--	4408.53	
May-23	--	4616.23		--	4476.71	
Jun-23	--	4639.14		--	4498.73	
Jul-23	--	4652.98		--	4485.79	
Aug-23	--	4662.42		--	4507.07	
Sep-23	--	4673.68		--	4543.42	
Oct-23	--	4688.11		--	4535.78	
Nov-23	--	4703.51		--	4519.40	
Dec-23	--	4717.94		--	4539.73	

Table 3: Forecasting of chickpea prices in Khamgaon and Latur APMC (Rupees/Q)

Year	Khamgaon			Latur		
	Actual price	Predicted price	Difference (%)	Actual price	Predicted price	Difference (%)
Jan-22	4175.73	4076.56	-2.37	6350.00	4660.69	-26.60
Feb-22	4323.86	4268.07	-1.29	4660.95	6334.57	35.91
Mar-22	4410.56	4299.09	-2.53	4660.53	4630.61	-0.64
Apr-22	4374.00	4432.30	1.33	4597.14	4516.40	-1.76
May-22	4165.18	4387.55	5.34	4480.00	4793.16	6.99
Jun-22	4134.25	4172.57	0.93	4589.20	4728.96	3.05
Jul-22	4409.28	4156.24	-5.74	4790.50	4635.13	-3.24
Aug-22	4490.75	4442.50	-1.07	4800.00	4508.26	-6.08
Sep-22	3947.39	4463.04	13.06	4303.538	4908.98	14.07
Oct-22	3935.14	4519.85	14.86	4426.389	5071.21	14.57
Nov-22	4038.77	4512.06	11.72	4432.158	5085.65	14.74
Dec-22	4003.54	4521.84	12.95	4492.5	5302.37	18.03
Jan-23	4069.86	4556.19	11.95	4570.833	5245.06	14.75
Feb-23	--	4552.71		--	5138.63	
Mar-23	--	4569.68		--	5264.66	
Apr-23	--	4596.44		--	5246.09	
May-23	--	4592.86		--	5327.37	
Jun-23	--	4618.42		--	5430.37	
Jul-23	--	4633.53		--	5309.85	
Aug-23	--	4637.77		--	5361.63	
Sep-23	--	4662.86		--	5424.56	
Oct-23	--	4672.69		--	5394.54	
Nov-23	--	4683.12		--	5510.88	
Dec-23	--	4705.56		--	5492.24	

Table 4: Forecasting of chickpea prices in Murtizapur and Nagpur APMC (Rupees/Q)

Year	Murtizapur			Nagpur		
	Actual price	Predicted price	Difference (%)	Actual price	Predicted price	Difference (%)
Jan-22	4508.00	4457.03	-1.13	4479.13	4899.56	9.39
Feb-22	4624.71	4669.94	0.98	4494.38	4680.47	4.14
Mar-22	4554.23	4627.92	1.62	4539.94	4474.78	-1.44
Apr-22	4455.71	4587.48	2.96	4416.79	4325.61	-2.06
May-22	4267.22	4531.83	6.20	4240.71	4506.43	6.27
Jun-22	4334.55	4337.21	0.06	4321.10	4290.74	-0.70
Jul-22	4805.00	4382.53	-8.79	4607.20	4410.66	-4.27
Aug-22	4823.75	4746.63	-1.60	4623.11	4618.50	-0.10
Sep-22	4555.00	4746.60	4.21	4329.87	4596.70	6.16
Oct-22	4442.50	4677.91	5.30	4357.19	4557.62	4.60
Nov-22	4508.75	4689.50	4.01	4384.52	4605.74	5.05
Dec-22	4558.75	4853.03	6.46	4507.11	4736.73	5.09
Jan-23	4475.00	4912.31	9.77	4506.14	4785.86	6.21
Feb-23	--	4866.24		--	4732.40	
Mar-23	--	4883.72		--	4645.01	
Apr-23	--	4858.66		--	4633.29	
May-23	--	4851.52		--	4706.14	
Jun-23	--	4869.00		--	4776.72	
Jul-23	--	4871.79		--	4782.41	
Aug-23	--	4904.33		--	4748.43	
Sep-23	--	4961.78		--	4747.79	
Oct-23	--	4990.12		--	4804.02	
Nov-23	--	5021.65		--	4867.49	
Dec-23	--	5030.04		--	4882.13	

Table 5: Forecasting of chickpea prices in Washim and Akot APMC (Rupees/Q)

Year	Washim			Akot		
	Actual price	Predicted price	Difference (%)	Actual price	Predicted price	Difference (%)
Jan-22	4267.86	4593.31	7.63	5768.01	5624.81	-2.48
Feb-22	4306.25	4258.14	-1.12	5887.65	5781.16	-1.81
Mar-22	4466.67	4237.56	-5.13	6007.30	5910.87	-1.61
Apr-22	4275.00	4313.39	0.90	6126.94	6015.01	-1.83
May-22	4171.43	4437.20	6.37	6246.59	6099.52	-2.35
Jun-22	4180.00	4097.57	-1.97	6366.23	6206.40	-2.51
Jul-22	4550.00	4313.15	-5.21	4900.00	5833.13	19.04
Aug-22	4516.67	4549.57	0.73	6126.46	5028.81	-17.92
Sep-22	4000.00	4548.97	13.72	--	6192.80	
Oct-22	4033.33	4396.02	8.99	--	5930.02	
Nov-22	4090.91	4531.49	10.77	--	6148.85	
Dec-22	4031.25	4599.36	14.09	--	6073.25	
Jan-23	4050.00	4659.25	15.04	--	5968.84	
Feb-23	--	4557.57		--	6308.26	
Mar-23	--	4570.82		--	6351.67	
Apr-23	--	4588.95		--	6228.16	
May-23	--	4680.36		--	6230.95	
Jun-23	--	4662.49		--	6208.11	
Jul-23	--	4665.26		--	6233.04	
Aug-23	--	4642.02		--	6335.07	
Sep-23	--	4697.18		--	6343.12	
Oct-23	--	4713.50		--	6311.62	
Nov-23	--	4740.55		--	6329.95	
Dec-23	--	4721.67		--	6364.50	

CONCLUSION

There was less variation between actual and forecasted prices of chickpea which shows the suitability of fitted model. The forecasted prices will be higher in Latur Market as compared to other major markets.

SUGGESTION

On the basis of price forecasting analysis of chickpea in ten major markets (Latur, Daryapur, Hinganghat, Amravati, Nagpur, Akola, Washim, Khamgaon, Murtizapur and Akot) of Maharashtra, the prices of chickpea will be maximum during the months of September to December, 2023 and comparatively highest in Latur market. Therefore, it is recommended that the farmers may sell their chickpea during the months of September to December, 2023 in ten major markets for better prices.

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Retail Marketing of Selected Mango Processed Products in Ratnagiri District

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ABSTRACT

The present study was conducted in Ratnagiri district of Konkan region purposively. Six tahsils viz., Ratnagiri, Chiplun, Khed, Dapoli, Sangmeshwar and Guhagar were selected randomly from Ratnagiri district. 5 supermarkets, 10 retailers and 100 consumer samples were selected randomly from each market area of selected tahsils. Thus, total sample size was 190 respondents. The data for present study pertained to the year 2023. Standard cost concept was used to study the cost of marketing. The results showed that, mango leather (15.22%) had highest per cent share in total margin received by retailer in a year followed by mango pickle (14.67%) and mango pulp (13.30%). The total gross margin received by retailer in a year by selling mango processed products was Rs.60,837. The mango pickle (67%) had highest per cent share in total margin received by supermarkets in a year selling mango products followed by mango barfi (26.30%). The total gross margin received by supermarket owner in a year by selling mango processed products was Rs.31,269. The taste is most significant factor for purchase of products followed by price, availability, income level in mango processed products. Nearly all consumers in sample respondents of consumer consider quality as the foremost important factor while purchasing for specific brand.

Keywords: Mango, cost concept, price spread, gross margin.

INTRODUCTION

India offers great potential and positioned for a significant retail revolution. Out of 912.22 million tons of fruits production (food primary, Source: FAO) in the world, India accounts for 107.85 million tons in 2021. India's exports of Processed Food have 388,207.95 MT accounted to Rs. 59,580.72 Crores (7,408.64 USD Millions in 2022-23) which including the share of products like mango Pulp Rs. 1189.66 Crores (147.60 USD Millions), Processed Fruits, Juices & Nuts Rs. 4754.83 Crores (590.21 USD Millions) (Source APEDA). The mango (*Mangifera indica*) one of the most significant tropical and subtropical fruits in the world, is known as the "king of fruits" because of its high nutritional content, delicious flavour, alluring aroma, and health-improving properties. Due to its several uses; mango is one of the most popular fruits grown in India. India has richest collection of mango cultivars India ranks first among world's mango producing countries accounting for about 51 per cent of total the world's mango production in year 2022. It is also known as the king of tropical fruits. Mango is excellent source of vitamins A and C. There are many different types of processed products made

from mango, including pickles, chutneys, jam, juices, mango leather, and pulp. In India area under mango cultivation is 22.97 hectare from which production is 151.88 lakh metric ton in growing season with a productivity of 6.60 ton/ hectare. while in Maharashtra area under cultivation is 5.66 hectare which has production and productivity 3.31 lakh metric ton and 2 ton per hectare respectively (source vikaspedia). With 23.89 per cent of the nation's total mango production, Andhra Pradesh is the State with the highest production in year 2022 with highest productivity (Source APEDA). Two major mango-based products which are being exported from India are mango pulp and mango pickles. The raw material is available in abundance which is why there is immense scope for its processing both at the micro and the macro level. India is also the major exporter of mango pulp in the world and mango pulp worth more than ₹.585 Cr has been exported. Major export destinations are Saudi Arab, Yemen Republic, Netherlands, Kuwait and USA. Indian mango pickles are also in great demand and are mostly exported to the USA, Russia, Belgium, Netherlands, and France. The pulp industry is dependent on the selected varieties and it

is localized in different parts of the country. But there are a certain limited number of clusters where mango pulp is being produced whereas pickle is produced throughout the country and there are more than 100 recipes through which pickles are produced. In some parts of the country like Karnataka and Tamil Nadu, pickles are made and exported. As far as mango pulp is concerned, it is converted into several products like juices, nectars, drinks, jams, fruit cheese, and many other beverages. It is also used for puddings, bakery fillings, fruit meals, and dishes, especially for children. It is also abundantly used in ice creams, yogurt, and confectionery products. Mango pulp industry is important for the country and it is limited to only a few varieties like Alphonso, Totapuri, Kesar, and sometimes, a few other varieties, but those contribute less to the major chunk of the mango pulp production. There are two main clusters in India where mango pulp is produced; these clusters have good linkages between the processing units and the farmers. One major cluster is in Chittoor (Andhra Pradesh) and the other one is in Krishnagiri (Tamil Nadu) while some of the processing units exist in Maharashtra and Gujarat as well. Food processing is the next step in sustainable development since it reduces food waste because processed foods are less prone to spoil. Understanding consumer interests, preferences, brand loyalty and constraints faced by shopkeeper in marketing with regard to mango processed products is crucial because they determine the future of the market for mango processed products. Therefore, the present study entitled, "Retail Marketing of Selected Mango Processed Products in Ratnagiri District" was undertaken.

METHODOLOGY

As Ratnagiri district is one of the major cashew and mango producing region, a multitude of

Table 1 General information of sample respondent

Sr. No.	Item	Retailers (N=60)	Supermarket (N=30)	Consumers (N=100)
1	Age (Years)	42.3	44.5	41.7
2	Educational Score	15	14.56	16.32
3	Monthly income (Rs.)	60,000	1,00,000	65,000
4	Size Of Family			
	A. Male	3.9	5.1	4.5
	B. Female	2.2	2.3	1.9
	Total	6.1	7.4	6.4

It is revealed from the Table 1 that the average age of retailers was 42.3 years, whereas in

processed fruit products are manufactured. Hence the Ratnagiri district of Konkan region is selected purposively. The six tahsils namely Ratnagiri, Chiplun, Khed, Dapoli, Sangmeshwar and Guhagar were selected from Ratnagiri district. The sample for the present study is 190 respondents. The 5 supermarket and 10 retailers in from each market area of tahsils selected randomly and from market area 100 consumer samples were selected randomly thus final sample size is 190. The data were collected by survey method from the selected retailers and supermarkets, the respondents were interviewed personally with the help of comprehensive pretested schedule designed for purpose. The collected data were analyzed for arriving at useful conclusion by tabular method. Simple and arithmetical tools such as averages, frequency distribution and percentage were used. The data analyzed for each group separately. The results of the analysis are presented in simple tabular form following analytical techniques were used.

Cost concept used in analysis:

Standard cost concept used in study *viz.*, cost of marketing

i) Cost of marketing: Cost of marketing included cost incurred by retailers and supermarket owner on processed products of mango and cashew trading.

ii) Price spread: Price spread included difference between cost incurred and profit by the producer (here retailers and super market owner)

Price spread = Price paid by consumer – (price paid by retailer + Cost and margin Incurred by agencies involved)

RESULT AND DISCUSSION

General Information of sample respondent

General information of sample regarding age, education, monthly income, family size *etc.* is given in Table 1

case supermarket owners it was 44.5 years and 41.7 years in consumers. The average educational score

for retailer was 15.00 and it was 14.56 for supermarket owner. However, the average education score of consumers was found to be 16.2 score. The average level of monthly income of supermarket owner was higher (Rs.1 lakh/month) as compared to retailers (Rs. 60,000/month). While monthly income of consumer was accounted to Rs. 65,000/month.

Intermediary wise per annum average quantity of mango processed product trade by retailers and supermarket

The average quantity of mango processed products sold by retailers and supermarket owners per year is given in Table 2.

It was observed from the Table 2 that the mango pulp (260.39 kg/annum) were sold by retailers which was followed by ripe mango juice (230.33 kg/annum), mango pickle (181.64 kg/annum), raw mango juice (170.41 kg/annum), amba mava (160.90 kg/annum) and *Kairi chunda* (110.87 kg/annum). However, other product like dried mango slice, mango leather, *amchoor* powder, mango *barfi*, mango *poli* and mango jam were found to be less than 100 kg per annum which was might

be due to less popularity, non-availability of that product. However, the study area become tourist place in the harvesting season during December to May, most of tourists were visit to that area and demand from tourist for process product was more. Similarly, in the study area very small seller were also sales these products at any corner of the village and town so supply of these products were limited. Therefore, the retailers were not able to sale some of the products. In case of supermarkets the annual average quantity of mango pickle was found to be highest and it was accounted to 293.87 kg per annum. However, product like *amchoor* powder, mango *barfi* and mango jam were sold by supermarket which accounted to 12.73 kg per annum, 37.38 kg per annum, and 31.86 kg per annum respectively. These products were found to be in small quantity trade that might be due to supermarket owner has diversified product to sale and not able to concentrate on mango products and not easy availability of mango process product to the sale.

Table 2. Per year average quantity of mango processed products sold by retailers and supermarket

Sr. No.	Particulars	Average quantity sold/year (Kg)	
		Retailers	Supermarket
1	Mango pickle	181.64	293.87
2	Mango pulp	260.39	-
3	Ripe mango juice	230.33	-
4	Raw mango juice	170.41	-
5	<i>Kairi chunda</i>	110.87	-
6	Mango leather	90.11	-
7	Mango <i>muramba</i>	70.53	-
8	Mango <i>mava</i>	60.9	-
9	<i>Amchoor</i> powder	8.74	12.73
10	Mango <i>barfi</i>	29.34	37.38
11	Mango <i>poli</i>	11.87	-
12	Mango jam	22.69	31.86
13	Dried mango slice	8.07	-

Price spread of various mango processed products and income received by retailers

The product and unit wise price spread of mango process product marketed by retailers and net

margin received by them is analyzed and presented in the Table 3.

It was revealed from the Table 3, that 200 gm and 500 gm unit of mango pickle was sold by the retailer in the study area. The price paid by

the retailer to the producer for 200 gm and 500 gm of packet was Rs.35 and Rs.85. Whereas, price paid by consumer to retailer for the respective mango pickle packet was Rs.80 and Rs.110. However, the net margin for 200 gm and 500 gm of mango pickle packets received by the retailer was accounted to Rs.14.43 and Rs.29.47 respectively. From the table it was also observed that the total sale of mango pickle by the retailer in a year was worked out to 545 packets of 200 gm and 36 packets of 500 gm. Thus, gross margin received by retailer in a year from sale of mango pickle was accounted to Rs. 8925 which was 14.67 per cent of the total margin received by retailer annually by selling mango products. The retailers in the study area sold mango pulp units size 450, 500, 850 gm, and 1 kg. The price paid to producers by retailers for the respective bottles of pulp was Rs.170, Rs.175, Rs.369, and Rs.384. However, the gross margin received by the retailer from sale of 84 bottles of size 450 grams, 55 bottles of unit 500 grams, 36 bottles of 850 grams and 83 bottles of 1 kg was Rs.8774 which was 14.42 per cent of total margin in a year by selling mango products.

Similarly, in the same context, retailers in the study area also sold dried mango slices in 250 grams and mango *muramba* in 200 gram packet size. Meanwhile, retailers incurred marketing costs of Rs. 0.41 and Rs. 0.45 for the respective size of dried mango slices and mango *muramba*. This resulted in net margins of Rs. 27.53 for 250 gm of dried mango slices and Rs.14.55 for 200 gm packets of mango *muramba*. It is also observed from the table that the total sale of dried mango slice and mango *muramba* by the retailer in a year was worked out to 40 packets of 250 gm and 450 packets of 200 gm of dried mango slice and mango *muramba* respectively. Thus, gross margin received by retailer in year from sale of dried mango slice and mango *muramba* was accounted to Rs. 1101 and Rs. 3322 respectively which were 1.8 per cent and 5.48 per cent of the total margin received by retailer respectively in a year by selling mango products.

Additionally, retailers in the study area sold ripe and raw mango juice in units of 500 ml, 750 ml bottles of ripe juice and 500 ml and 1 litre bottles of raw mango juice. Thus, gross margin received by retailer in year from sale of ripe mango juice was accounted to Rs. 4132 which was 6.89 per cent of the total margin received by retailer in a year by selling mango products. Similarly, thus, gross margin received by retailer in year from sale of raw

mango juice was accounted to Rs. 190 which was 3.12 per cent of the total margin received by retailer in a year by selling mango products.

It was also observed from the table that the total sale of mango leather and *kairi chunda* by the retailer in a year was worked out to 450 packets and 554 packets of 200 grams of mango leather and *kairi chunda*. Thus, gross margin received by retailer in year from sale of mango leather and *kairi chunda* was accounted to Rs. 9265 and Rs. 8055 which was 15.22 per cent and 13.3 per cent of the total margin received by retailer respectively by selling mango products in a year.

The mango *mava* and mango *barfi* in 200 gm packages and mango *poli* in 100 gm package was sold by retailer and . The gross margin received by retailer in a year from sale of mango *mava*, mango *barfi* and mango *poli* was accounted to Rs. 5950, Rs. 4277 and Rs. 2355 respectively. Which was 9.8 per cent, 7.05 per cent, and 3.87 per cent of the total margin received by retailer respectively in a year by selling mango products received by retailer respectively in a year by selling mango products.

Furthermore, retailers in the study area sold 200 gm and 500 gm packet of mango jam. Thus, gross margin received by retailer in a year from sale of mango jam was accounted to Rs.1690 which was 2.7 per cent of the total margin received by retailer in a year by selling mango products. The gross margin received by retailer in a year from sale of *amchoor* powder was accounted to Rs.1080 which estimated to 1.8 per cent of the total margin received by retailer annually by selling mango products. It is concluded from the Table 5.14 mango leather (15.22%) had highest per cent share in total margin received by retailer in a year which is followed by mango pickle (14.67%) mango pulp (14.42%) and *kairi chunda* (13.3%).

Price spread of various mango processed products and net margin received supermarket owner

The product and unit wise price spread of mango processed product marketed by supermarket owner is analyzed and presented in Table 4.

It was revealed from the Table 4 that in the study area, supermarkets sold mango pickle in units of 200 gm, 500 gm and 5 kg. The supermarkets purchased these packages from producers at rates of Rs.345, Rs.77, Rs.175, and Rs.750 respectively. The marketing costs incurred by the supermarket owners were estimated Rs. 0.66, Rs.1.04, Rs.1.06, and Rs.1.33 for 200 gm, 500 gm, 1 kg, and 5 kg of

mango pickle units respectively. Notably, the net margins received by supermarket owner were found to be Rs.19.34 for 200 gm, Rs.31.96 for 500 gm, Rs.53.94 for 1 kg, and Rs.218.67 for 5 kg of mango pickle and it was also observed from the table that unit sale of mango pickle was worked to 895 packets, 32 packets, 38 packets and 2 packets of 200 gm, 500 grams, 1 kg and 5 kg unit and thus gross return received by the supermarket owner was Rs.20,953 which accounted to 67 per cent of total margin received by supermarket owner in a year selling mango products.

In the case of *amchoor* powder, supermarkets in the study area sold packages of 100 gm and 500 gm. The supermarket owner gained net margins of Rs.23.97 and Rs.38.69 for 100 gm and 500 gm packages of *amchoor* powder, respectively. And the gross margin received by the supermarket owner from the both packets was Rs.1712 which was 5.47 per cent of total margin received by supermarket owner in a year selling mango products.

Supermarkets in the study area also sold mango *barfi* in 250 gm packets and mango jam in 500 gm packets. The price paid by supermarket

owner to producers was found to be Rs.190 for 250 gm packet of mango *barfi* and Rs.180 for 500 gm packets of mango jam. Marketing costs incurred by supermarket owners were Rs.1.09 for mango *barfi* and Rs.1.06 for mango jam. However, the total unit sale of mango *barfi* and mango jam in a year was observed to be 185 packets and 16 packets of unit 250 gm and 500 grams and the gross margin received by supermarket owner from the sale of respective packets was Rs.8140 and Rs. 464 which accounted to 26.03 per cent and 1.5 per cent of the total margin received by supermarket owner in a year respectively by selling mango products. It is concluded from the table that, mango pickle (67%) had highest share in total margin received by retailer in a year which was followed by mango *barfi* (26.3%), *amchoor* powder (5.47%) and mango jam (1.5%).

Table 3. Unit wise price spread of mango processed products and gross margin received by retailer by									
Sr. No.	Mango Products	Quantity in kg	Cost paid by retailer (Rs.) (per unit)	Marketing cost Per unit (Rs.)	Price paid by consumer (Rs.) (per unit)	Net margin (Rs.) (Per unit)	Total unit sale in year	Gross margin by retailer in year	Percentage (%)
1	Mango pickle	0.2	35	0.57	50	14.43	545	7864	-
		0.5	80	0.53	110	29.47	36	1061	-
								8925	14.67
2	Mango pulp	0.45	170	0.49	190	19.51	84	1638	-
		0.5	175	0.45	210	34.55	55	1900	-
		0.85	369	0.46	410	40.54	36	1459	-
		1	384	0.49	430	45.51	83	3777	-
								8774	14.42
3	Dried mango slice	0.25	197	0.41	225	27.53	40	1101	1.8
4	Ripe mango juice	0.5	99	0.33	129	29.67	52	1543	-
		0.75	133	0.3	160	26.7	97	2589	-
								4132	6.79
5	Raw mango juice	0.5	79	0.33	95	15.67	68	1065	-
		1	110	0.42	135	24.58	34	836	-
								1901	3.12
6	Mango <i>muramba</i>	0.2	45	0.45	60	14.55	229	3332	5.48
7	Mango leather	0.2	54	0.41	75	20.59	450	9265	15.22
8	<i>Kairi chunda</i>	0.2	45	0.47	60	14.53	554	8055	13.3
9	Mango <i>mava</i>	0.2	65	0.49	85	19.51	305	5950	9.8
10	Mango barfi	0.2	70	0.4	100	29.6	145	4277	7.05
11	Mango <i>poli</i>	0.1	60	0.41	80	19.59	120	2355	3.87
12	Mango jam	0.2	80	0.41	100	19.59	80	1600	-
		0.5	190	0.33	220	29.67	3	90	-
								1690	2.7
13	<i>Amchoor</i> powder	0.1	60	0.41	75	14.59	44	660	-
		0.5	145	0.37	165	19.63	21	420	-
								1080	1.8
	Total							60,837	100

Table 4. Unit wise price spread of various mango processed products and gross margin received by supermarket owner

Sr. No.	Mango Products	Quantity in kg	Cost paid by super-market owner (Rs.)(per unit)	Marketing cost (Rs.) (Per unit)	Price Paid by Consumer (Rs.) (Per unit)	Net Margin received by super market owner (Rs.)	Total unit sale in a year	Gross margin received by super market owner
1	Mango Pickle	0.2	45	0.66	65	19.34	895	17,309 (55.3)
		0.5	77	1.04	110	31.96	32	1,034 (3.3)
		1	175	1.06	230	53.94	38	2,052 (6.6)
		5	750	1.33	970	218.67	2	558 (1.81)
Total								20,953 (67)
2	Amchoor powder	0.1	55	1.03	80	23.97	65	1,560 (4.98)
		0.5	140	1.31	180	38.69	4	152 (0.48)
Total								1712 (5.47)
3	Mango barfi	0.25	190	1.09	235	43.91	185	8,140 (26.03)
4	Mango Jam	0.50	180	1.06	200	18.94	16	464 (1.5)
Total								31,269 (100)

(Figures in parentheses indicates percentage to total)

CONCLUSIONS

The results showed that mango leather (15.22%) had highest per cent share in total margin received by retailer in a year followed by mango pickle (14.67%) and mango pulp (13.30%). The total gross margin received by retailer in a year by selling mango processed products was Rs.60,837. The mango pickle (67%) had highest per cent share in total margin received by supermarkets in a year selling mango products followed by mango *barfi* (26.30%). The total gross margin received by supermarket owner in a year by selling mango processed products was Rs.31,269. The taste is most significant factor for purchase of products followed by price, availability, income level in mango processed products. Nearly all consumers in sample respondents of consumer consider quality as the foremost important factor while purchasing for specific brand.

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Price Analysis of Soybean in APMC Ahmednagar

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ABSTRACTS

The present investigation was undertaken for Price Analysis of Soybean in APMC Ahmednagar for 18 years. The secondary data of arrivals and prices of Soybean crop was collected from APMC Ahmednagar. The collected data were further compiled and analysed keeping in view the objectives of the study. The data was analyzed to compute the growth rates, trends, seasonal indices and variability in arrivals and prices of Soybean.

The highest prices of Soybean crop in APMC Ahmednagar were found in the year 2021, which was increased by 371.20 per cent over the base year, while prices are more or less similar except the year 2017 over the base year. In case of prices the co-efficient of variation ranges from 37.52 to 50.86 per cent, this clearly indicates that there was a less variation in the prices of the Soybean crop. The correlation coefficients of soybean crop was negative during the whole year indicating that increased arrivals resulted into decreased in prices; in this case the phenomenon of inverse relationship is proved. The maximum variation in arrivals of soybean in APMC Ahmednagar was found in the month of February (92.72 %) followed by August (81.51 %), while minimum variation in arrivals was found in the month of October (55.74 %) followed by April (56.745 %). The less arrivals of soybean were observed during the months of April, to August. Therefore, farmers are advised to schedule the sale of Soybean in Ahmednagar APMC during the April, to August to get the better prices.

Keywords : Prices analysis, Secondary data, Seasonal indices & Variability of Soybean

INTRODUCTION

Soybean is emerging as major oilseed crop with growth of 164 per cent in area and 214 per cent in production during the last 10 years and contributing 91.6 per cent oilseed production. Madhya Pradesh and Maharashtra are the highest Soy oil consuming state.

India ranks 5th in the list of major soybean producing countries of the world. Among the major soybean producing states, Madhya-Pradesh ranks first in terms of area, production and productivity followed by Maharashtra and Rajasthan. Indore, Sagar and Itarsi in Madhya Pradesh, Akola, Washim, Latur and Nagpur in Maharashtra and Kota in Rajasthan are important markets for soybean trading in India.

Soybean is a short duration crop which is adaptable to a wide range of agro climatic situations, having high yield potential, suitable for cultivation in all seasons, due to its day neutral nature and can fit well in various inter and sequence cropping systems. Area under soybean cultivation in Maharashtra is

52,800 ha in *kharif* season, while in *rabi* season it was 71,700 ha. However, the average yield of this crop in India is lowest; it is less than half the world average. Emergence of new diseases and large climatic variations, particularly recurrence of drought stress during critical growth stages, has affected stability and yield on a regular basis.

The production of soybean in India is dominated by Madya Pradesh, Maharashtra and Rajasthan which contribute 89 per cent of the total production. The arrivals of soybean in the market are not uniform through the year. Generally, arrivals are more in the production season in the producing areas and lesser in the other seasons. Its market arrivals and price exhibit a seasonal pattern. The seasonality in production causes fluctuations in prices from season to season. The seasonal and yearly fluctuation in price causes wide variation in the income of soybean growers.

The demand for soybean crop is increasing very tremendously therefore, it is felt necessary to study the various reasons behind it; looking to the above the present study is undertaken to study Price

Analysis of Soybean in APMC Ahmednagar. In view of the objectives of the study are to examine trends in arrivals and prices of Soybean, to estimate the seasonal indices of arrivals and prices of Soybean and to examine the variability in arrivals and prices of Soybean.

METHODOLOGY

The data present for study was undertaken for the period of 18 years from 2003-04 to 2020-21 of APMC Ahmednagar. The secondary data of arrivals and prices of Soybean crop was collected from APMC Ahmednagar. The collected data were further compiled and analysed keeping in view the objectives of the study.

The data was analyzed to compute the growth rates, trends, seasonal indices and variability in arrivals and prices of Soybean.

I. Trends in Arrival and Prices

The growth rate of arrivals and prices of Soybean was estimated by using semi log trend equation.

$$Y_a = ab^t \text{ and } Y_p = ab^t$$

$$\text{CGR (\%)} = (\text{antilog } b - 1) \times 100$$

Y_a and Y_p = Monthly arrivals and prices respectively

a = Constant

b = Trend Coefficient

t = Time Period

Table 1. Changes in Arrivals and Prices of Soybean in APMC Ahmednagar

Sr.No.	Year	Arrival (q.)	% Change Over 2003	Price (Rs./q.)	% Change Over 2003
1	2004	553	---	1120.58	---
2	2005	647	17.00	1177.54	5.08
3	2006	678	22.60	1222.83	9.13
4	2007	3110	462.39	1540.04	37.43
5	2008	873	57.87	2110.88	89.37
6	2009	521	-5.79	2170.38	93.68
7	2010	11009	1890.78	1926.25	71.90
8	2011	14214	2470.34	2184.79	94.97
9	2012	6898	1147.38	2589.08	131.05
10	2013	19936	3505.06	3207.96	186.28
11	2014	5987	982.64	3357.83	199.65
12	2015	5518	897.83	3237.75	188.94
13	2016	22325	3937.07	3128.13	179.15
14	2017	79005	14186.62	2624.46	134.21
15	2018	21151	3724.77	3054.17	172.55
16	2019	27301	4836.89	3344.67	198.48
17	2020	23880	4218.26	3271.92	191.98
18	2021	35818	6377.03	5280.21	371.20

II. Compound growth rates of arrivals and prices of Soybean

The annual compound growth rate of arrivals and prices of Soybean were estimated and presented in Table 2.

II. Seasonal indices of arrivals and prices of Soybean

The seasonal indices of Soybean were worked out by ratio to moving average method.

III. Variability in Arrivals and Prices

$$\text{CV} = \text{SD}/\text{Mean} \times 100$$

Where,

CV= Coefficient of variation

SD= Standard Deviation

Mean= $\sum X/N$

X =Monthly arrivals and prices

N= Number of years

RESULTS AND DISCUSSION

I. Changes in Arrivals and Prices of Soybean

It can be revealed from the Table 1, that the highest arrivals was found in the year 2017 i.e. 79005 quintals, which was 14186.62 per cent over the base year (2003-04), while lowest arrivals in the year 2009 (521 q.), which was less over the base year (2003-04) indicating negative growth (-5.79per cent) over the base year. The highest prices of Soybean crop was found in the year 2021, which was 371.20 per cent high over the base year, while prices are more or less similar except the year 2017.

Table 2. Annual compound growth rates of arrivals and prices of Soybean in APMC Ahmednagar

Sr.No.	Period	Arrival	Prices
1	Period I (2004-2012)	47.09**	11.37 ***
2	Period II (2013-2021)	17.42 ^{NS}	3.32 ^{NS}
3	Overall (2004-2021)	30.24***	7.59***

(*,**,and *** indicates significant at 10,5 and 1 per cent level of significance)

It can be revealed from table 2 that, in period I (2004 to 2012), the arrivals and prices of Soybean was significantly increased by 47.09 per cent and 11.37 per cent respectively. In period II (2013 to 2021), the arrivals and prices of soybean was increased 17.42 per cent and 3.32 per cent, respectively, but showing non-significant indicated stagnant growth in arrivals and prices of soybean in APMC Ahmednagar.

In overall level, an arrivals of Soybean was significantly increased by 30.24 per cent on the contrary prices have increased by 7.59 per cent.

III. Seasonal indices of arrival and prices of Soybean

The seasonal indices of arrival and prices of soybean were estimated over a period of 18 year from 2003-04 to 2020-2021 and are presented in Table 3.

Table 3. Seasonal Indices of Arrivals and Prices of Soybean in APMC Ahmednagar

Month	Arrival		Price	
	Mean (q.)	Seasonal Indices	Mean (Rs./q.)	Seasonal Indices
January	550.11	42.52	2469.08	95.48
February	296.78	22.94	2476.97	95.78
March	124.44	9.62	2507.06	96.95
April	97.67	7.55	2637.61	102.00
May	60.00	4.64	2628.61	101.65
June	77.39	5.98	2639.50	102.07
July	75.72	5.85	2699.11	104.37
August	50.56	3.91	2699.64	104.39
September	745.78	57.65	2650.03	102.48
October	8200.78	633.94	2508.75	97.01
November	3501.56	270.68	2493.31	96.42
December	1742.78	134.72	2623.31	101.44

The result of analysis revealed that, the peak arrivals of soybean were concentrated in month of September to December. The indices of arrivals were lowest during the month of March to August. The seasonal indices regarding prices revealed that, there were less fluctuations in prices as it is ranged between 95.48 to 104.39 per cent. The price index for the month of September was highest i.e. 104.39 per cent followed by July (104.37 per cent).

IV. Correlation between arrivals and prices of Soybean in APMC, Ahmednagar

Co-relation indicates the relationship between market arrivals and prices of soybean crop. The phenomenon of inverse relationship between arrivals and prices is well known. The degree of relationship between market arrivals and prices of soybean crop were studied for 12 months over the period from 2003-04 to 2020-21 by computing correlation coefficient. The results of correlation analysis are depicted in Table 4.

Table 4. Correlation between Arrivals and Prices of Soybean in APMC Ahmednagar

Month	Soybean
January –June	-0.78
July-Dec	-0.84
Annual	-0.39 ***

It can be revealed from Table 4 that, there exist negative relationship between market arrivals and prices of Soybean in APMC, Ahmednagar for whole year. This implies that, arrivals and prices of Soybean have moved in opposite direction in APMC, Ahmednagar during the study period. The correlation coefficients were negative during the whole year indicating that decreased arrivals resulted into increase in prices.

Table 5. Variability in Arrivals and Prices of Soybean in APMC Ahmednagar

Month	Arrivals		Prices	
	Mean (q.)	CV (%)	Mean (q.)	CV (%)
January	550.11	183.64	2469.08	37.52
February	296.78	214.70	2476.97	37.56
March	124.44	217.02	2507.06	38.19
April	97.67	178.36	2637.61	38.98
May	60.00	176.95	2628.61	38.53
June	77.39	148.18	2639.50	42.14
July	75.72	160.84	2699.11	46.55
August	50.56	172.47	2699.64	50.86
September	745.78	178.48	2650.03	44.03
October	8200.78	135.66	2508.75	41.66
November	3501.56	133.91	2493.31	41.01
December	1742.78	165.26	2623.31	41.08

CONCLUSIONS

- i) The highest prices of Soybean crop in APMC Ahmednagar were found in the year 2021, which was increased by 371.20 per cent over the base year, while prices are more or less similar except the year 2017 over the base year, while in the rest of years prices were ranged from Rs. 1120 per quintal to Rs. 3344 per quintal.
- ii) At overall level, an arrivals and prices of Soybean was increased 30.24 per cent and 7.59 per cent, respectively.
- iii) The seasonal indices for arrivals of soybean, the peak arrivals of soybean were concentrated in month

V. Variability of arrivals and prices of Soybean crop

The pattern of market arrivals and prices variability of Soybean crop during the period 2003-04 to 2020-21 was examined by using the coefficient of variation for the 12 months and the details are depicted in Table 5

It can be revealed from table, that the maximum variation in arrivals was found in the month of March (217.02 %) followed by February (214.70 %), while minimum variation in arrivals was found in the month November (133.91 %) followed by October (135.66 %). In case of prices the Co-efficient of variation ranges from 37.52 to 50.86 per cent, this clearly indicates that there was a less variation in the prices of the soybean.

of September to December. The indices of arrivals were lowest during the month of March to August. The seasonal indices regarding prices revealed that, there were less fluctuations in prices as it is ranged between 95.48 to 104.39 per cent. The price index for the month of September was highest i.e. 104.39 per cent followed by July (104.37 per cent).

- iv) In case of prices the co-efficient of variation ranges from 37.52 to 50.86 per cent, this clearly indicates that there was a less variation in the prices of the Soybean crop.

v) The correlation coefficients of soybean crop was negative during the whole year indicating that increased arrivals resulted into decreased in prices; in this case the phenomenon of inverse relationship is proved.

vi) The maximum variation in arrivals of soybean in APMC Ahmednagar was found in the month of February (92.72 %) followed by August (81.51 %), while minimum variation in arrivals was found in the month of October (55.74 %) followed by April (56.745 %).

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Impact of Farmer Producer Organizations (FPOs) on Farm Economy: A Comparative Analysis

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ABSTRACT

Farmer Producer Organizations (FPOs) play a crucial role in enhancing farm profitability and economic sustainability by providing collective bargaining power, improved market access, and technical support. This study evaluates the economic performance of FPO-member farmers and non-members across different farming enterprises, including soybean, onion, pomegranate, and goat rearing.

The findings indicated that FPO membership positively impacts yield, gross and net returns, cost-effectiveness, and the benefit-cost (B:C) ratio, ultimately leading to higher profitability and improved financial stability for member farmers. Specifically, soybean member farmers achieved 12.5% higher main produce yield (20.58 q/ha vs. 18 q/ha), with net returns of ₹29,321.30 per hectare, 43.20% higher than non-member farmers, and a B:C ratio of 1.43 compared to 1.25. Onion member farmers experienced a 52.70% increase in net returns (₹54,592.87/ha vs. ₹25,838.62/ha) and had a higher B:C ratio (1.25 vs. 1.12). Pomegranate members received 17.9% more net returns (₹4,90,778.7/ha vs. ₹4,02,735.15/ha) and a B:C ratio of 2.66 compared to 2.46. Additionally, goat-rearing FPO members had a net profit of ₹88,690.41 per flock, nearly double that of non-members (₹47,137.47), with an input-output ratio of 2.53 versus 1.95. These findings highlight the economic advantages of FPO membership in enhancing agricultural profitability, cost-effectiveness, and financial resilience.

Keywords: Farmer Producer Organizations, Economic Performance, Benefit-Cost Ratio, Cost-Effectiveness, Incremental Cost-Benefit Ratio

INTRODUCTION

Agriculture plays a vital role in the Indian economy, providing employment to a significant portion of the population and contributing substantially to the country's GDP. However, small and marginal farmers often face challenges such as limited access to markets, inadequate bargaining power, and insufficient financial and technical resources. To address these issues, Farmer Producer Organizations (FPOs) have emerged as a collective model that enables farmers to work together to achieve economies of scale, access better market opportunities, and improve their profitability.

FPOs facilitate collective input procurement, improved production techniques, and better access to financial and market linkages, thereby reducing costs and enhancing farmers' incomes. By strengthening the bargaining power of farmers, these organizations help bridge the gap between primary producers and markets, ensuring that farmers receive fair prices for their produce. Various studies have highlighted the economic advantages of FPO membership, including increased productivity, higher gross and net returns, and improved cost-effectiveness.

This study aims to evaluate the economic performance of FPO-member farmers in comparison to non-members across different agricultural

enterprises such as soybean, onion, pomegranate, and goat rearing. By analyzing key financial indicators such as yield, gross and net returns, cost-effectiveness, and benefit-cost ratios, this research provides insights into the impact of FPOs on farm profitability and economic sustainability. The findings will help policymakers, stakeholders, and farmers understand the significance of FPOs in fostering rural economic growth and financial stability.

METHODOLOGY

This study employs a comparative approach to assess the economic performance of Farmer Producer Organization (FPO) member farmers and non-members across four major agricultural enterprises: soybean, onion, pomegranate, and goat rearing.

The research was conducted in regions with active FPOs involved in these agricultural enterprises. A purposive sampling method was used to select FPOs based on their operational effectiveness and farmer participation. For each enterprise, 30 FPO-member farmers and 30 non-member farmers were selected, resulting in a total sample size of 240 farmers (120 members and 120 non-members).

Primary data were collected through structured interviews using a pre-tested questionnaire.

RESULTS AND DISCUSSION

Table 1. Economic Performance of Soybean Cultivators

Sr. No	Particular	Member (N=30)	Non-Member (N=30)	Per cent impact
A	Yeild (q/ha)			
	i) Main Produce	20.58	18	12.5
	ii) By-produce	10	9.93	0.7
B	Economics			
	i) Gross return	96948.7	82057.7	15.4
	ii) Cost of Cultivation	67627.4	65394	3.3
	iii) Net returns	29321.3	16663.7	43.2
C	B:C ratio	1.43	1.25	12.5
D	Cost effectiveness of member farmer of soybean crop			
	i) Added returns	14891		
	ii) Added cost	12657.7		
	iii) Added yield (q)	2.58		
	iv) % increase in yield	19.58		
	v) Cost (Rs./q)	3286.07	3633	
	vi) ICBR	1.18		

The questionnaire covered key economic parameters, including yield, gross returns, cost of cultivation, net returns, benefit-cost (B:C) ratio, and cost-effectiveness indicators. Secondary data were obtained from FPO records, agricultural department reports, and relevant published sources.

Analytical Framework

To compare the economic performance of member and non-member farmers, the following indicators were analyzed:

Yield (q/ha) – Main and by-produce yields were recorded.

Economic Returns – Gross returns, cost of cultivation, and net returns were calculated.

Benefit-Cost (B:C) Ratio – The ratio of gross returns to total cost was determined to assess profitability.

Cost Effectiveness Analysis – Incremental Cost-Benefit Ratio (ICBR) was used to evaluate the cost efficiency of FPO membership.

The percentage impact of FPO membership was computed for each parameter to quantify differences in economic performance. Descriptive statistics, such as mean, percentage change, and standard deviation, were used to summarize the findings.

Table 1 compares the economic performance of soybean cultivators who are members of a farmer organization with those who are not. It shows that member farmers achieve higher yields and better financial outcomes. Specifically, member farmers produce 20.58 quintals per hectare compared to 18 quintals for non-members, and their gross return is ₹96,948.7 per hectare, which is 15.4 per cent higher than non-members' ₹82,057.7. The net return for member farmers is ₹29,321.3 per hectare, significantly higher than the ₹16,663.7 for non-members.

The Benefit-Cost (B:C) ratio is also better for members at 1.43, compared to 1.25 for non-members. Additionally, member farmers enjoy an added yield of 2.58 quintals per hectare, with a 19.58 per cent increase in yield. The cost per quintal for member farmers is ₹3,286.07, lower than the ₹3,633 for non-members. The Incremental Cost-Benefit Ratio (ICBR) for member farmers stands at 1.18, indicating that the additional benefits outweigh the additional costs. Overall, member farmers benefit from higher yields, better economic returns, and greater cost-effectiveness.

Table 2. Economic Performance of Onion Cultivators

Sr. No.	Particular	Member	Non-Member	Per cent Impact
A	Yeild (q/ha)			
	i) Main Produce	171.2	166.5	2.7%
B	Economics			
	ii) Gross return	275482.54	240205.86	12.8%
	iii) Cost of Cultivation	220889.67	214367.24	3.0%
	iv) Net returns	54592.87	25838.62	52.7%
C	B:C ratio	1.25	1.12	10.2%
D	Cost effectiveness of member farmer of onion crop			
	i) Added returns	35276.68		
	ii) Added cost	6522.43		
	iii) Added yield (q)	4.7		
	iv)% increase in yield	2.7%		
	v) Cost (Rs./q)	1290.24	1287.49	
	vi) ICBR	5.41		

Table 2 represent the economic performance of onion cultivators indicates that member farmers achieved a slightly higher yield of 171.2 q/ha compared to 166.5 q/ha for non-members, reflecting a 2.7 per cent increase. Gross returns for members (₹2,75,482.54) were 12.8 per cent higher than non-members, while the cost of cultivation was marginally higher by 3.0 per cent. However, net returns for members (₹54,592.87) were significantly higher, showing a 52.7 per cent improvement. The benefit-cost ratio was also better for members (1.25) compared to non-members (1.12), indicating a 10.2 per cent increase in profitability. Additionally, members gained an added return of ₹35,276.68 with an added cost of ₹6,522.43, resulting in an incremental cost-benefit ratio (ICBR) of 5.41. These findings highlight that FPO membership enhances profitability and cost efficiency for onion farmers.

Table 3 compares the economic performance of pomegranate cultivators who are members of a farmer organization with those who are not. Member farmers achieve slightly higher yields, producing 82.17 quintals per hectare compared to 79.46 quintals for non-members, reflecting a 3.3 per cent increase.

In terms of economics, member farmers generate a gross return of ₹785,720.3 per hectare, which is 4 per cent higher than the ₹678,035.71 earned by non-members. The cost of cultivation for member farmers is ₹294,941.6 per hectare, slightly higher than the ₹275,300.56 for non-members, marking a 6.7 per cent increase. Despite the higher costs, the net return for member farmers is significantly higher at ₹490,778.7 per hectare, compared to ₹402,735.15 for non-members, indicating a 17.9 per cent increase.

Table 3. Economic Performance of Pomegranate Cultivators

Sr. No	Particular	Member (N=30)	Non-Member (N=30)	Per cent impact
A	Yeild (q/ha)			
	i) Main Produce	82.17	79.46	3.3
B	Economics			
	ii) Gross return	785720.3	678035.71	13.7
	iii) Cost of Cultivation	294941.6	275300.56	6.7
	iv) Net returns	490778.7	402735.15	17.9
C	B:C ratio	2.66	2.46	7.5
D	Cost effectiveness of member farmer of Soybean crop			
	i) Added returns	107684.6		
	ii) Added cost	19641.02		
	iii) Added yield (q)	2.70		
	iv) % increase in yield	3.3%		
	v) Cost (Rs./q)	3589.50	3464.46	
	v) ICBR	5.48		

The Benefit-Cost (B:C) ratio is also better for members at 2.66, compared to 2.46 for non-members, reflecting a 7.5 pere cent improvement. Additionally, member farmers enjoy added returns of ₹107,684.6 per hectare, with additional costs of ₹19,641.02, achieving an added yield of 2.7 quintals per hectare. The cost per quintal for member farmers

is ₹3,589.50, slightly higher than the ₹3,464.46 for non-members. The Incremental Cost-Benefit Ratio (ICBR) is 5.48, indicating that the additional benefits far outweigh the additional costs. Overall, member farmers benefit from higher yields, better economic returns, and greater cost-effectiveness.

Table 4. Economic Performance of Goat Rearing Farmers

Sr. No	Particular	Per flock		Per goat	
		Member (N=30)	Non-Member (N=30)	Member (N=30)	Non-Member (N=30)
1	Gross returns	146587.83	96965.33	22436.91	13786.54
2	Working cost	35192.97	37222.04	5386.68	5292.23
3	Fixed Cost	22704.45	12605.82	3475.17	1792.30
4	Total Cost	57897.42	49827.87	8861.85	7084.53
5	Net profit	88690.41	47137.47	13575.06	6702.01
6	Input-Output Ratio	2.53	1.95	2.53	1.95
	Cost effectiveness of goat rearing member farmer				
	i) Added returns	49622.50		8650.37	
	ii) Added total cost	10098.63		1682.87	
	iii) ICBR	4.91			

Table 4 represents the economic performance of goat-rearing farmers, showing that member farmers earned higher gross returns, with ₹1,46,587.83 per flock and ₹22,436.91 per goat, compared to non-members who earned ₹96,965.33 per flock and ₹13,786.54 per goat. While the working

cost remained similar for both groups, fixed costs were higher for members. However, total costs per flock and per goat were still higher for members, at ₹57,897.42 and ₹8,861.85, compared to ₹49,827.87 and ₹7,084.53 for non-members. Despite this, member farmers had a significantly higher net profit

of ₹88,690.41 per flock and ₹13,575.06 per goat, compared to ₹47,137.47 and ₹6,702.01 for non-members. The input-output ratio was better for members (2.53) than non-members (1.95), indicating higher profitability. Additionally, members gained added returns of ₹49,622.50 per flock and ₹8,650.37 per goat with an added total cost of ₹10,098.63 and ₹1,682.87, respectively, resulting in an incremental cost-benefit ratio (ICBR) of 4.91. These findings highlight the economic advantage of FPO membership in goat rearing.

CONCLUSION

The study highlights the significant economic advantages of Farmer Producer Organization (FPO) membership across different agricultural enterprises, including soybean, onion, pomegranate, and goat rearing. The findings indicate that FPO members experience higher yields, better cost-effectiveness, and greater profitability compared to non-members. Specifically, soybean member farmers had a 12.5% higher yield and 43.2% greater net returns, while onion farmers saw a 52.7% increase in net returns. Similarly, pomegranate farmers and goat-rearing members achieved 17.9% and 88.2% higher net returns, respectively.

The benefit-cost ratio (B:C) was consistently higher for FPO members, reflecting improved financial sustainability. Additionally, cost-effectiveness measures, such as the Incremental Cost-Benefit Ratio (ICBR), indicated that the additional benefits derived from FPO membership outweigh the associated costs. These results emphasize the role of FPOs in enhancing farmers' income, reducing risks, and improving financial stability through collective action, better market linkages, and input cost efficiency.

POLICY IMPLICATIONS

- Given the significant economic advantages, the government should focus on increasing FPO membership through targeted awareness campaigns, training programs, and financial incentives. Providing

subsidies, tax benefits, and reduced input costs for FPO members can encourage more farmers to join.

- Local agriculture departments and NGOs can play a pivotal role in **educating farmers about the benefits of FPO membership** and assisting them in the registration process. These institutions should facilitate on-ground support, capacity-building initiatives, and access to necessary documentation for seamless integration into FPOs.

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Techno-Economic Analysis of Cotton Stalk Biochar Production Using Continuous Reactor Systems

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ABSTRACT

The safe disposal of the biomass is gaining more attention due to the increase in air pollution due to crop stubble and waste burning. Bioenergy can be generated from a variety of sources, including forestry and agricultural residues, energy crops, organic waste and by-products from industrial processes. The cotton stalk agro residue is an abundant biomass available in India and its safe disposal without burning in the field is a concern to be addressed. The biochar reactor was developed by considering thermal behavior of agro residue which was then fabricated by integrating electrical indirect heating system provided with screw auger, belt conveyor, cyclone separator, digital temperature indicator and electronic circuit. The study was further extended to examine the effect of parameters such as temperature, residence time and particle size on the different properties of biochar such as volatile matter, ash content, fixed carbon, iodine value, pH, electrical conductivity and calorific value. The performance of continuous biochar production system was evaluated at temperature of 350, 400 and 450, residence time of 3, 6 and 9 min and particle size of 6, 8 and 10 mm. Box Behnken model based on response-surface methodology was used to optimize the process parameters of continuous biochar production system. The system was operated continuously and found that the machine components were worked properly, uniform and efficient heat transfer led to convert agro residue into good quality biochar as compared to conventional pyrolysis technologies. The optimized operating conditions for biochar production from cotton stalk were found to be 410 °C temperature, 6 min residence time and 8 mm particle size. The corresponding values of yield, volatile matter, ash content, fixed carbon, iodine value, pH, electrical conductivity and calorific value were found to be 35.74 %, 18.79 %, 10.65, 67.14 %, 329.42 mg/g, 10.14, 1.95 ds/m and 5115.17 kcal/kg, respectively. The net present worth of the developed machine biochar production from cotton stalk was found to be Rs. 8,44,776.79 for 10 years. The benefit-cost ratio was found to be 1.56 with a payback period of 3.76 months respectively. Thus the system was found economically feasible and can be integrated in present energy scenario for converting waste into wealth.

Key Words: Cotton stalk, Characterisation, Pyrolysis, Biochar, cost economics

INTRODUCTION

Agro residue, such as crop residues and agricultural by-products, often pose disposal challenges and environmental concerns. By utilizing these residues for biochar production, the study contributes to waste management efforts by converting agricultural waste into a valuable resource. Biochar has been shown to improve soil fertility, water retention, and nutrient availability. The study has the potential to enhance soil health and productivity, leading to increase crop yields and sustainable agricultural practices. Biochar is a stable form of carbon that can sequester carbon dioxide from the atmosphere for hundreds to thousands of years when applied to soil. The investigation contributes to climate change mitigation efforts by exploring a method for converting agro residue into biochar, thereby reducing greenhouse gas emissions and promoting carbon sequestration in agricultural soils. Continuous biochar reactors have an advantage to optimize process parameters and efficient energy utilization for biochar production as compared to traditional batch pyrolysis methods. By investigating the performance of a continuous reactor for biochar production, the study aims to enhance resource efficiency and reduce energy consumption in the production process. Sustainable agricultural practices are essential for maintaining food security and environmental stewardship. By exploring the feasibility of continuous biochar production from agro residue, the study contributes to the development of sustainable agricultural waste management practices that promote soil health, crop productivity and environmental sustainability. Biochar production has the potential to create economic opportunities for farmers, entrepreneurs, and rural communities. The investigation on continuous biochar production technologies assesses the economic viability and market potential of biochar as a value-added product, thus fostering economic development and livelihood improvement in agricultural regions. Research on continuous biochar reactors for biochar production contributes to scientific understanding and technological innovation in the field of biomass conversion and its utilization for energy generation. The study generates valuable insights into process optimization and product characterization, which would be beneficial for future research and development efforts in sustainable bioenergy development.

Overall, the investigation on development of continuous biochar reactor for biochar production

from cotton stalk agro residue is important for addressing region specific environmental, agricultural, and socioeconomic challenges.

METHODOLOGY

The present study was carried out at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the effect of process parameters on properties of cotton stalk biochar by continuous auger pyrolysis reactor using response surface methodology.

Collection and preparation of biomass

Cotton stalk (*Gossypium arboreum*) used in this study were obtained from Cotton Research Centre, Dr. PDKV, Akola, Maharashtra, India. The cotton stalk particle size was reduced to a 6, 8 and 10 mm by CS33 Electric motor Driven biomass shredder which have output 300kg/h and power is 3 HP Mesh sieve was used biomass shredder to ensure a particle size. The shredded cotton stalk was utilized as a feedstock for the production of cotton stalk biochar. The proximate analysis, bulk density and calorific values of cotton stalk were determined before the experimentation.

Characterization of cotton stalk and biochar

Characterization of a cotton stalk and cotton stalk biochar were done by using proximate analysis

Proximate analysis

The proximate composition of biomass includes moisture content, volatile matter, ash content and fixed carbon of the and were calculated by ASTM-D-3173-3175

Experimental setup

The experiment was conducted by using continuous auger pyrolysis reactor having 30 kg/h capacity with indirect heating method. The reactor was developed for the production of biochar from cotton stalk with different particle sizes and different temperature and residence time as shown in Fig. 1. The system consists of a hopper, horizontal screw reactor (auger), redler conveyor, heating coil, temperature measurement and control system, control panel, exhaust gas outlet, biochar outlet tray and main frame. The reactor consists of a screw auger of length 2.4 m for conveying the material from one end to the other. The auger is driven by electrical motor with speed control mechanism and enclosed with in a cylindrical chamber. The external electrical coils were fixed over the chamber. The speed of the auger controlled using variable frequency drive to set the desired rpm. The temperature is controlled by PID

based digital temperature controller. The reactor is split into three heating zones along the length of screw as T1, T2 and T3. Temperature sensors are provided with digital indicator for each zone. The middle temperature sensor indicated by T2 is

temperature controller sensor. The cotton stalk were fed into the reactor by redler conveyor and the biochar was collected through biochar outlet tray. The flue gases leave through the exhaust gas duct provided to the reactor.



Fig 1 Continuous auger pyrolysis biochar reactor system

Experimental design

A statistical analysis tool ‘Design of Experiment’ was used to examine the experimental data for the production of biochar. The independent and dependent variables were selected to analyse the experimental data shown in table 1. The response surface methodology with a Box Behnken Design

was used to assess the influence of parameters such as temperature, residence time, and particle size on yield, volatile matter, ash content, fixed carbon, iodine value and calorific value to identify the ideal process conditions. Table 1 listed the experimental range and level values for each variable used in this study.

Table 1 Experimental variables and the levels

Independent parameter					
S. N.	Variables	Units	levels		
			-1	0	1
1.	Temperature	°C	350	400	450
2.	Residence time	min	3	6	9
3.	Particle size	mm	6	8	10

Performance evaluation of biochar system

Evaluating the performance of a continuous biochar production system involves assessing various aspects related to the efficiency, quality of the process.

1 Mass Yield

The percentage of mass yield was calculated using the following eq 1

$$\text{Yield (\%)} = \frac{\text{Total mass of biochar produced (kg)}}{\text{mass of biomass as recieved (kg)}} \times 100 \dots(1)$$

2 Properties of Biochar

The biochar obtained from the continuous biochar reactor from the cotton stalk was grinded and sieved to less than 40 microns for the evaluation of physical and chemical properties. The performance and suitability of biochar for different plants and soils can be significantly influenced by its numerous physicochemical qualities, which include moisture content, volatile matter, ash content, pH, and electrical conductivity. Plant germination, plant growth, soil microbial community, soil fertility, and related nutrient turnover are all impacted by the characteristics of biochar when combined with soil.

Fixed carbon and calorific value calculations were made in order to assess the fuel's potential for use in the production of heat.

Techno economic analysis

The economic evolution of the developed continuous biochar reactor was carried out in terms of

net present worth, benefit cost ratio, internal rate of return, payback period [Pawar and Panwar 2020].

RESULT AND DISCUSSION

The cotton stalk, shredded cotton stalk and cotton stalk biochar are shown in fig 2 (a), (b) and (c), respectively.

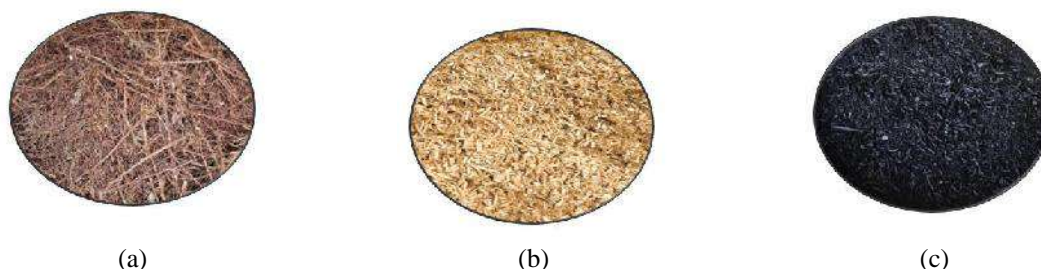


Fig. 2 (a) Cotton stalk, (b) shredded cotton stalk and (c) cotton stalk biochar

3.1 Physicochemical properties of cotton stalk

Performing a physicochemical analysis of cotton stalk before pyrolysis is essential to understand

its composition and characteristics, which helps to optimize the biochar production process for the desired outcome. The results of proximate are presented in Table 2.

Table 2 Physicochemical properties of cotton stalk

Parameter	Cotton stalk (This Study)	[Xiong et al., 2021]
Bulk density (kg/m ³)	215.80	-
Moisture Content (%)	7.56	4.66
Volatile Matter (%)	71.65	74.96
Ash Content (%)	4.32	2.59
Fixed Carbon (%)	16.03	17.8
Calorific Value (MJ/kg)	18.25	17.18

2 Performance evaluation of system

The effect of operating parameters viz., temperature (T), residence time (RT) and particle size

(PS) on properties of biochar were presented in this section. Here, the 17 experimental runs were conducted according to BBD RSM to study the effect of operating parameters as listed in Table 3.

Table 3 BBD run order of experiment design and experimental results

Run Sr. No.	Operating parameters			Responses							
	T (°C)	RT (min)	PS (mm)	Y (%)	VM (%)	AC (%)	FC (%)	IV (mg/g)	pH	EC (ds/m)	CV (kcal/kg)
1	450	6	6	38.50	18.60	15.16	61.82	394.4	11.1	3.2	4980.1
2	350	3	8	43.95	29.86	9.84	46.40	230.8	9.2	1.5	3960.3
3	400	3	10	42.35	24.68	11.12	56.22	300.4	10.3	2	4538.1
4	450	3	8	40.11	20.16	12.94	61.22	393.2	10.6	3	4930.6

5	400	9	10	40.12	21.56	12.98	60.84	398.5	11.3	2.5	5273.3
6	350	6	10	43.75	27.12	9.8	48.22	279.6	9.7	1.4	4090.1
7	350	6	6	42.50	28.65	10.16	50.65	200.1	9.6	1.9	4015.3
8	400	3	6	41.00	23.82	11.44	59.21	308.2	10.1	2.1	4800.4
9	400	6	8	35.72	18.98	11.96	64.60	368.6	10.7	1.9	5434.9
10	400	6	8	35.75	19.68	12.48	63.90	398.8	10.9	2.3	5340.2
11	400	6	8	35.80	19.62	12.88	66.14	384.2	11	2.1	5172.8
12	350	9	8	41.90	26.46	10.88	52.80	261.2	9.8	1.9	4320.6
13	450	9	8	37.50	17.31	17.44	62.18	482.2	11.7	3.6	5220.4
14	400	9	6	39.00	20.92	14.26	62.54	310.8	10.9	2.5	4902.1
15	450	6	10	39.41	19.62	14.24	62.12	430.2	11.5	3.4	5010.3
16	400	6	8	35.62	20.16	12.64	63.52	377.4	11.1	2	5089.4
17	400	6	8	35.68	19.86	13.14	64.94	372.6	10.8	2.2	5120.8

*T – temperature, (°C); PS – particle size (mm); RT – residence time, (min); Y - yield, (%); VM – volatile matter, (%); AC – ash content, (%); FC – Fixed carbon, (%); IV – iodine value, (mg/g); CV - calorific value (kcal/kg)

3 Modelling and statistical analysis

An analysis of variance for different biochar characteristics was shown in Table 4. The biochar properties has positive correlation with the regression model, as indicated by the low P-values and higher F-values. All models had acceptable differences

between the adjusted R^2 and anticipated R^2 , with the difference being less than 0.2. The link between process variables was depicted by the polynomial regression models in terms of the following factors are coded: where A, B, and C stood for temperature (°C), residence time (min) and particle size (mm), respectively.

Table 4 Analysis of variance (ANOVA) for various properties of biochar.

Source	Sum of Squares	df	Mean Square	F-value	p-value
Yield (Y)					
Model	140.17	9	15.57	1978.79	< 0.0001
A-Temperature	34.36	1	34.36	4365.81	< 0.0001
B-Residence Time	9.88	1	9.88	1255.16	< 0.0001
C-Particle Size	2.68	1	2.68	340.45	< 0.0001
AB	0.0784	1	0.0784	9.96	0.0160
A ²	32.70	1	32.70	4154.50	< 0.0001
B ²	23.54	1	23.54	2990.26	< 0.0001
C ²	27.15	1	27.15	3449.32	< 0.0001
Lack of Fit	0.0364	3	0.0121	2.59	0.1901
Volatile matter (VM)					
Model	232.67	9	25.85	122.50	< 0.0001
A-Temperature	165.62	1	165.62	784.78	< 0.0001
B-Residence Time	18.82	1	18.82	89.17	< 0.0001
AC	1.63	1	1.63	7.70	0.0275
A ²	21.70	1	21.70	102.81	< 0.0001
B ²	9.70	1	9.70	45.94	0.0003
C ²	10.35	1	10.35	49.02	0.0002
Lack of Fit	0.7229	3	0.2410	1.28	0.3955
Ash content (AC)					

Model	63.44	9	7.05	54.53	< 0.0001
A-Temperature	45.60	1	45.60	352.76	< 0.0001
B-Residence Time	13.06	1	13.06	101.00	< 0.0001
C-Particle Size	1.04	1	1.04	8.02	0.0253
AB	2.99	1	2.99	23.15	0.0019
Lack of Fit	0.1113	3	0.0371	0.1870	0.9001
Fixed carbon (FC)					
Model	595.42	9	66.16	90.82	< 0.0001
A-Temperature	303.44	1	303.44	416.58	< 0.0001
B-Residence Time	29.30	1	29.30	40.22	0.0004
C-Particle Size	5.81	1	5.81	7.98	0.0256
AB	7.40	1	7.40	10.16	0.0153
A ²	177.07	1	177.07	243.09	< 0.0001
B ²	26.00	1	26.00	35.70	0.0006
C ²	24.91	1	24.91	34.20	0.0006
Lack of Fit	0.9573	3	0.3191	0.3082	0.8195
Iodine value (I)					
Model	89370.52	9	9930.06	73.35	< 0.0001
A-Temperature	66302.61	1	66302.61	489.74	< 0.0001
B-Residence Time	6055.50	1	6055.50	44.73	0.0003
C-Particle Size	4762.88	1	4762.88	35.18	0.0006
AB	858.49	1	858.49	6.34	0.0399
BC	2280.06	1	2280.06	16.84	0.0046
A ²	1845.37	1	1845.37	13.63	0.0077
B ²	1294.64	1	1294.64	9.56	0.0175
C ²	4671.82	1	4671.82	34.51	0.0006
Lack of Fit	385.64	3	128.55	0.9148	0.5095
Ph					
Model	8.05	9	0.8941	61.06	< 0.0001
A-Temperature	5.45	1	5.45	371.85	< 0.0001
B-Residence Time	1.53	1	1.53	104.57	< 0.0001
C-Particle Size	0.1513	1	0.1513	10.33	0.0148
A ²	0.5921	1	0.5921	40.44	0.0004
B ²	0.1684	1	0.1684	11.50	0.0116
Lack of Fit	0.0025	3	0.0008	0.0333	0.9906
Electrical conductivity (EC)					
Model	6.36	9	0.7070	46.04	< 0.0001
A-Temperature	5.28	1	5.28	343.90	< 0.0001
B-Residence Time	0.4513	1	0.4513	29.38	0.0010
AC	0.1225	1	0.1225	7.98	0.0256
A ²	0.3789	1	0.3789	24.68	0.0016
Lack of Fit	0.0075	3	0.0025	0.1000	0.9559
Calorific value (CV)					
Model	3.534E+06	9	3.927E+05	29.41	< 0.0001
A-Temperature	1.763E+06	1	1.763E+06	132.00	< 0.0001
B-Residence Time	2.764E+05	1	2.764E+05	20.70	0.0026
BC	1.003E+05	1	1.003E+05	7.51	0.0289
A ²	1.007E+06	1	1.007E+06	75.43	< 0.0001
B ²	76237.45	1	76237.45	5.71	0.0482
C ²	2.012E+05	1	2.012E+05	15.07	0.0060
Lack of Fit	4391.43	3	1463.81	0.0657	0.9753

4 Effect of process parameters on biochar yield.

The effect of temperature and residence time on biochar yield is shown in Fig. 4(a). The biochar

output decreased by 35.62% when the temperature was raised from 350 to 450°C at various residence times, ranging from 3 to 9 minutes. The plot shows

that higher amounts of biochar were formed at low temperatures and short residence times. As the temperature of pyrolysis increased, the yield of biochar dropped (from 43.95 to 35.62%). It was also found that the yield of biochar decreased with increasing temperature. At 350°C, residence time of 3 minutes, and particle size of 8 mm, the highest biochar yield of 43.95% was achieved; at 400°C, residence time of 6 minutes, and particle size of 8 mm, the minimum biochar yield was also achieved. Due to the removal of low hydrocarbon in the gaseous form of higher volatility, the biochar yield decreased at high temperatures. According to Suliman et al. (2016), the temperature range at which the majority of the thermal breakdown of lignocellulosic materials takes place, from 349.85 to 499.85 °C, is where the biochar output dramatically dropped as the pyrolysis temperature climbed. revealed that while the yield of biochar improves with residence time, it decreases with temperature. The yield showed a significant 28% reduction from 300°C to 500°C, while a small decrement was noted for temperatures between 500°C and 700°C.

5 Effect of process parameters on volatile matter

Fig. 4(b) revealed the interaction between temperature and residence time on volatile matter. When the temperature increased from 350 to 450°C at different residence time from 3 to 9 min the volatile matter was decreased by 17.31 %. It was observed from the plot that high temperature and high residence time removed more volatile matter from the cotton stalk due to the thermochemical conversion which mostly degrades pyrolytic volatiles in the form of syngas. Volatile matter decreased with increasing pyrolysis temperature and residence time (from 29.86 to 17.44 %). It was observed that higher solid residence time caused a reduction in the volatile matter of the cotton stalk. The maximum volatile matter 29.86 % was obtained at temperature 350°C, residence time 3 minute and particle size 8 mm and minimum volatile matter 17.44% was obtained at temperature 450°C, residence time 9 minute and particle size 8 mm. The pyrolysis temperature increased, the volatile matter contents markedly decreased. According to Stefanko *et al.*, 2020 various pyrolysis conditions like temperature, residence time and particle size affected the structure of the biochar due to volatilization and formation of intermediate melts and relinquish of volatiles.

6 Effect of process parameters on ash content

Fig. 4(c) shows the combine effect of temperature and residence time on ash content. When the temperature increased from 350 to 450°C at different residence time from 3 to 9 min the ash content increased up to 17.44 %. It was observed from the plot that high temperature and high residence time produced more ash. Increasing pyrolysis temperature and residence time resulted in an increase in ash content from 9.8 to 17.44 %. Laghari et al., 2021 and Qin et al., 2021 reported biochar ash increase with rise in pyrolysis temperature. The maximum ash content 17.44 % was obtained at temperature 450°C, residence time 9 minute and particle size 8 mm and minimum ash content 9.8 % was obtained at temperature 350°C, residence time 6 minute and particle size 10 mm.

7. Effect of process parameters on fixed carbon

The interaction between temperature and residence time on the fixed carbon was shown in fig. 4(d). When the temperature increased from 350 to 450°C at different residence time from 3 to 9 min the fixed carbon was increased up to 66.14 %. It was observed from the plot that high temperature and high residence time gave more fixed carbon. The maximum fixed carbon 66.14% was obtained at temperature 400°C, residence time 6 minute, particle size 8 mm and minimum fixed carbon 46.40 % was obtained at temperature 350°C, residence time 3 minute and particle size 8 mm. Rubi et al., 2023 reported that fixed carbon only increased with temperature the increase in fixed carbon might be due to a decreased in volatile matter during pyrolysis, which results in more fixed carbon.

8 Effect of process parameters on Iodine value

The interaction between temperature and particle size on iodine value was shown in Fig. 4(e). It was observed that with increase in temperature from 350 to 450°C at different particle size from 6 to 10 mm, the iodine value was found to be increased up to 415.2 mg/g. It was observed from the plot that high temperature and high particle size gave high iodine value. The maximum iodine value 415.2 mg/g was obtained at temperature 450°C, residence time 9 minute and particle size 8 mm and minimum volatile matter 221.8 mg/g were obtained at temperature 350°C, residence time 3 minute and particle size 8 mm. A similar trend for increased iodine value of biochar at high – temperature was reported by Akila

et al., 2018 because at lower pyrolysis temperature, pore formation was lower due to incomplete removal of volatiles. As more volatiles were removed, surface turns to be porous so maximum iodine adsorption achieved at 450°C.

9 Effect of process parameters on pH

Fig. 4(f) expresses the interaction between temperature and residence time on pH of biochar. It was observed that the pH was strongly influenced by increasing temperature and found in the range of 9.2 to 11.6. When the temperature increased from 350 to 450°C at different residence time from 3 to 9 min the pH was increased up to 11.6. It can be observed from the plot that high temperature and high residence time gave high pH which might be due to further loss of alkali elements at a higher temperature. The maximum pH 11.6 was observed at temperature 450°C, residence time 9 minute and particle size 8 mm and minimum pH 9.2 was observed at temperature 350°C, residence time 3 minute and particle size 8 mm. Zhao et al., 2017 found generated biochar were generally alkaline (pH > 7) and the pH of biochar significant increased from 7.48 to 11.62 when the pyrolysis temperature increased from 300 to 500 °C, and then decreased to 10.60 in BC600.

10 Effect of process parameters on EC

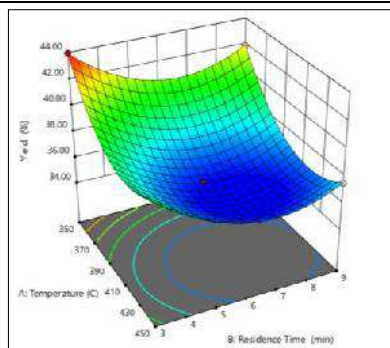
A study of the effect of temperature and residence time on the EC of biochar is presented in Fig. 4(g). The EC was also significantly impacted by rising temperatures. the temperature increased from 350°C to 450°C at different residence time from 3

min to 9 min the EC was found increased up to 3.3. The plot shows that higher EC associated with higher temperature and longer residence times. As the pyrolysis temperature and residence time increased from 1.4 to 3.3, the EC increased as well. At 450°C, the maximum EC of 3.3 was recorded, accompanied by a 9-minute residence time and an 8-mm particle size. Conversely, at 350°C, the minimum EC of 1.4 was recorded, accompanied by a 3-minute residence time and an 8-mm particle size. The possibility that the EC rose as the temperature rose is related to the volatiles in the biomass being lost during pyrolysis (Rehrah et al., 2014).

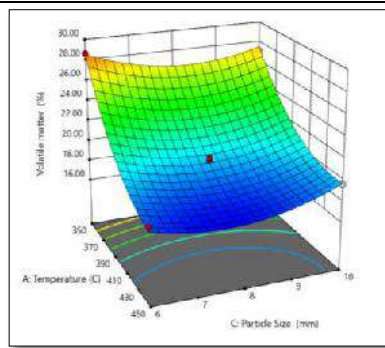
11 Effect of process parameters on calorific value

The effect of temperature and residence duration on calorific value is expressed in Fig. 4(h). The purpose of determining the calorific value was to evaluate the fuel's potential for use in the production of heat. It was found that the calorific value increased to 5243.96 kcal/kg when the temperature was raised from 350 to 450°C during a range of residence times, from 3 to 9 minutes. The plot shows that high temperatures and long residence times increased the calorific value of the biochar. The calorific value rose (from 46.40 to 66.14%) when the pyrolysis temperature and residence time increased. Similar conclusions were also found by Makavana et al., 2020. At 400°C, residence time of 6 minutes, and particle size of 8 mm, the maximum calorific value of 5243.96 kcal/kg was obtained. At 350°C, residence time of 3 minutes, and particle size of 8 mm, the minimum calorific value of 3960.31 kcal/kg was produced.

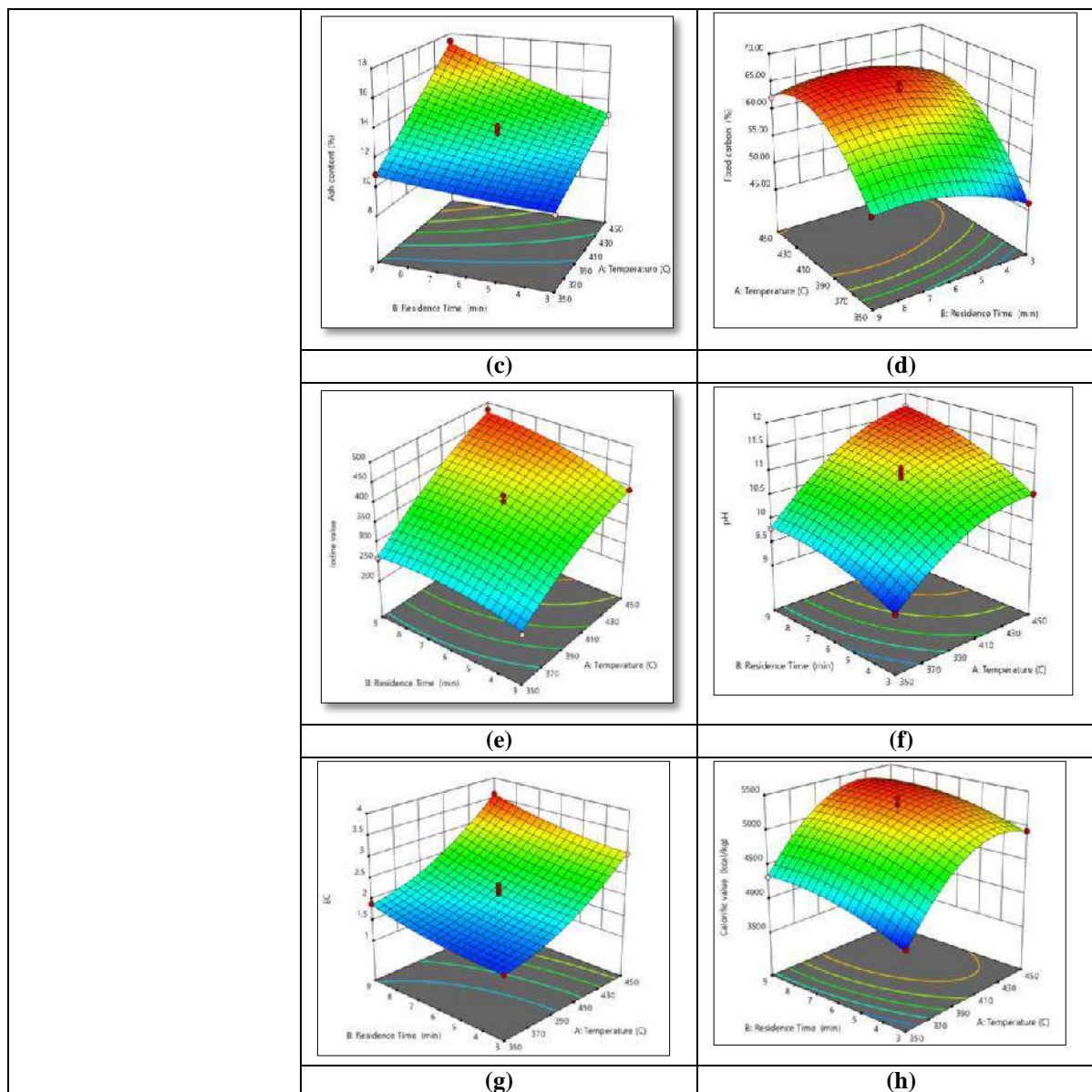
Fig 4 3-D surface response for (a) yield (b) volatile matter, (c) ash content (d) fixed carbon (e) iodine value (f) pH (g) EC (h) calorific value of biochar with the design factors temperature, residence time and particle size



(a)



(b)



12 Modelling and process optimization

The optimization of the process variable was done using the Design Expert software 11. By placing the process parameter values inside the experimental range based on the instantaneous combination of all response targets, mathematical optimisation was carried out. Table 6 listed the expected values and process parameter optimisation. For the high-quality biochar, the optimal combination of operating parameters was found to be 409.38°C, 5.43 min, and

7.86 mm for temperature, residence time, and particle size, respectively. The optimised results showed that under the ideal conditions, biochar of high quality may be produced. The biochar may be used for both soil application and the production of biochar pellets, which are then burned as fuel. Thus, it becomes advantageous to concentrate on the creation of a continuous biochar reactor system that, when operated under suggested conditions, produce high-quality biochar.

Table 6. Optimized variables and their predicted responses of the experiments.

Responses												
Sr. No.	Temperature (°C)	Residence Time (min)	Particle Size (mm)	Yield (%)	Volatile matter (%)	Ash content (%)	Fixed carbon (%)	Iodine value (mg/g)	pH	EC (ds/m)	Calorific value (kcal/kg)	Desirability
Optimize condition												
1.	409.38	5.43	7.86	35.69	19.21	12.82	65.19	324.60	10.72	2.074	5065.328	0.787
Experimental result												
2.	410	6	8	35.74	18.79	10.65	67.14	329.42	10.14	1.95	5115.17	

14 Techno Economic analysis

Including repair and maintenance, the total cost of a continuous biochar reactor system is Rs 1,10,000. This system operated eight hours a day, 300 days a year, with 10% of the total expenditure eight hours a day, 300 days a year, with 10% of the total expenditure going towards repairs and

maintenance. The net present worth of the developed machine biochar production from cotton stalk was found to be Rs. 8,44,776.79 for 10 years. The benefit-cost ratio was found to be 1.56 with a payback period of 3.76 months. The continuous biochar reactor system that has been developed is expected to last for ten years. Table 7 provides a summary of the entire investment and possibly feasible profit.

Table 7 Economics of continuous biochar production system

S.N	Particular	Cost (Rs.)
	1 HP motor with gearbox	15,000
	Belt conveyor	10,000
	Screw reactor	10,000
	Cyclone separator	5,000
	Hopper, biochar outlet tray, exhaust pipe, control panel box, main frame	11,000
	Energy meter	4,000
	Heating coil	8,000
	3 temperature Sensors	2,400
	Voltmeter	800
	Ammeter	800
	2 Temperature controller and display	6,000
	Variable frequency drive	8,000
	3 phase Indicators	5,000
	MCB	2,000
	Painting	5,000
	Fabrication cost	15,000
	Other wiring	2,000
	Total cost	1,10,000

CONCLUSION

The continuous biochar production system was developed and its performance was evaluated for production of biochar from locally available cotton stalk. The pyrolysis reactor was fabricated and comprised of electrical indirect heating system with screw auger, redler conveyor, cyclone separator, digital temperature indicator and controller. The study was further extended to examine the effect of parameters such as temperature, residence time and particle size on the different properties of biochar. The continuous biochar production system was evaluated at temperature 350, 400 and 450°C, residence time 3, 6 and 9 min, particle size 6, 8 and 10mm. Box Behnken model response-surface methodology was used to optimize continuous biochar production system parameters. The system operated for 08 hours per day for 300 days. Continuous biochar reactor continuously fed into the reactor. In this reactor the feedstock is evenly distributed and comes into contact with the heated walls of the reactor, leading to efficient heat transfer and uniform thermal processing and achieve high biochar yields which is significantly higher than some other conventional pyrolysis technologies. Overall, the continuous biochar reactor is a reliable and efficient technology that convert agro residues (cotton stalk) into biochar. Additionally, some important findings are concluded as follows:

- The maximum biochar yield from cotton stalk was recorded 43.95 % at the temperature 350 °C, residence time 3 min and particle size 8 mm and minimum 35.62 % at the temperature 400 °C, residence time 6 min and particle size 8 mm.
- In proximate analysis, the moisture content, volatile matter, ash content and fixed carbon in cotton stalk biochar was found to be 3.1 - 4.9, 17.31 - 29.86, 9.8-17.44 and 46.40 - 66.14%, respectively.
- The maximum iodine value of biochar from cotton stalk was recorded as 415.2 mg/g at the temperature 450 °C, residence time 9 min and particle size 8 mm and minimum 221.8 mg/g at temperature 350 °C, residence time 3 min and particle size 8 mm.
- The maximum calorific value of biochar from cotton stalk was recorded as 5234.96 kcal/kg at the temperature 400 °C, residence time 6 min and particle size 8 mm and minimum 3960.31 kcal/kg at temperature

350 °C, residence time 3 min and particle size 8 mm.

- The maximum pH value of biochar from cotton stalk was recorded 11.6 at the temperature 450 °C, residence time 9 min and particle size 8 mm and minimum 9.2 at temperature 350 °C, residence time 3 min and particle size 8 mm.
- The maximum EC value of biochar from cotton stalk was recorded 3.3 ds/m at the temperature 400 °C, residence time 6 min and particle size 8 mm and minimum 1.4 ds/m at temperature 350 °C, residence time 3 min and particle size 8 mm.
- The net present worth of the developed machine biochar production from cotton stalk was found to be Rs. 8,44,776.79for 10 years. The benefit-cost ratio was found to be 1.56with a payback period of 3.76 months.

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Dimension of Input Cost and Output Prices of Paddy in Andhra Pradesh

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ABSTRACT

Agricultural growth with stability has been a matter of concern in Andhra Pradesh. As paddy is the major crop growing in the state, the present study was therefore carried out with the objectives to examine the changes in cost and Prices, growth, trend, parity between cost and Prices, gap between FHP (Farm Harvest Prices) and MSP (Minimum Support Prices), impact of MSP on area, production and productivity of Paddy in Andhra Pradesh. The data of cost and Prices of Paddy were collected from the period 2000-01 to 2019-20 and analysed the temporal change, growth by using CGR (Compound Growth Rate), instability by using CV (Coefficient of Variation), trends by using linear and non-linear trend model, index number, effectiveness of the Prices policy during the harvest periods was examined by the deviations of FHP from MSP and classified into positive and negative deviations. These deviations calculated by using MAPD, MAND, AMPD and AMND formulas. To study the impact of lagged Minimum Support Prices (MSPs) on the acreage allocation, production and productivity, linear Regression equations have been fitted. The result shows that the temporal change of cost of Paddy crop increased subsequently over the period of time. This increase could due to increase in level of input use for Paddy is increases in Andhra Pradesh. The growth analysis revealed that the growth in various cost of Paddy are found positively significant at 5 per cent level for overall period. For FHP and MSP of Paddy crop are found positively significant at 5 per cent level for overall period. The Coefficient of variation for various cost and Prices was found to be high in the Period-I and low in the Period-II, on the whole, it was observed that the degree of stability is increasing for over the period. There was an increase in trend in cost and Prices of Paddy during overall period and among the competitive parametric models third degree model are found best fitted based on R² significance. The gap analysis in which deviations of FHPs from MSPs of Paddy crop results in maximum negative deviations (MSP ruled higher than FHP) in Andhra Pradesh. The result shows that previous year Prices influences current years' area, production and productivity of Andhra Pradesh.

Introduction

Rice (*Oryza Sativa*) is the second highest produced grain in the world after corn (maize). It is the most important grain with regard to human nutrition and calorific intake, providing more than one fifth of the calories consumed by worldwide by the human species. During the recent times, there has been a declining trend in rice production and productivity accompanied by a rapid fall in the area under cultivation of rice. This necessitates massive increases in productivity to commensurate with the population growth. India ranks second world-wide in the production of rice, only after China, with a share of 22% of the total world rice production. However, Indian productivity is lower than that of many other nations of the world.

Andhra Pradesh is an agriculturally developed state, with nearly 23.9% of the GSDP coming from the agriculture sector employing about

62.17% in this sector. The agricultural sector employs around 60% of the main work force of the state and 76% of the marginal work force, thus proving to be the largest employment generating sector. Nearly 45.24% (i.e. 45.63 lakh hectares) is under paddy cultivation in Andhra Pradesh. This contributes to 69.1% of the total food grains production of the state. The yield rate of paddy in Andhra Pradesh is higher than the average yield rate for India at 2178 kgs/hectare. Despite the advances in cultivation profile of the state, rice productivity is still significantly lower than Andhra Pradesh's productivity (4022 kgs/hectare).

Rice cultivation in the state is typically done under irrigated conditions. This is one of the prime reasons for higher productivity from the state. However, this has leads to problems of ground water exploitation and depletion of ground level reserves. A major source of irrigation other than wells and tube

wells is canal irrigation from the rivers of Krishna and Godavari. Andhra Pradesh enjoys a comparative advantage in rice production in relation to many other states in terms of availability of labour, geographical conditions and governmental support.

Rice is grown in almost all districts of Andhra Pradesh. However, the Krishna Godavari delta areas are the main 'rice bowl' areas of Andhra Pradesh. Andhra Pradesh has a pre-dominant rural economic structure. The agrarian relations that determine the structure of the agricultural economy of the state are complex and multi-layered. The dominant mode of production in the rural regions of Andhra Pradesh is however capitalist in nature. As a way out of the present agrarian crisis plaguing the cultivators of Andhra Pradesh, reforms and policy interventions that serve to increase yields and hence incomes are necessary. Increasing productivity is the only way to ensure vertical expansion of the farm sector.

Methodology

The data was used for study is entire based on secondary source from Agriculture statistics at a glance. The data was collected from various government publications, and websites. Data from the previous 20 years was collected for the study and analysis from 2000-01 to 2019-20. The entire data was split up into two periods and overall i.e. period I: 2000-01 to 2010-11, period II: 2011-12 to 2019-20 and Overall: 2000-01 to 2019-20.

The study was undertaken to study the temporal changes in input use, cost and return of paddy. To estimate growth rates of input utilization and costs of paddy. To examine parity between cost and prices. To work out the impact of prices on area, production and productivity.

Table; Linear and Non Linear Trend Model.

Model no.	Model	Name of model
1.	$Y_t=b_0+b_1t$	Linear equation
2.	$Y_t=b_0+b_1t+b_2t^2$	Second degree polynomial
3.	$Y_t=b_0+b_1t+b_2t^2+b_3t^3$	Third degree polynomial

5.An index number is a statistical measure design to show the changes in variables or group of related variables or group of related variables with respect to time.

The index number was calculated by choosing the 1st triennium average as a base year.

1.The growth rates were used to measure the past performance of the economic variable. The growth rates are used to examine cost and prices change over a period of time.

Growth rate was worked from using the following exponential function.

$$Y = a b^t$$

Where, Y= Cost/ Prices, T= time in years, b = regression coefficient, a = intercept

The compound growth rates 'r' was calculated by using the following formula

$$CGR(r) = [Antilog (\log b)-1] \times 100$$

Where, r = compound growth rates

2.To measure the instability in cost of cultivation and input utilization, an index of instability was used as measure of variability. The coefficient of variation (CV) will be calculated by the formula.

$$C.V. (\%) = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

3.The factors affecting the cost of cultivation of paddy crops from the last 20 years was determined the differentials in costs of cultivation and Input use of crops. The significance level of changes in cost will be tested by 't' test.

The effect of cost of cultivation were explained to a certain degree by multiple regression analysis.

4.The behaviour of cost and prices of paddy for major states was studied by analysing the trend in the cost and prices of paddy for major states was worked out by fitting linear, quadratic, 3rd degree polynomial equation.

$$\text{Index Number} = \frac{\text{Current Year Value}}{\text{Base Year Value}} \times 100$$

6.Factors affecting cost of cultivation was analysed by using multiple linear regression analysis. Multiple linear regression analysis is a statistical technique used to understand the relationship between multiple

independent variables and a dependent variable. In the context of calculating the cost of cultivation, it can be employed to predict the costs based on various factors that influence cultivation expenses. The equation for multiple linear regressions can be represented as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \epsilon$$

Where:

Y = the dependent variable (cost of cultivation).

β_0 = intercept or constant term.

$\beta_1, \beta_2, \dots, \beta_5$ = coefficients associated with independent variables

X_1, X_2, \dots, X_5

X_1 = Seed, X_2 = Fertilizer and Manure, X_3 = Human labour, X_4 = Animal labour

X_5 = Machin labour, X_6 = Plant protection, ϵ = error term, representing the unexplained variability in the model.

7. The study was based on the farm harvest Prices and minimum support Prices is of major crops in India. To study the parity between the cost and Prices, the tabular analysis was used. To study the effectiveness of the Prices policy during the harvest period of deviation of farm harvest Prices from the MSP was worked out and classified into the negative and positive deviation to examine whether the market Prices ruled higher or lower over the MSP. Hence the absolute positive deviation (APD) or absolute negative deviation (AND) and mean absolute positive derivation (MAPD) or mean absolute negative deviation (MAND) calculated. Also adjusted mean positive deviation (AMPD) and adjusted mean negative deviation (AMND) was worked out.

$$\text{MAPD or MAND} = 1/n \sum | \text{FHP}_i - \text{MSP}_i |$$

If, $\text{FHP} > \text{MSP}$ = Positive deviation (PD)

$\text{FHP} < \text{MSP}$ Negative deviation (ND)

Where,

MAPD = Mean absolute positive deviation,

MAND = Mean absolute negative deviation,

FHP = Farm harvest prices,

MSP = Minimum support prices, and

n = Frequency of positive or negative deviations.

These deviations were adjusted with MSP in order to examine the degree of their deviation from the MSP. The formulae used for the adjusted mean negative/positive deviation was as follows:

$$\text{AMPD or AMND} = 1/n \sum (\text{FHP}_i - \text{MSP}_i) / \text{MSP}_i * 100$$

Where,

AMPD = Adjusted mean positive deviation, and

AMND = Adjusted mean negative deviation

The significance of gap between FHP and MSP of paddy for major states was tested by two sample t-test.

$$t = \frac{(x - y) - (u_x - u_y)}{\sqrt{\frac{1}{n_x} + \frac{1}{n_y}}}$$

Where, x = mean of FHP of size n_x , y = mean of MSP of size n_y , Sp^2 = pooled variance

$$Sp^2 = \frac{(n_x - 1)S_x^2}{(n_x - 1) + (n_y - 1)}$$

To study the impact of lagged minimum support Prices on the area, production and productivity of the paddy. Linear form of equation was used. The previous year MSP generally influence the producer farmer decision on a carrier location for the current year the linear.

1. Linear regression equation:

a. $A_t = a + b Pr_{t-1}$

b. $P_t = a + b Pr_{t-1}$

c. $Y_t = a + b Pr_{t-1}$

2. Logarithmic regression equation:

a. $\text{Log. } A_t = \log a + b Pr_{t-1}$

b. $\text{Log. } P_t = \log a + b Pr_{t-1}$

c. $\text{Log. } Y_t = \log a + b Pr_{t-1}$

Where,

A_t = Area of paddy crop at (t^{th}) period,

P_t = Production of paddy crop at (t^{th}) period,

Y_t = Productivity of paddy crop at (t^{th}) period,

Pr_{t-1} = Minimum Support Prices of major crops taken in per quintal at

($t - 1^{th}$) period.

1.3 Result and Discussion

1.3.1 Temporal changes in input use, cost and returns of paddy.

The Temporal changes in cost and Prices crop have been examined as a whole for Paddy. The temporal changes in cost and Prices were estimated form the period 2000-01 to 2019-20.

The temporal changes in cost of paddy in Andhra Pradesh was presented in Table 1 shows the changes in the cost cultivation of Paddy in Andhra Pradesh. The total cost of Paddy has gone up from Rs. 46130.33 per hectare in 2000-01, Rs.73574.3 per hectare in 2010-11 to Rs.137239.4 per hectare in 2019-20 depicting an increase 159.49 per cent and 297.50 per cent during a period of study. The increase has occurred in Paddy of cost like hired human labour, family labour, bullock labour, machine labour, seed, fertilizer, farm yard manure, insecticide, rental value of owned land and interest on working capital, costs of interest on fixed capital

and depreciation cost. The cost of human labour, family labour, machine labour, seeds, fertilizer, and insecticide has increased at a faster rate. Among total hired human labour (213.73 per cent) in 2010-11 and (333.99 per cent) in 2019-20 recorded the maximum share followed total family labour (174.95 per cent) in 2010-11 and (210.32 percent) in 2019-20 followed by machine labour (368.13 per cent) in 2010-11 and (889.35 percent) in 2019-20 in the increase in cost of cultivation over time. Out of the total increase of 159.49 per cent and 297.50 per cent in the total cost of cultivation in 2010-11 and 2019-20 respectively. The items contributed about 192.50 per cent and 350.48 per cent and the remaining 133.51 per cent and 255.66 per cent by fixed cost items in 2010-11 and 2019-20 respectively.

Table 1: Temporal changes in cost of Paddy in Andhra Pradesh

Particulars	Rs/ha			Percent charges over Base period i.e. 2000-01	
	2000-01	2010-11	2019-20	2010-11	2019-20
Hired human labour	8974.88	19182.17	29974.86	213.73	333.99
Total family labour	3148.3	5507.86	6621.56	174.95	210.32
Bollock labour	585.26	635.2	786.67	108.53	134.41
Machine labour	1553.31	5718.17	13814.36	368.13	889.35
Seed	804.19	1608.79	2214.16	200.05	275.33
Fertilizer	2243.07	3168.88	8557.19	141.27	381.49
Manures	585.06	281.52	2227.44	48.12	380.72
Irrigation charges	790.51	1567.4	4277.71	198.28	541.13
Insecticides	1206.94	585.89	1003.55	48.54	83.15
Interest on working capital	424.98	853.91	1767.48	200.93	415.90
Cost A	20316.5	39109.79	71244.98	192.50	350.68
Fixed costs	9003.9	17818.5	35157.95	197.90	390.47
Rental value	7934.26	15129.43	29423.48	190.68	370.84
Interest on fixed capital	745.17	1285.13	1271.43	172.46	170.62
Depreciation	196.24	229.58	141.6	116.99	72.16
Land revenue	7934.26	1.87	-	0.02	-
Cost B	25813.83	34464.51	65994.46	133.51	255.66
Cost C	46130.33	73574.3	137239.4	159.49	297.50

The increase in insecticide and fertilizer charges has been to the tune of 198.28 per cent, 541.13 per cent and 141.27 per cent, 381.49 per cent in 2010-11 and 2019-20 respectively, of the total increase in cost of cultivation. The percent changes over inputs in the cost of cultivation of Paddy at two points of time are also given in Table 4.3 the per cent changeover has remained around per cent in 2010-11, which was lower than that in 2019-20. Within the operational cost, the percent changeover of machine labour in the total cost increased from 368.13 per cent in 2010-11 to 889.35 per cent in 2019-20 and the percent changeover of bullock labour in the total cost increase from 108.53 per cent in 2010-11 to 134.41 per cent in 2019-20. The decrease in the percent changeover of bullock labour is on account of substitution by machine labour. The percent changeover of fertilizer in the total cost increase from 141.27 per cent in 2010-11 to 381.49 per cent in 2019-20, for Paddy.

The extent of change in physical inputs and their prices along with changes in physical output and their prices and gross return for Paddy over time is given in Table 2 It is remarkable

to note that the physical quantity of bullock labour, seed and manure has come down for Paddy due to increase in the wage rate of bullock labour and prices of manure, seed. Only physical quantity of fertilizer is increase and decrease in human labour due to increase in price of fertilizer and demand for human labour. The gross return for Paddy has recorded a 204.88 per cent in 2010-11 and 423.70 per cent in 2019-20 during the period study.

The increase in gross return from Paddy is attributable to the increase in the main and by-product of Paddy as well as increase in their prices over the years. It worth mentioning that the rate of increase in the prices of main product and by-product of Paddy has much higher compared to the increase in the physical yield of main product and by-product. The cost of production of Paddy has increased from 2000-01, 2010-11 and 2019-20 i.e. 496.59 Rs per quintal 916.98 Rs per quintal 1483.62 Rs per quintal respectively. While the cost of production has recorded 184.66 per cent and 298.76 per cent in 2010-11 and 2019-20 during the period being study.

Table 2 The extent of changes in physical inputs, input Prices, physical output, output Prices and gross return for paddy in Andhra Pradesh

S.N	Particular	2000-01	2010-11	2019-20	Percent charges over Base period i.e. 2000-01	
					2010-11	2019-20
A	Quantity of input					
1	Seed (Kg/Ha)	86.16	78.54	59.65	91.16	69.23
2	Fertilizer (Kg/Ha)	189.46	226.15	277.24	119.37	146.33
3	Manure (Qtl/Ha)	25.94	8.05	26.25	31.03	101.20
4	Human labour (hrs/ha)	1014.21	735.64	464.51	72.53	45.80
5	Bullock labour (hrs/ha)	39.43	14.25	4.58	36.14	11.62
B	Prices of input					
1	Seed (Rs/Ha)	9.33	18.89	37.12	202.47	397.86
2	Fertilizer (Rs/Ha)	11.84	14.01	30.87	118.33	260.73
3	Manure (Rs/Ha)	22.56	34.98	83.87	155.05	371.76
4	Human labour (Rs/ha)	8.85	26.08	64.53	294.69	729.15
5	Bullock labour (Rs/ha)	14.84	44.59	171.67	300.47	1156.81
C	Yield (Qtl/Ha)					
1	Main Product	49.00	52.60	63.71	107.35	130.02
2	By- product	3.40	3.57	3.64	105.13	107.21
D	Prices of output (Rs/Qtl)					
1	Main Product	511.42	977.38	1685.76	191.11	329.62
2	By- product	35.44	66.33	96.33	187.17	271.80
E	Value of output (Rs/Ha)					
1	Main Product	25059.70	51410.01	107399.70	205.15	428.58
2	By- product	1736.61	3489.22	6137.04	200.92	353.39
3	Gross Return	26796.31	54899.23	113536.74	204.88	423.70
F	Cost of production (Rs/Qtl)	496.59	916.98	1483.62	184.66	298.76

Temporal changes in Farm Harvest Prices of paddy

The results shown in Table 3 shows the changes in farm harvest Prices of paddy in Andhra Pradesh. The increase has occurred form the year

2000-01 to 2019-20. Andhra Pradesh and MSP shows 345.6 per cent ,190.74 per cent change during 2019-20 over 2000-01 respectively. Andhra Pradesh shows the positive increase in farm harvest Prices of paddy.

Table 3 Changes in Farm Harvest Prices of paddy in Andhra Pradesh

S.N.	STATES	2000-01	2019-20	% change during 2019-20 over 2000-01
1	Andhra Pradesh	500	1728	345.6
2	Minimum Support Prices	540	1030	190.74

1.3.2 Growth rates of cost and Prices of paddy in Andhra Pradesh

The rate of change in terms of various Costs of paddy in Andhra Pradesh expressed in terms

of compound growth rates estimated through exponential function were presented in Table 4

Table 4 Compound growth rate of cost of paddy in Andhra Pradesh

S.N.	Particular	Period I	Period II	Overall
		2000-01 to 2010-11	2011-12 to 2019-20	2000-01 to 2019-20
1	Cost -A	6.92*	7.22*	8.51*
2	Cost -B	7.73*	7.28*	8.45*
3	Cost -C	7.39*	6.82*	8.32*
4	Cost of production	6.00*	4.62*	6.97*

Note: *= Significance at 5 per cent level

During the first period 2000-01 to 2010-11 (Period-I) the estimated compound growth rates were found to be significant for all the cost of Paddy is found to be satisfactory. Cost of production shows the positive and significant growth rate at 5 per cent level.

During the 2011-12 to 2019-20 (Period-II) all the costs of Paddy show positive and significant growth rates at 5 per cent level. Cost of production shows the positive and significant growth rate at 5 per cent level.

In the overall period, all the costs of Paddy showed positive and significant growth rates at 5 per cent level. In general, it can be concluded that there was positive and significant growth rate during the period of study.

Instability of cost of paddy in Andhra Pradesh

As seen from Table 5, that coefficient of variation of Cost-B for Paddy in Andhra Pradesh was highest during overall period by 70.19 per cent. For period-I the coefficient of variation is highest for Cost-B i.e. 180.96 per cent. And for period-II it is highest for cost of productivity i.e. 324.89 per cent.

Table 5 Instability for cost of paddy in Andhra Pradesh

S.N	Particular	Coefficient of variation (CV)(%)		
		Period-I	Period-II	Overall
1	Cost -A	170.10	193.66	70.23
2	Cost-B	180.96	191.20	70.91
3	Cost-C	178.71	192.30	70.41
4	Cost of production	109.34	324.89	60.32

Trends in cost and Prices of paddy in India

The trend equations were fitted to assess the cost and Prices of paddy crops in India. Depending upon its better fit, was analysed by the

production model viz, linear, second degree and third degree polynomial equation trends results are assessed and presented under cost and Prices of selected crops.

Table 6 Trend in cost of paddy in Andhra Pradesh

S.N.	Particulars	Model	R^2	Coefficient			
				b_0	b_1	b_2	b_3
1	Cost A	Third Degree Polynomial	0.98	15672.5	-6.93	303.46	-1321.63
2	Cost B	Third Degree Polynomial	0.99	25585.02	-12.43	512.44	-2040.23
3	Cost C	Third Degree Polynomial	0.99	30543.17	-19.01	715.96	-3414.03
4	Cost of production	Third Degree Polynomial	0.98	599.89	-0.44	14.72	-78.43

For trend analysis of Cost-A of paddy (Table 1.6), maximum value of R^2 is 0.98 third degree polynomial trend is best fitted. In trend analysis of Cost-B, maximum value of R^2 i.e. 0.99 is best fitted for third degree polynomial trend. In trend analysis of Cost-C, maximum value of R^2 i.e. 0.99 is best suited for third degree polynomial trend. For trend analysis of cost of production, maximum value of R^2 i.e. 0.98 is for third degree polynomial trend which is best suited.

Index number

An index number is a statistical measure design to show the changes in variable or group of related variables with respect to time. The index numbers were worked out for the cost and Prices of paddy crop. The basic object of estimating

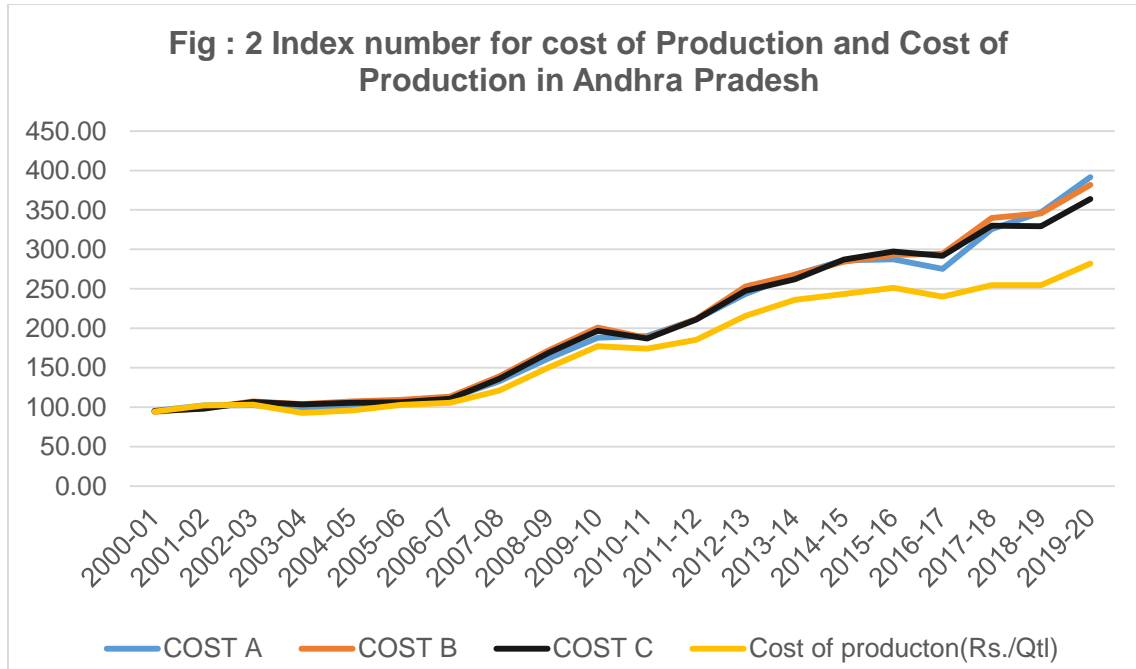
index numbers was to make the trends in cost and Prices of selected crops. For this analysis the data pertaining to the year 2000-01 to 2019-20 i.e. last 20-year data were used. The results are presented in following tables.

In table 7 indicate that the highest increase in index number of Cost-A was (391.47) in the year 2019-20 and with lowest (95.34) in the year 2000-01. Index number for Cost-B was recorded highest (381.60) among all the cost from 2019-20 and with lowest (94.00) in year 2000-01. For Cost-C index number was (363.89) the highest value in 2019-20 and with lowest (95.15) in the year 2000-01. Cost of production has the highest index number of in 2019-20 (281.94) and lowest (92.90) in year 2003-04.

Table 7 Index number for cost of paddy in Andhra Pradesh

(First triennium average as a base year)

YEAR	COST A	COST B	COST C	Cost of production
2000-01	95.34	94.00	95.15	94.37
2001-02	102.20	98.76	98.30	102.31
2002-03	102.46	107.24	106.55	103.32
2003-04	98.65	103.91	103.72	92.90
2004-05	100.88	107.42	105.62	95.73
2005-06	106.80	109.35	106.35	102.80
2006-07	111.26	113.40	110.84	105.77
2007-08	133.01	139.05	136.11	121.35
2008-09	161.79	172.00	168.85	150.11
2009-10	188.01	200.95	197.03	177.18
2010-11	190.22	187.76	187.22	174.26
2011-12	211.45	211.91	210.93	185.54
2012-13	243.37	253.06	247.72	215.69
2013-14	267.97	267.82	262.04	236.13
2014-15	286.26	284.47	287.05	243.66
2015-16	287.50	292.93	297.38	251.14
2016-17	275.46	294.65	291.90	240.27
2017-18	325.73	339.73	330.14	254.65
2018-19	346.95	345.61	329.23	254.63
2019-20	391.47	381.60	363.89	281.94



Factors affecting cost of cultivation of paddy in Andhra Pradesh

The multiple linear regressions were carried out between the independent variables and dependent variable. The independent variables that

represent seeds, fertilizer and manure, human labour and bullock labour, machine labour and plant protection while dependent variable represent cost of cultivation of paddy in Andhra Pradesh for overall period (2000-01 to 2019-20).

Table 8 Factors affecting cost of cultivation of paddy in Andhra Pradesh

S.r. no	Variables	Coefficients	Standard Error	t Stat
1	Intercept	-1664.55	5190.45	-0.32
2	X ₁ (Seed)	1.60	0.41	3.88
3	X ₂ (Fertilizer & Manure)	4.50	3.94	1.14
4	X ₃ (Human Labour)	1.05**	1.43	0.73
5	X ₄ (Bullock Labour)	1.11	1.25	0.89
6	X ₅ (Machine Labour)	5.26	3.04	1.73
7	X ₆ (Plant protection)	2.42	1.83	1.32
8	R²	0.99		
9	F	245.14		

Note: **Significant at 5% level

Table 8 shows that the coefficient of determination (R²) is used to measure how much the ability of the independent variable in explaining the bound variation. The coefficient of determination (R²) obtained was 0.99. This means that 99 per cent variation explained by the studied independent variable while the remaining 1 per cent is influenced by other variable. Human labour value was significant at 5 per cent level.

Parity between cost and Prices

In this objective the gap between Minimum Support Prices (MSP) and cost of production of major crops and gap between the Farm Harvest Prices (FHP) and Minimum Support Prices (MSP) of paddy crop from 2000-01 to 2019-20 was studied.

Gap between Minimum Support Prices and Cost of cultivation of paddy in Andhra Pradesh

The gap between Minimum Support Prices and cost of cultivation of paddy in Andhra Pradesh is presented in the Table 9. The gap is calculated for the study period i.e. 2000-01 to 2019-

20. The results revealed that the gap between MSP and cost of cultivation in Andhra Pradesh recorded which ranged from 16.29 Rs/Qt to 430.09 Rs/Qt.

Table 9 Gap between Minimum Support Prices and cost of production of Paddy in Andhra Pradesh

YEAR	MSP	Cost of production	Gap
2000-01	540	496.59	43.41
2001-02	560	538.35	21.65
2002-03	560	543.71	16.29
2003-04	580	488.83	91.17
2004-05	590	503.73	86.27
2005-06	590	540.96	49.04
2006-07	610	556.6	53.4
2007-08	675	638.56	36.44
2008-09	880	789.9	90.1
2009-10	1030	932.35	97.65
2010-11	1030	916.98	113.02
2011-12	1110	976.36	133.64
2012-13	1280	1135.01	144.99
2013-14	1345	1242.54	102.46
2014-15	1400	1282.17	117.83
2015-16	1450	1321.55	128.45
2016-17	1510	1264.33	245.67
2017-18	1590	1340.01	249.99
2018-19	1770	1339.91	430.09
2019-20	1835	1483.62	351.38

Gap between Farm Harvest Prices and Minimum Support Prices of paddy in India

The gap between Farm Harvest Prices and Minimum Support Prices of paddy in Andhra

Pradesh markets of are presented in the Table 10 results revealed that the average gap between FHP and MSP of paddy in Andhra Pradesh recorded was -42.15 Rs./Qt.

Table 10 Gap between Farm Harvest Prices and Minimum Support Prices of Paddy in Andhra Pradesh

FHP	MSP	Gap (MSP-FHP)
1088.90	1046.75	-42.15

Deviations of FHPs from MSPs of paddy in Andhra Pradesh

To examine the effectiveness of MSP policy for paddy in Andhra Pradesh, difference between its FHP and MSP was calculated in different years and is given in Table 11 Andhra Pradesh experienced

positive deviations 13, times in 20 years during 2000-01 to 2019-20. This means that the average FHP was ruled higher than MSP in 13 times out of 20 years. The adjusted difference (positive) between MSP and FHP was low as 65 per cent of MSP and the negative difference was 35 per cent.

Table 11 Deviations of FHPs from MSPs of paddy in Andhra Pradesh

POSITIVE DEVIATION				
Frequency	MAPD	Range	AMPD	Per cent
13	87.69	3-180	9.19	65
NEGATIVE DEVIATION				
Frequency	MAND	Range	AMND	Per cent
7	-42.43	(-6)-(107)	-3.67	35

Impact of MSP on Area, production and productivity of Paddy on Andhra Pradesh

The numerical values of the linear lag function for paddy indicates that R² is significant at 1 per cent level and supports the results that variation in Area of paddy is explained by the explanatory variable, i.e. previous year's minimum support Prices of the Paddy. Table no 12 revealed that 22 per cent variation in area, 1 per cent variation in production,

38 per cent variation in productivity of Andhra Pradesh is explained by independent variable i.e. lagged MSP.

The elasticity for these variables is significant at 1 per cent level in case of area, production and productivity found as -0.45 per cent, 0.35 per cent, 0.71 per cent respectively indicating thereby that previous year Prices influences current year's area production and productivity of major growing State Andhra Pradesh.

Table 12 Impact of MSP on Area, production and productivity of Paddy on Andhra Pradesh

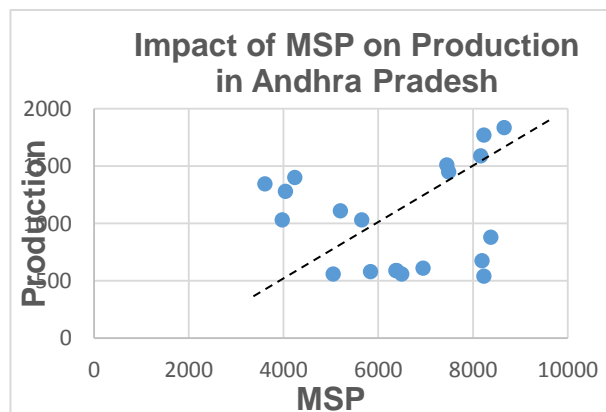
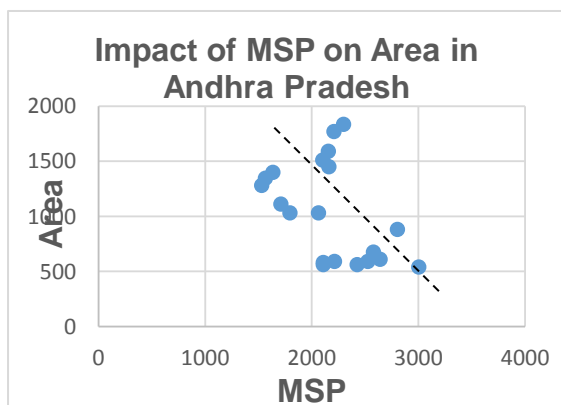
S.N.	Variables	R ²	S.E. of R	Linear regression equation
1	Area	0.22	367.49	$A_t = 2627.85 + (-0.45)Pr_{t-1}$
2	Production	0.01	1703.49	$P_t = 6085.58 + (0.35)Pr_{t-1}$
3	Productivity	0.38	399.35	$Y_t = 2227.32 + (0.71)Pr_{t-1}$

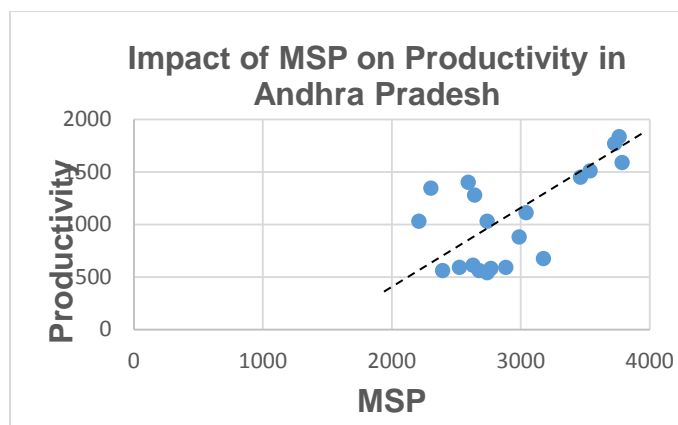
A_t = Area of paddy crop at (t^{th}) period,

P_t = Production of paddy crop at (t^{th}) period,

Y_t = Area of paddy crop at (t^{th}) period,

Pr_{t-1} = MSP of paddy taken in Per quantal at ($t - 1^{th}$) period





Conclusions

The study of temporal changes, growth rate and trend enable one to indicate the general direction of change in Prices in different markets. To study the effectiveness of the Prices policy during the harvest periods, the deviations of farm harvest Prices (FHP) from the Minimum Support Prices (MSP) were worked out and divided into positive and negative deviations to examine whether market Prices ruled higher or lower than the minimum support Prices. The negative deviations reflected ineffectiveness of MSP policy for producers. These deviations were adjusted with MSP in order to examine the degree of their departure from the minimum support Prices. By using linear and logarithmic regression equations we examined the impact of previous year Minimum Support on farmer decision on acreage allocation, production, productivity for the current year.

The total cost of Paddy in Andhra Pradesh has gone up from 46130.33 per hectare in 2000-01 to 73574.3 per hectare in 2010-11 and 137239.4 per hectare in 2019-20 depicting an increase during a period of study. The increase has occurred in all major items of cost total machine labour 368.13 per cent and 889.35 per cent recorded the maximum share during percent change over in 2010-11 to 2019-20 respectively. The gross return for Paddy has recorded 204.88 per cent and 423.70 per cent form 2010-11 to 2019-20 respectively during the period study.

The compound growth rates of various cost revealed that, during overall period growth rates of cost were increasing significantly at 5 per cent level of significance. Among the cost the growth rate for Cost-A found highest increased significantly by 8.51 per cent during the study period followed by Cost-B, Cost-C and Cost of production has found increased

significantly by 8.45 per cent, 8.32 per cent and 6.97 per cent resp. during the study period.

Trend analysis of cost of paddy and Prices i.e. MSP and FHP for the overall period showed that, a wide range of models has been explored, among the competitive models the best fitted models are selected based on the R^2 significance. Among the competitive parametric models, almost all cases Third Degree Polynomial models are found best fitted; thereby indicating that the movement of all the series was uniform throughout the India. The gap between MSP and cost of production of Paddy in Andhra Pradesh recorded which ranged from -16.29 to 430.09 Rs/Qt. The highest gap was registered in year 2018-19 (430.09 Rs/Qt).

Average gap between FHP and MSP of paddy highest gap was registered in Andhra Pradesh State (-42.15 Rs/Qt). The impact of MSP shown by linear regression equation analysis. The State wise impact of MSP on the areas, production and productivity of paddy is explained by the explanatory variable, i.e., previous year's Minimum Support Prices of the paddy. The result revealed that 22 per cent, 1 per cent and 38 per cent respectively, variation in Andhra Pradesh state, Value of elasticity has found as -0.33, 1.90 and 0.72 respectively for area, production and productivity. The gap analysis in which deviations of FHPs from MSPs of Paddy crop results in maximum negative deviations (MSP ruled higher than FHP) in Andhra Pradesh.

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