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Dr. Panjabrao Deshmukh Krishi Vidyapeeth
Akola - 444 104 (Maharashtra)
Email: secretarymsae@gmail.com www.msaeindia.in

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Correspondence address :

Department of Agricultural Economics & Statistics

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

444 104 (Maharashtra) India.
www.msaeindia.in
Email : secretarymsae@gmail.com

CONTENT

Price Behaviour of Pigeon Pea in Major Markets of Maharashtra

Manjanagouda. I. Patil[1], Sachin. S. More[2] and Vasant. G. Jadhav[3]

1. M.Sc. (Agri) student, Department of Agricultural Economics, College of Agriculture, VNMKV, Parbhani, 431402, India Phone no : 9380196920
2. HEAD, Department of Agricultural Economics, College of Agriculture, VNMKV, Parbhani, 431402 (MS.) India sachinmorehope@gmail.com
3. PhD research scholar, Department of Agricultural Economics, College of Agriculture, VNMKV, Parbhani, 431402, India. agriculturaleconomist94@gmail.com

*Correspondence: Patilmanjanagouda2000@gmail.com
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ABSTRACT

India is the largest pulse-producing country in the world. In India major pigeon pea- cultivated states are Maharashtra, Karnataka, Telangana, Andra Pradesh, Uttar Pradesh, and Gujarat. In that Maharashtra rank first in pigeon pea production at national level. The present study aimed to know growth performance and price volatility of Pigeon pea prices in major markets of Maharashtra. For study purpose the monthly time series data of the pigeon pea crop of Nanded, Yavatmal, Latur, Amaravati, and Buldhana APMC markets were collected from official records for last thirteen years i.e. 2011 to 2023. The Growth Rate data analyzed with the help of Compound Annual Growth Rate (CAGR) Revealed that the prices of pigeon peas have increased at positive rates in all the market that was the subject of the investigation. The markets viz; Nanded, Yavatmal, Latur, Amaravati, and Buldhana had compound growth rates of 0.45, 0.46, 0.39, 0.51, and 0.69 respectively. The Buldhana APMC market had the highest growth rate, measuring 0.69 percent, while the Latur APMC market had the lowest growth rate, measuring 0.39 percent. The price volatility analysed using ARCH-GARCH model revealed that among the selected markets, the sum of Alpha and Beta is nearer to 1 i.e. 0.95, 1.1, 0.98, 0.99, 0.91 for Nanded, Yavatmal, Latur, Amaravati, and Buldhana respectively, indicated that the volatility shocks in the prices of Pigeon pea are quite persistent for a long time in these markets.

Keywords: *Pigeon pea, Growth, volatility, CAGR, ARCH-GARCH model.*

INTRODUCTION

In India, major pulses like chickpea, pigeon pea, green gram, black gram, lentils, and peas are typically grown under rainfed conditions, making them ideal for areas where water- intensive crops are not prioritized. but this study focuses on pigeon pea as it is the second most important pulse in Maharashtra, after chickpea, and holds significant economic value for farmers. Pigeon pea, a major pulse crop native to India, is now widely grown in tropical and subtropical regions around the world. With approximately 22% protein, three times more than cereals, it is a nutritious and affordable staple, widely consumed as "Dal" by vegetarians.

The global pulse production stands at approximately 973.92 lakh tonnes, with India leading in both area and production.(FAOSTAT, 2022). India contributes 361.11 lakh hectares of cultivated land and produces 276.69 lakh tonnes of pulses annually. The top five pulse- producing states in India are Rajasthan, Madhya Pradesh, Maharashtra, Uttar Pradesh, and Karnataka. (Anonymous 2022)

The major pigeon pea producing countries in the world include India, Malawi, Myanmar, Tanzania, and Kenya. Global pigeon pea production stands at approximately 53.27 lakh tonnes, with India being the dominant producer. India together with Malawi and Myanmar are some of the major leading countries producing 7.74 lakh tonnes of pigeon pea globally. In India, during 2021-2022, area of pigeon pea cultivation was 49.00 lakh ha. with production of 42.20 lakh tonnes (FAOSTAT, 2022). The area and production of Pigeon pea in Maharashtra during 2021-22 was 1335.10 thousand ha. with an annual

production of 1391.17 thousand tonnes (INDIASTAT, 2021-22).

Objectives:

1. To study Growth rate of Pigeon pea prices in major markets of Maharashtra
2. To study Volatility in prices of Pigeon pea in major markets of Maharashtra

METHODOLOGY

The study area

For study purpose the major pigeon pea markets from the Maharashtra State were selected viz., Latur, Nanded, Buldhana, Amaravati, and Yavatmal.

Data

As per the records available, the time series data on monthly average prices of pigeon pea for the period from 2011 to 2023 was collected from the Agmarknet website.

Analytical tools :

Growth Rate

The growth rates were calculated by fitting non-linear models, particularly the exponential model, which is frequently applied in econometric analysis. Typically, compound growth rates are derived by transforming the growth model into its semi-logarithmic form and estimating it using the Ordinary Least Squares (OLS) method, assuming a multiplicative error term.

$$Yt = b0 * b1^{t} * et \quad [1]$$

$$ln\ (Yt) = b0 + t * ln\ b1 + et \quad [2]$$

Where,

***ln* (Yt)** is the natural logarithm of time series data for arrivals / prices for year t,

'b0' is the constant term,

't' is the time trend for years of interest,

'et' is the error term and

'b1' is the growth rate for the period under consideration (i.e. slope coefficient).

Then, Compound growth rate was calculated using following equation

Compound Growth Rate = [(Antilog b1)-1]*100

However, there are several problems associated with this methodology including the difficulty in estimating standard error of estimates of original parameters (Prajneshu & Chandran, 2005). Hence, a non-linear estimation technique for solving the exponential model assuming additive error terms was used to estimate the compound growth rates.

$$Yt = constant * (1+CGR)^{t} + et \quad [3]$$

Where,

'Yt' is the time series data for arrivals / prices for year t, 't' is the time trends for years of interest,

'et' is the error term and

CGR is the compound growth rate for the period under consideration

The Marquardt algorithm was used to estimate the parameters of equation [4]. The significance of regression coefficient 'b' (slope coefficient) was tested by applying a standard 't' test procedure (Gujarati and Sangeetha, 2007).

Price volatility

The measure that may be used to estimate instability in a variable over time should satisfy two minimum conditions. First, it should not include deviations in the data series that arise due to secular trend or growth. Second, it should be comparable across the data sets having different means (Mehra, 1981; Hazell, 1982). Simple coefficient of variation (CV) overestimates the level of instability in time series data, characterised by the long-term trends. To avoid the problem of overestimation, Mehra (1981) and Hazell (1982) has developed two independent methods of estimation of instability in the time series data. Both the methods

involve detrending of the data series. However, both methods have been criticized for measuring instability around arbitrarily assumed trend line, which greatly influences inference regarding changes in instability (Ray, 1983).

However, in recent year at the international level, Cuddy-Della Valle Index was used as a measure of variability in time series data analysis (Weber and Sievers, 1985; Singh and Byerlee, 1990). Cuddy-Della Valle Index is a modification of the coefficient of variation [CV] to accommodate trend, which is commonly present in time series economic data. It is superior over other scale dependent measures such as Standard Deviation or Root Mean Square of the residuals (RMSE) obtained from the fitted trend lines of the raw data, and hence suitable for cross comparisons (Cuddy and Della Valle, 1978).

The Cuddy-Della Valle Index (Ix) was calculated as follows:

$$Ix = SEE * \frac{100}{\bar{Y}} \quad [4]$$

Where,

Ix = Instability index

SEE = Standard error of the trend line estimates

y = Average value of the time series data

Alternatively, Ix could be measured as:

$$Ix = CV\sqrt{(1-R^2)}$$

Where,
Coefficient of variation = SD/Mean*100
Standard deviation (SD)= $\sqrt{(x-\bar{x})^2}/n$
R^2 = Adjusted coefficient of multiple determination

Where ever trend in the time series data was non-significant, instability of that particular series was analysed with the help of conventional statistical tool of instability i.e. coefficient of variation.

ARCH -GARCH Model

To assess the presence of price volatility the ARCH-GARCH analysis was carried out. The ARCH model has two distinct specifications one for the conditional variance and the standard GARCH (1, 1) specification is presented below:

Yt = γ 0 + γ 1 X1t + + γ k Xkt + e (1)

σ^2 t = ω + α e^2 t-1 + β σ^2 t-1 (2)

Equation (1) is the mean equation and equation (2) is the conditional variance equation. The ARCH component (Alpha) indicates the lag of the squared residual from the mean equation. The GARCH term (Beta) indicate the last period's forecast variance. The resultant sum of this co-efficient (Alpha + Beta) is closer to one indicate volatility.

Applying the GARCH approach

The rejection of the hypothesis of no ARCH effect leads to the application of the GARCH approach. The univariate GARCH (1,1) model is presented as

$$\sigma^2 = y0 + y1E^2 \quad) + y2\sigma^2 \quad \textbf{(3)}$$
$$1(t-1\ (t-1)$$

Where σ^2_1 is the variance of Et conditional upon information up to period t.

When using the GARCH approach the conditional standard deviation is the measure of volatility, and is given by the square root of each of the fitted values of (equation 3). Unlike the volatility in the absence of ARCH effect (where it remains constant for the entire period and can hence be presented by a single value), the conditional standard deviation varies over time. The fact that it varies over time makes it impossible to present the conditional volatility as a single value over a period, hence it is presented graphically instead.

RESULTS AND DISCUSSION

Growth rate of Pigeon pea prices in major markets of Maharashtra

The Compound Annual Growth Rate in pigeon pea prices were estimated for month to month data collected from the selected markets from the year 2011 to 2023(Total 156 observations) for major pigeon pea markets of Maharashtra viz., Nanded, Yavatmal, Latur, Amaravati, and Buldhana. The findings showed that the prices of pigeon peas have increased at positive rates in all the market that was the subject of the investigation. From table 1 it can be concluded that the markets viz; Nanded, Yavatmal, Latur, Amaravati, and Buldhana had compound growth rates of 0.45, 0.46, 0.39, 0.51, and 0.69 respectively. The Buldhana APMC market had the highest growth rate, measuring 0.69 percent, while the Latur APMC market had the lowest growth rate, measuring 0.39 percent. It was observed from the above results that, the prices of pigeon pea in all selected markets was increased over the period of 13 years, all the CAGR were statistically significant. Verma *et al*. (2017) reported that for soybeans, prices was increased in all selected markets of Rajasthan.

Volatility in prices of Pigeon pea in major markets of Maharashtra

The Volatility in pigeon pea arrivals and prices in major markets Viz; Nanded, Yavatmal, Latur, Amaravati, and Buldhana was assessed with the help of coefficient of variation, cuddy Della valle instability index and most advanced statistical tools like ARCH- GARCH. The results of instability in pigeon pea prices are reported in table 2.

The results of coefficient of variation is presented in table 2 which indicates that a higher CV indicates greater price volatility, whereas a lower CV suggests more stable prices. From table 2, we can conclude that the Buldhana market has the highest coefficient of variation (44.66) value, indicating the highest price volatility among the markets listed. The Nanded market has the lowest coefficient of variation (34.62), suggesting the most stable prices.

The Cuddy-Della Valle Index (CDVI) is another method for measuring price volatility. A high CDVI indicates high volatility. The CDVI values for pigeon pea prices are shown in table 2, from the table we can conclude that the Buldhana market has the highest Cuddy- Della Valle Index value (30.52), indicating the highest price volatility among the markets listed. Amaravati has the lowest Cuddy-Della Valle Index value (27.20), suggesting the most stable prices. Both the coefficient of variation and

the Cuddy-Della Valle Index show Buldhana asthe most volatile market in pigeon pea prices.

The CV and the CDVI are useful for providing a snapshot of price volatility and relative stability across different markets. However, they have limitations in capturing the dynamic nature and potential patterns in volatility over time. This is where ARCH and GARCH models come into play. ARCH-GARCH models offer a more comprehensive and dynamic approach which helps in understanding and forecasting price volatility. They are essential for capturing the complex behaviors of time series data.

To assess the volatility in pigeon pea prices with the help of ARCH-GARCH it is important to ensure that the prices are stationary. To verify this, we conducted an Augmented Dickey-Fuller (ADF) test and the results are presented in Table 3. The results revealed that, pigeon pea prices at level are non-stationary and they become stationary at 1st order difference.

So, the ARCH-GARCH analysis was carried out and the results are presented in Table 4. The sum of Alpha and Beta (α+β), indicated the ARCH and GARCH effect for the given market. It was observed that among the selected markets, the sum of Alpha and Beta is nearer to 1 i.e. 0.95, 1.1, 0.98, 0.99, 0.91 for Nanded, Yavatmal, Latur, Amaravati, and Buldhana respectively, indicated that the volatility shocks in the prices of Pigeon pea are quite persistent for a long time in these markets. Sharab *et al*. (2018) reported that the sum of Alpha and Beta is close to 1 for selected garlic markets, indicating that volatility shocks in garlic prices are quite persistent over time in the markets studied. In all the selected APMC markets, the volatility in pigeon pea prices over the 13-year period i.e. from 2011 to 2023 is due to factors such as fluctuating production levels, weather-related uncertainties, changes in demand and supply, and market speculation and government policy changes

CONCLUSION

The following conclusions were emerged from the present study.

Prices of pigeon pea crop have shown an increasing trend year by year during the study period, in Yavatmal, Amaravati, Nanded, Latur, and Buldhana APMC markets. In some years low Prices for pigeon pea was seen and in some years high prices were seen. The reasons behind the low and high Prices of pigeon pea was high and low arrivals of pigeon pea in APMC, and Latur, respectively.

There was moderate variation and instability observed in the market price of pigeon pea. The results of ARCH-GARCH analysis showed that volatility shocks in the prices of pulses were persistent in the selected markets of pigeon pea in Maharashtra.

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Table 1: Compound annual growth rate (CAGR) for prices of Pigeon pea prices in major markets of Maharashtra.

Sr. no.	Name of the Market	Intercept (a)	CGAR	SE	$_R2$
1	**APMC Nanded**	3430.90	0.45	0.04	0.36
2	**APMC Yavatmal**	3639.64	0.46	0.05	0.35
3	**APMC Latur**	4089.70	0.39	0.05	0.26
4	**APMC Amaravati**	3506.78	0.51	0.04	0.43
5	**APMC Buldhana**	2528.81	0.69	0.05	0.56

Table 2 : Instability in prices of Pigeon pea in major markets of Maharashtra

Sr. No	Markets	Coefficient of variation (Percent)	CDVI (Percent)
1	**Nanded**	34.62	27.84
2	**Yavatmal**	35.28	28.85
3	**Latur**	34.75	30.14
4	**Amaravati**	35.40	27.20
5	**Buldhana**	44.66	30.52

Table 3: ADF test results of pigeon pea prices in major markets of Maharashtra

At level series			
Markets	**Equation I**	**Equation II**	**Equation III**
Nanded	0.82	-1.08	-2.30
Yavatmal	-0.25	-1.95	-2.52
Latur	0.54	-0.97	-1.45
Amaravati	0.05	-1.50	-2.47
Buldhana	0.84	-0.22	-1.24
At 1st Difference series			
Nanded	-14.67	-14.75	-14.73
Yavatmal	-11.59	-11.55	-11.49
Latur	-10.75	-10.76	-10.75
Amaravati	-10.74	-10.71	-10.76
Buldhana	-11.46	-11.51	-11.56
Critical value at 5%	-1.94	-2.88	-3.43
Critical value at 1%	-2.58	-3.47	-4.01

Note: Equation I- None, Equation II- No intercept No trend, Equation III- Intercept and trend

Table 4 : ARCH- GARCH test Results for major markets of Maharashtra

Sr. No	Markets	Alpha	Beta	Sum of alpha & beta
1	**Nanded**	0.26	0.69	0.95
2	**Yavatmal**	0.40	0.61	1.1
3	**Latur**	0.14	0.84	0.98
4	**Amaravati**	0.24	0.75	0.99
5	**Buldhana**	0.08	0.83	0.91

A Case Study of Chhattisgarh linseed Exchange (CLX): A Digital Marketplace Experience

V. K. Choudhary[1] and Chanchal[2]

1.Professor and Head, and 2.Ph.D. Scholar Department of Agricultural Economics, Indira Gandhi Krishi Vishwavidyalaya, Raipur- 492012 (Chhattisgarh).
College of Agriculture, Raipur (C.G.)
*Correspondence: choudhary.igkv@gmail.com
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ABSTRACT

This study investigates the level of market integration across the primary linseed markets in Chhattisgarh, specifically Jashpur, Balrampur, and Rajnandgaon. The study primarily utilizes wholesale pricing data from 2010 to 2022. The findings indicate that there is a persistent link between these markets over a long period of time. However, there is a lack of strong market integration, which is seen in limited price transmission and coordination. The AGMARKNET database for markets Jashpur, Balrampur, and Rajnandgaon was analysed using Johansen's multiple cointegration test and Granger causality test. The findings established a persistent connection between these markets, as evidenced by the Granger causality test which indicated a positive but statistically insignificant correlation between each pair of markets. In order to enhance market development and facilitate efficient information flow, it is imperative to establish a tangible spot market and seamlessly link it with the derivatives market. This may be achieved by raising awareness, strengthening institutional capabilities, enhancing delivery-based assistance, and revising contractual agreements. Additionally, supporting research and development initiatives to improve linseed varieties and production technology is recommended. By effectively resolving these limitations and adopting the proposed policies, the productivity of linseed in Chhattisgarh may be significantly enhanced, resulting in benefits for farmers, merchants, and the general economy.

Keywords: *Linseed, Market integration,*

INTRODUCTION

At present, fibre yielding plants are regarded as the most important crops after cereals. To increase the profitability of linseed crop and to create jobs, product diversification for medicinal and other industrial uses of linseed must be created through collaborative research activities. Flax seed has grown in popularity globally in current years due to multiple benefits and commercial applications. In addition to being used in culinary products like food and oil, flaxseed has recently acquired favour in the textile sector. The fibre is obtained from blue and white flowered plant stalk (stover) and woven into a fabric generally known as linen. Farmers consume around 20 per cent of all linseed oil produced in India, with the remaining 80 per cent going to industry. Flaxseed oil and meal are used to produce both human and animal food products. Flax oil is widely used in the manufacture of soaps, paints, varnishes, vanaspati, oilcloth, linoleum, and printing. Linseed is used in making paper and plastic. (A/C to AICRP of Linseed and Mustard, Akola 2014) In international market, flaxseeds can be crushed to make oil and flax meal. It can also be utilized whole, roasted, sprouted, and grounded seeds. Flaxseeds are less expensive as than chia seeds and quinoa seeds for animal feed and industrial purpose, which increase global output. As a result, some of the factors expected to drive the flax seed market in the coming year include rising use of

flaxseeds for health benefits and industrial application, which are pushing global production. As a result, some of the reasons expected to drive the flax seed market in the coming year include increased use of flaxseeds for health benefits and industrial applications, which are pushing global production. The popularity of super ingredients increased significantly in recent years, as people want natural and nutritious products. These goods are high in polyphenols, antioxidants, vitamins, and minerals, making them outstanding in terms of nutrition. Flax seeds are high in fibre, antioxidants, and protein, so eating them on a daily basis aids digestion.

METHODOLOGY

The selection of Jashpur, Balrampur, and Rajnandgaon markets was based on their highest linseed arrival. A comprehensive dataset of monthly wholesale market prices was compiled for these markets, covering a 13-year spanning from January 2010to December 2022. The time-series secondary data was gathered from the AGMARKNET website. The ADF test consider the null hypothesis that given series has a unit-root, i.e. it is non-stationary. If the series is found to be non- stationary, the first difference of the series are tested for stationary. The number of times (d) a series is differenced to make it stationary is referred to as the order of integration, I(d). The autoregressive formulation of the ADF test with a drift term is given by below equation.

$$\Delta p_t = a_0 + \gamma p_{t-1} + \sum_{i=2}^{n} \beta_i \Delta p_{i-j+1} + \varepsilon_t$$

Where,

p_{it} is the price in market i at the time t, $\Delta p_{it} = (p_{it} - p_{it-1})$ and is the intercept or drift term. The joint hypothesis to check the presence of unit root is H_0: $\gamma = a_0 = 0$ using φ_1 statistics. For cointegration analysis, the Johansen (1988) maximum likelihood estimator was chosen over the Engle-Granger (1987) two-step method is used to test for co integration between the variables.

Johanson's multiple cointegration test

Johansen's multiple co-integration test is employed to determine the long run relationship between the price series. The test shows weather the selected markets are integrated or not. Johansen (1988) relies heavily on the relationship between the rank of a matrix and its characteristic roots. The Johansen procedure is a multivariate generalization of the Dickey-Fuller test.

The formulation is as follows-

$$p_{it} = A_1 p_{it-1} + \varepsilon_t$$

So that,

$$\Delta P_{it} = A_1 p_{it-1} - p_{it-1} + \varepsilon_t$$

$$\Delta p_i t = (A_1 - I) P_{it-1} + \varepsilon_t$$

$$\Delta p_{it} = \Pi P_{it-1} + \varepsilon_t$$

Where,

p_{it} and $\varepsilon_t$are (n×1) vectors, A_1 = (n×n) matrix of parameters, I = an (n×n) identity matrix and $\Pi = (A_1 - I)$matrix.

Trace test

Trace test was used to determine the presence of cointegration relationship between the prices–series, using the estimates of the characteristic's roots, the test for the number of characteristic roots that are insignificant different from unity was conducted using the following statistics-

$$\lambda_{trace}(r) = -T \sum_{j=r+1}^{n} h\,(1 - \hat{\lambda}_j)$$

Where,

λ denotes the estimated values of the characteristic's roots (eigen value) obtained from the estimated matrix and T is the number of usable observations. The Eigen values representing the strength of the correlation between the first difference and error – correction.

Granger causality test

In order to know the direction of causation between the markets, Granger causality test was employed. When co-integration relationship is present for two variables, a Granger causality test can be used to analyze the direction of this co-movement relationship. This was done with the help of EViews Student 11 software.

After establishing by the use of Johansen procedure, that two markets, p_1 and p_2 are cointegrated, Granger causality test (Granger, 1969) can be used to analyze the direction of this co – movement relationship. Whether market p_1 Granger cause market p_2 or vice versa was checked using below equation.

$$p_{1t} = c + \sum_{j=1}^{n} (\Phi_j p_{1t-j} + \square_j p_{2t-j}) + \varepsilon_t$$

A simple test of the joint significance was used to check the Granger causality, i.e.

$$H_0: S_1 = S_2 = S_n = 0$$

RESULT AND DISCUSSION

Testing of stationarity in prices of linseed markets

The Augmented Dickey-Fuller (ADF) based on unit root test is carried out to check the stationary of time series price data of linseed in selected market of Chhattisgarh. It is presenting in Table 1

Hypothesis

H_0 -The time series data is non stationary

H_A – The time series data is stationary

The Table 1 shows t statistics value was observed for the ADF test at the level the ADF values of Jashpur and Balrampur were less than critical value at 1% level of significance and it suggests the presence of unit root in the time series data that means that the time series price data was stationary and the ADF value of Rajnandgaon market was greater than the critical value at 1% level of insignificant that means suggest the absence of unit root implied that the time series price data was non stationary of Rajnandgaon market. The Table further shows that in first difference with lag 1, the ADF values of Rajnandgaon was lower than of critical value at 1% level of first difference. This implied that the time series price data become stationary at first order difference level. It can be seen from the given Table 1 and the results of ADF at first difference was significant thereby rejecting the null hypothesis, so the price series of all markets were stationary at their first difference.

Table 1: ADF test for unit root in prices of linseed markets in Chhattisgarh

Market	Augmented dickey-fuller test statistic at level			
	At Level	At 1 difference	Critical value (1%)	Probability
Rajnandgaon	-3.650392	-7.063877	-4.297073	0.0237
Jashpur	-5.079227	-	-4.200056	0.0027
Balrampur	-6.860640	-	-4.20595	0.0005

4.3.9 Jhonson multiple cointegration test for linseed markets of Chhattisgarh

Under this co-integration analysis, after confirming the stationarity of all the price series and long-run relationship between the price series of selected markets were tested using the Johansen co-integration test. It involves three basic steps, first stationarity of price series was confirmed using ADF test, second appropriate lag length i.e., second step was chosen as suggested by AIC criteria. In third step, two tests i.e., Trace and Max Eigen test were conducted, and results were presented in Table 2 to 3.

Hypothesis

H_0 – There is no cointegration between the market

H_A -There is a cointegration between the market

This test shows whether the linseed markets are integrated or not. The results of this test were presented in given below Table2. It confirmed that trace test procedure indicated the linseed markets were integrated with three co-integrating equations. From Table2 and Table 3 shows that the corresponding trace value and maximum eigen statistics was greater than the corresponding critical value at 5% level of significance which means perusal of this value indicated that both tests was rejected and the null hypothesis of no cointegration show the existence of co-integration among markets and it confirmed that there was a long -run relationship among the markets.

Table 2: Unrestricted cointegration rank test (Trace) of selected market in Chhattisgarh

Hypothesized No. of CE(S)	Eigen value	Trace statistics	0.05 critical value	Prob**
None*	0.920164	42.03053	29.79707	0.0012
At most 1*	0.719800	16.75267	15.49471	0.0322
At most 2*	0.331699	4.030163	3.841465	0.0447

Trace test indicates 3 cointegrating eqn (s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 3: Unrestricted cointegration rank test (Maximum Eigen Value) of selected market in Chhattisgarh

Hypothesized No. of CE(S)	Eigen value	Max-Eigen statistics	0.05 critical value	Prob**
None*	0.920164	25.27786	21.13162	0.0123
At most 1*	0.719800	12.72251	14.26460	0.0864
At most 2*	0.331699	4.030163	3.841465	0.0447

Max-Eigen statistics test indicates 1 cointegrating eqn(s) at the 0.05 level
* Denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Pairwise Granger causality tests for prices of linseed markets in Chhattisgarh

Granger Causality test is a statistical tool which is used F- test to know this test recognizes the direction of causation relationship between two market prices of selected linseed markets. Co-integration relationship shows two price series and a granger causality test is used to analysis the direction of co-movement relationship. The results of pair-wise granger causality test showing the relationship of prices between selected linseed market and it was presented in Table 4.

Hypothesis

H_0 – There is no market price influence one market to another market

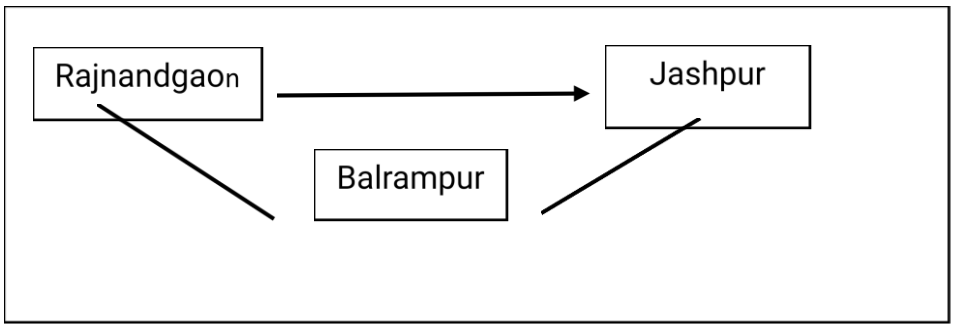
H_A - There is market price influence one market to another market

The finding revealed that no co-integration was existing within five pair of market (Jashpur - Balrampur-, Balrampur – Jashpur, Rajnandgaon – Balrampur, Balrampur – Rajnandgaon, Jashpur – Rajnandgaon). It was indicated that price shocks in one linseed market not transmitted to other market except the prices of Rajnandgaon market influenced the price of Jashpur market in unidirectional way show in Fig 1.

Table 4: Pairwise granger causality tests of different linseed markets in Chhattisgarh

Null hypothesis	F-Statistics	Probability	Reject H_0
Jashpur does not granger cause Balrampur	1.79662	0.2582	Accept
Balrampur does not granger cause Jashpur	1.11647	0.3973	Accept
Rajnandgaon does not granger cause Balrampur	0.37471	0.7053	Accept
Balrampur does not granger cause Rajnandgaon	1.34709	0.3404	Accept
Rajnandgaon does not granger cause Jashpur	10.5662**	0.0160	Reject (unidirectional)
Jashpur does not granger cause Rajnandgaon	0.59598	0.5859	Accept

**denotes significant at 5 % level of significance



CONCLUSION

The study has shown, a long-run relationship among these markets, with Granger causality tests revealing a positive but non-significant correlation between each market pair. However, a unidirectional influence was observed from Rajnandgaon to Jashpur. To sustain the efficiency of linseed markets in Chhattisgarh, the government should continue to invest in linseed production, processing infrastructure, and other necessary facilities, and make protective efforts to engage all stakeholders, with a major focus on catering to the need of majority of small and marginal farmers associated with the linseed cropthrough supply and value chain linkages of seed, oil, high quality fibre and omega-3 product. To enhance linseed productivity in Chhattisgarh, the major constraints faced by the study period like limited irrigation facilities, in adequate access to quality seed, poor post-harvest management practices and lack of market information. To develop the market and improve the transmission of information, it is necessary to build a physical spot market and integrate it with the derivatives market, create awareness, build institutional capacity, improve delivery based support and revise contractual arrangements. The some policy alternatives for

investing in irrigation infrastructure to insure protective irrigation facilities, promote public and private partnership for HYVs seed, implement training programme for farmers on post harvest management, and encourage contract farming and support research and development interactive to improve linseed varieties and production technology. By addressing these constraints and implementing policy suggestion, linseed productivity in Chhattisgarh can be enhance benefited farmers, traders and overall economy

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Exploring Soybean Price Volatility and Growth Through Economic Analysis in Maharashtra

Rajendra G. Kharche*, Sachin S. More**, Vasant G. Jadhav***and Ranjit V. Chavan****

*PG. Research Scholar, Department of Agricultural Economics, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra

**Head, Department of Agricultural Economics, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra

***Ph.D. Research Scholar, Department of Agricultural Economics, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra

****Associate Professor, Department of Agricultural Economics, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra

*Correspondence: rajendrakharche018@gmail.com

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ABSTRACT

Oilseed sector occupies an important place in Indian economy but oilseed crops cultivated in high risky regions where there are uncertainties on production level, leads to wider fluctuation in arrivals and prices of these crops in the markets which ultimately contribute to price instability. The present study investigates the growth and volatility in arrival and prices of soybean in major APMCs in Maharashtra. The required data were collected from five major APMCs namely Latur, Nanded, Washim, Buldhana, and Dharashiv. For this purpose, monthly time series data on the prices and arrivals of soybean were collected from Agriculture Produce Market Committees (APMC) and AGMARKNET for the period from January 2011 to December 2023. Data were analysed with the help of Ordinary Least Square (OLS) technique, ARCH-GARCH model, Cuddy-Della Valle Index and Coefficient of Variation.The analysis was done with the help of SAS (9.3) software. Result of the study revealed that,APMC Latur recorded a significant CAGR (9.5 per cent), indicating a rapid increase in soybean arrivals were as,APMC Buldhanareported a negative CAGR (-1.3 per cent), indicating a decline in soybean arrivals.In case of prices, APMC Dharashiv registered the highest growth rate(0.70), followed by APMC Buldhana (0.55), APMC Washim (0.53),APMC Latur (0.52), and APMC Nanded(0.52). In case of volatility in arrivals, APMC Dharashiv experiences the greatest instability in soybean arrivals, marked by the highest CV (38.64 per cent) andCDVI of25.05percent whereas APMC Buldhana has the lowest values for both metrics (CV and CDVI at 24.81 per cent), reflecting the highest stability and minimal disturbances in arrivals.Volatility in prices APMCDharashiv has the highest CV at (38.64 per cent) and a CDVI of (25.05 percent), pointing to the most significant price fluctuations and disturbances whereas, APMC Buldhana reports the lowest CV at (32.13 per cent) and a CDVI of (23.08 per cent), indicating the most stable price conditions with minimal disturbances.

Key words; *ARCH-GARCH model, CAGR, Coefficient of Variation and Cuddy-Della Valle Index, Price volatility, Soybean.*

INTRODUCTION

Recent years have seen a significant shift in the oilseed production scenario, with oilseeds now becoming a net foreign exchange earner and sparking the "yellow revolution". Oilseeds are a great source of nourishment and energy. Edible oils and oil-basedmeals have a significant role in calorie nutrition and the alleviation of malnutrition in both human and animal populations.After cereals, oilseeds are India's second-largest agricultural commodities (FAO). Oils derived from plants are crucial in the food industry, with major sources including brassica, soybean, peanut, sunflower, sesame, niger, and safflower. Soybean is of paramount importance as an oilseed due to its extensive utility and economic impact across multiple sectors. As the most widely cultivated oilseed globally, soybeans play a crucial role in the agricultural and industrial landscapes. For the 2022–2023 crop year, soybeans have solidified their position as a leading oilseed, reflecting their dominant role in global production(Anonymous, 2023[a]).

The oil extracted from soybeans is integral to the food industry, where it is widely used for cooking and frying because of its neutral taste and stability at high temperatures. Beyond its culinary applications, soybean oil is increasingly valued in the energy sector. It serves as a primary feed stock for biofuels, including biodiesel and renewable diesel, thus contributing to the development of sustainable energy solutions. The soybean, is an annual legume crop. It is also referred to as soja bean or soya bean. It can be used for a wide range of purposes (food, feed, and non-edible), hasauniquechemicalcomposition. (Indian Institute of Nutrition, Hyderabad)

Origin of soybean's introduction into Indiais not exactlyknown,but it probablycame from Chinathrough the Himalayan mountains many centuries ago. Some believe that, it was also brought via Burma by traders from Indonesia. As a result, soybean has been traditionally grownon asmall scale in theKhasi Hills, Himachal Pradesh, Hills of Uttaranchal, the Kumaon, eastern Bengal, the Naga Hills, Manipur, and parts of central India covering Madhya Pradesh and Maharashtra. Inthemiddleofthe20th century, the soybean began to gain importance in the Midwest and South. Except for China, though, it continued to be a modest crop worldwide(Anonymous, 2023[a]).

Soybean known as the "golden bean"in India, soybean (*Glycine max L.*) is the most significant crop grown for both oil seed and pulses. It is an important natural source of protein and provides a range of amino acids that are essential for good health. The term glycine originates from the Greek word '*Glykus*,' meaning' sweet tuber. Native to China, the wild genus Glycine is a member of the Leguminosae family. The Phaseolus tribe of the Leguminosae family is the most significant economically. It is the most significant oil-seed crop in the world. It is commonly believed that soybeans originated in the Yellow River region of China. Warm weather is necessary for soybean growth in tropical, sub-tropical, and temperate climates. For most varieties, 26.5 to 30^0C seems to be the ideal range, while 30-35^0C is needed for germination. Hussain (2023). It thrives in soil that has apH of 6.0 to 7.5 and is well-drained. The crop fixes atmospheric nitrogen, which increases soil fertility. Dry-land farming is appropriate for soybean cultivation because it is a drought-resistant crop. To boost total yield and preserve soil fertility, it is frequently inter planted with other crops like sesame, pigeonpea, fingermillet, cotton, groundnut, sorghum, etc. It is sown from mid-June to mid-July (*Kharif*) and in November to December (*Rabi*).All things considered, soybeans are not only a significant source of food for humans and animals. This crop can be used to produce both high-quality protein (43%) and oil (20%) simultaneously. Approximately 50% of oilseeds produced and 30% of the world's total supply of vegetable oils are derived from soybean plants protein from soybeans is of a calibersimilar to that of meat, dairy, and eggs. It has been referred to by some as the "Cow of the field" perhaps because of this. Soybeans produce two to three times as much high-quality protein and cholesterol-free oil per hectare as other legumes.The protein found in soybeans is high (about 5%) in lysine, a mineral that is absent from most grains. Ten percent of all soybeans produced are used as seeds, five percent are used as food, and the remaining eighty-five percent are used for oil extraction.(Ministry of agriculture and farmers welfare, GOI)

Globally, soybean is grown in an area of 136.90 million hectares with a production of 378.37million metric tonnes and yield of 2.77 metric tonnes per hectare. In case of area Brazilstandsfirst with 44.60 million hectares then USA, Argentina, India, China, Russia and others with 34.87, 14.40, 13.08-, 10.24-, 3.36- and 16.35-million-hectare area respectively. In case of production Brazil stands first with 162.00 million metric tonnes then USA, Argentina, India, China, Russia and others with 116.22, 25.00, 12.41-, 20.28-, 6.00- and 36.46-million metric tonnes production respectively. In case of yield Brazil stands first with 3.63 metric tonnes per hectares then USA, Argentina, India, China, Russia and others with 3.33, 1.74, 0.95, 1.98, 1.79- and 13.81-metric tonnes per hectares respectively.In India area under soybean during the year 2022-23 was 130.06 lakh hectares. While, total production found 125.62 lakh tons and average yield (1032 Kg/ha).Among the states, in case of area, Madhya Pradesh stood first with (58.22 lakh ha) followed by Maharashtra (49.86 lakh ha), Rajasthan (11.27 lakh ha), Karnataka (4.06 lakh ha), Gujarat (2.66 lakh ha) and Telangana (1.81 lakh ha).In case of production Madhya Pradesh stood first with (51.29 lakh tones) followed by Maharashtra (52.69 lakh tons), Rajasthan (10.49 lakh tones), Karnataka (4.41 lakh tons), Gujarat (2.98 lakh tones) and Telangana (2.52 lakh tons).In case of yield (productivity)in kg/ha, Telangana stood first (1392) followed by Gujrat(1122), Karnataka (1085), Maharashtra (1036), Rajasthan (931), Chhattisgarh (850)Madhya Pradesh (881). Maharashtra is one of the leading soybeans producing state,contributing around 40 percent of India's total production, The major Soybean cultivating districts in Maharashtra including Latur, Dharashiv, Buldhana, Nanded and Washim, contribute nearly 43 percent of the total production under Soybean in the state. (Anonymous,2023[b])

METHODOLOY

The study was confined to the five major APMCs of Maharashtra state. The data from five major APMCs namely Latur, Nanded, Washim, Buldhana, and Dharashiv were selected based on area and production of soybean. These districts ranked highest in the area under cultivation of soybean in Maharashtra. It was assumed that farmers will sell their produce in near APMC. There are 306 APMC markets in Maharashtra but these five were chosen with the assumption that the main APMC of the district would be located within that district.

For the present study, monthly time series data on the prices and arrivals of soybean were collected for the period from January 2011 to December 2023. The study was based on secondary data. Hence, a reliable data source is very important to get the real picture. Secondary data consisting of monthly prices and arrivals of selected oilseed i.e; Soybean were collected from particular Agriculture Produce Market Committees (APMC). The data available on AGMARKNET were also used for the analysis purposes.

The choice of the statistical and econometric tools of analysis was decided with reference to the objectives of the study and the nature of data collected. The analytical techniques used in the study are presented below.

Compound Growth Rate

Compound growth rate is a key indicator to measure agricultural growth and can be used for forecasting the prices and arrivals of soybean. It plays a vital role in agricultural policy making, therefore, the estimated value of growth rate needs to be very precise, so that suitable policies can be adopted accordingly. The accuracy of estimated value of growth rate is largely depends on proper statistical procedures followed to estimate it.

Compound growth rate is simply a compounding of annual growth rates over period. It can be easily computed using two data points with constant returns as incase of fixed deposits. However, in case of annual growth rates which are notconstant, but for monotonically increasing or decreasing functions, the compound growth rate is computed based on its fit using non-linear models, especially, the exponential model. The exponential model is more commonly used in economic analysis. Conventionally, the compound growth rates were estimated after converting the growth model to semi-log form and estimated through Ordinary Least Square (OLS) technique assuming multiplicative error term.

$$Y_t = b_0 * b_1^t * e_t \quad [1]$$

$$ln(Y_t) = b_0 + t * ln b_1 + e_t \quad [2]$$

Where,

***ln* (Yt)** is the natural logarithm of time series data for arrivals / prices for year t,

'b0'is theconstant term,
't'isthetimetrendforyearsofinterest,
'**et'** is the error term and
'b1'is the growth rate for the period under consideration (i.e.slope coefficient).

Then, Compound growth rate was calculated using equation

Compound Growth Rate=[(Antilogb1)-1] *100 ---------- [3]

However, there are several problems associated with this methodology including the difficulty in estimating standard error of estimates of originalparameters (Prajneshu & Chandran, 2005). Hence, a non-linear estimation technique for solving the exponential model assuming additive error terms was used to estimate the compound growth rates.

$Yt=constant*(1+CGR)^{t}+et$ [4]
Were,
'Yt'is the time series data for prices for yeart,
't' is the time trends for years of interest,
'et'is the error term and
CGR is the compound growth rate for the period under consideration

The Marquardt algorithm was used to estimate the parameters of equation [4]. The significance of regression coefficient 'b' (slope coefficient) was tested by applying standard 't' test procedure (Gujarati and Sangeetha, 2007)

PriceVolatility

The measure that may use to estimate instability in a variable over timeshould satisfy twominimum conditions. First, it should not include deviations in the data series that arise due to secular trend or growth. Second, it should be comparable across the data sets having different means (Mehra, 1981; Hazell, 1982). Simple coefficient of variation (CV) overestimates the level of instability in time series data, characterised bythe long-term trends. To avoid the problem of overestimation, Mehra (1981) and Hazell (1982) has developed two independent methods of estimation of instability in the time series data. Both the methods involve detrending of the data series. However, both methods have been criticized for measuring instability around arbitrarily assumed trend line, which greatly influences inference regarding changesin instability.

Ray (1983) has developed a very simple measure of using standard deviation in annual growth rates. This method satisfies all the ideal properties like instability based on de-trended data and comparability. Moreover, the methodology does not involve actual estimation of the trend, computation of residuals and retrending ,but all these are taken care in the standard deviation of annual growth rates. This method does not suffer from the limitations of arbitrary choice of assumed trend line which was present in the methods developed by Mehra, 1981 and Hazell, 1982.

But, in recent year at international level, the Cuddy-Della Valle Index was used as a measure of variability in time series data analysis (WeberandSievers,1985; Singh and Byerlee, 1990; Singh and Byerlee (1990) found identical results of instability, when they estimated instability by Cuddy-Della Valle Index and Coefficient of Variation around trend as the standard error of regression divided by mean. Since both methods provides similar results and possess all desirableproperties, so we have estimated instabilityin arrivals and prices of soybean using the Cuddy Della Valle Index for the present investigation.

$$I_X=\frac{SEE}{\bar{Y}}*100$$

Where,

I_X= Instabilityindex

SEE=Standard error of the trend line estimates

y = Average value of the time series data
Alternatively,

Ix could be measured as:

$I_X CV\sqrt{(1-R^2)}$

Where,

Coefficient of variation=SD/Mean*100 Standard deviation (SD)= $\sqrt{(x-\bar{x})^2}/n$

R^2 =Adjusted coefficient of multiple determination

Where ever trend in the time series data was non-significant, instability of that particular series was analysed with the help of conventional statistical tool of instability i.e. coefficient of variation.

ARCH-GARCHModel

To assess the presence of price volatility the ARCH-GARCH analysis was carried out. Auto-

Regressive Conditional Heteroscedasticity (ARCH) models are specifically designed to forecast conditional variances. The ARCH model is introduced by *Engle (1982) a*nd generalized as GARCH by Bollersllev (1986). The instability in the prices of soybean was estimated with the help of the ARCH-GARCH model. The ARCH component (Alpha) indicates the lag of the squared residual from the mean equation. The GARCH term (Beta) indicate the last period's forecast variance. The resultant sum of these co-efficient (Alpha + Beta) is closer to one indicatevolatility. These models arewidelyused in various branches of econometrics, especially in financial time series analysis. The ARCH model has two distinct specifications one for the conditional variance and the standard GARCH (1, 1) specification is presented below

Yt=γ0 +γ1X1t+……...+γkXkt+e(1)-Mean Equation

σ ^{2}t= ω + α e^{2}t-1+ β σ ^{2}t-1(2)- conditional VarianceEquation

(1) is the mean equation and equation (2) is the conditional variance equation. The ARCH component (α) indicates the lagof the squared residual from the mean equation and the GARCH term (β) the last period's forecast variance and the resultant sum of these co-efficient (α + β) are presented. The sum of co-efficient very close to 1 would indicate that the volatility shocks are quite persistent in the series.

Once the key market is identified, volatility of price series of that market is checked by testing the presence of heteroskedasticity through ARCH. If heteroskedasticity has found in price series, then to deal with this, the popular and non-linear model is the autoregressive conditional heteroscedastic (ARCH) model. In the GARCH model, the conditional variance is also a linear function of its own lags. As in ARCH this model is also a weighted average of past squaredresiduals, but ithas declining weights that never go completely to zero. Apart from these two models, there are other models such as TARCH, EGARCH and PARCH. The best fit model was selected out of these models based on AIC and SIC values. The forecasting performance of fitted models is assessed with respect to two traditional accuracy measures viz., the root means square error (RMSE) and the mean absolute percentage error (MAPE).

Test for the presence of ARCH effect

The rejection of the null hypothesis of no ARCH effect indicates the fact that the series varies over time and suggests that the GARCH approach should be used instead. The Box-Jenkins approach is based on the assumption that the residuals are homoscedastic, or remain constant over time. Since the standard error of equation is used as a measure of volatility, the homoscedastic assumption has the implication that uncertainty or volatility remains constant over time. The robustness of this assumption was tested by fitting. ARCH equations.

The presence of ARCH effect (whether or not volatility varies over time) has to be tested in the conditional variance of:

$$h^2 = (u_1 / \Omega_{t-1}) \quad \textbf{(3)}$$

$$h^2 = Po + P1u_{t-1}^2 + p_2 U_{t-2}^2 + \cdots p_q u2_{t-q} \quad \textbf{(4)}$$

where u_1^2 is the squared residual in period t, and P0,P1,P2,P3are the parameters to be estimated.

When fitting ARCH equations, Lagrange Multiplier (LM) and F-tests were used to test the null hypothesis of no ARCH effect, Probabilityvalues lower than 0.05 indicate that the null hypothesis is rejected at 5 percent level of significance, indicating that the volatility varies over time.

Applying the GARCH approach

The rejection of the hypothesis of no ARCH effect leads to the application of the GARCH approach. The univariate GARCH (1,1) model is presented as

$$\sigma_1^2 = y_0 + y_1 E_{(t-1)}^2 + y_2 \sigma_{(t-1)}^2$$

Whereσ_1^2s the variance of E_t conditional upon information upto period t.

When using the GARCH approach the conditional standard deviation is the measure of volatility, and is given by the square root of each of the fitted values of (equation 5). Unlike the volatility in the absence of ARCH effect (where it remains constant for the entire period and can hence be presented by a single value), the conditional standard deviation varies over time. The fact that it varies over timemakes it impossible to present the conditional volatility as a single value over a period, hence it is presented graphically instead.

RESULTS AND DISCUSSION

1. Growth in arrival and prices of soybean APMCs in Maharashtra

The growth in soybean arrivals and prices in the selected markets was analyzed using the Compound Annual Growth Rate (CAGR). To assess the annual increase in prices and arrivals on a monthly basis, the month-by-month CAGR was computed. The missing observations were computed with linear interpolation method in E Views 12 student version. The analysis of Compound Annual Growth Rate (CAGR) in both arrivals and prices is essential to understanding the long-term performance and market dynamics of agricultural commodities. In the context of this study, the focus is on soybean markets in Maharashtra. The CAGR of arrivals and prices over the period from 2011 to 2023 provides insights into market growth. This trend analysis offers a comprehensive view of how different markets have evolved, highlighting areas of significant growth as well as markets that may be experiencing stagnation or decline. By examining these trends, we can better understand the factors influencing market performance, guide future forecasting efforts, and inform policy recommendations aimed at improving market efficiency and farmer profitability. The analysis was done with the help of SAS (9.3).

1.1 Compound annual growth rate (CAGR) for arrivals and price ofsoybean during 2011-2023.

The Compound Annual Growth Rate (CAGR) of soybean arrival swas estimated for year-to-year data. Total data period was 13 years ranges from 2011 to2023.Table 1 revealed that the Compound Annual Growth Rate(CAGR)of soybean arrivals a cross the major five APMC markets in Maharashtra from 2011to2023 exhibited notable variation among the five markets. In APMC Nanded, the CAGR for soybean arrivals was (0.95 per cent), indicating minimal growth. The high standard error (3.09) and low R-squared value (0.0064) suggested that the model was not well-fitted, implying significant volatility and weak predictability in arrival trends. The Latur market exhibited the highest CAGR at (9.4 per cent), reflecting robust growth in arrivals. The standard error (2.8224) was moderate, and the R- squared value (0.5873) indicated a relatively strong model fit, signifying consistent growth trends and reliable predictability. In APMC Washim, the CAGR was (4.8 per cent), showing moderate growth inarrivals with a standard error of 1.2669, the results were relatively precise, and the R- squared value of 0.5799 suggested a good fit. These results indicates that, the trend was fairly consistent over time.The Dharashiv market recorded a CAGR of (7.1 per cent), reflecting considerable growth. However, the high standard error (5.4699) and low R-squared value (0.0918) highlighted significant variability and a weak fit, suggesting that the growth was inconsistent and unpredictable.In APMC Buldhana, the CAGR for soybean arrivals was (-1.3 per cent), indicating a decline in arrivals over the period. The standard error was(1.2101),and the R-squared value of (0.1054) showed a poor model fit, pointing to instability and limited reliability in the trend analysis. The decline in the arrivals of soybean APMC Buldhana market indicated that, farmers have preferred an alternate market for soybean marketing.From overall analysis, Latur recorded a significant CAGR of (9.5 per cent), indicating a rapid increase in soybean arrivals during study period. APMC Washim followed with a robust CAGR of (4.8 per cent), reflecting a substantial and consistent upward trend in arrivals. Dharashiv showed a considerable CAGR of (7.1 per cent), highlighting a notable rise in soybean supply, though with greater variability. Nanded experienced a low CAGR of (0.95 per cent), suggesting a stable but less pronounced increase in arrivals. In contrast, APMC Buldhana reported a negative CAGR of (-1.3 per cent), indicating a decline in soybean arrivals over the study period. These varying growth rates underscore distinct market dynamics, with Latur experiencing the most dramatic expansion, while Buldhana exhibited a contraction in soybean arrivals.

Table1 Compound annual growth rate (CAGR) of soybean arrivals

Sr.No.	Nameofthe Market	Intercept(a)	CAGR (percent)	Std. Error	'R' Square
1	APMCNanded	102331.3	0.95	3.0931	0.0064
2	APMCLatur	894422	9.4	2.8224	0.5873
3	APMCWashim	357296.9	4.8	1.2669	0.5799
4	APMCDharashiv	19758.51	7.1	5.4699	0.0918
5	APMCBuldhana	121404.6	-1.3	1.2101	0.1054

The Compound Annual Growth Rate of soybean prices was estimated for month-to-month data series, the Total observations were 156 starting from Jan. 2011 to Dec. 2023. The resultsreported in table 2, it showed the Compound Annual Growth Rate (CAGR) for soybean prices across five major APMC markets in Maharashtra, revealing distinct trends in each market. In the Nanded APMC, the CAGR for soybean prices was 0.52 percent, indicating moderate growth during the period.standard error was 0.0406, and the R-squared value of 0.5300 suggested a reasonable model fit, reflecting a steady upward trend with moderate reliability in predicting future prices.Latur market recorded a CAGR of 0.52 per cent, closely aligning with Nanded's growth. The standard error was slightly higher at 0.0419, and the R-squared value was 0.5130, indicating a moderate fit. The trend showed consistent growth, although with slightly more variability than APMC Nanded. The CAGR for Washim was 0.53 per cent, showing the highest growth among the three markets with similar trends. The standard error was the lowest at 0.0405, and the R-squared value of0.5325 indicated a good model fit, reflecting a stable and reliable growth trend.Dharashiv exhibited the highest CAGR at 0.70 per cent, reflecting significant growth in soybean prices. The standard error was (0.0417), and the R-squared valueof 0.6597 suggested a strong model fit, indicating a robust and consistent upwardtrend in prices, with high predictability. The CAGR for APMC Buldhana was 0.55 per cent, indicating moderate growth. The standard error was 0.0380, the lowest among all markets, and the R-squared value of 0.5785 showed a strong model fit, reflecting stable growth and high reliability in trend analysis.The above analysis showed that CAGR values ranged from (0.52 to 0.70). Among the selected markets, APMC Dharashiv registered the highest growth rate at (0.70), followed by APMC Buldhana at (0.55), APMC Washim at (0.53), APMC Latur at (0.52), and APMC Nanded at (0.52). The R-squared values, ranging from 0.5130 to 0.6597, indicate a good fit of the model, showing a reliable trend in theprice growth of soybean across these markets.

Table2:Compound annual growth rate (CAGR) of soybean prices.

Sr.No.	Nameof theMarket	Intercept(a)	CAGR (percent)	Std. Error	'R' Square
1	APMCNanded	2441.907	0.52	0.0406	0.5300
2	APMCLatur	2549.617	0.52	0.0419	0.5130
3	APMCWashim	2454.523	0.53	0.0405	0.5325
4	APMCDharashiv	1916.594	0.70	0.0417	0.6597
5	APMCBuldhana	2237.165	0.54	0.0380	0.5785

Deokate *et al.* (2020) reported that prices of soybean were increasing over a period of time in major APMC. Hile *et al.* (2017) discussed price trends and fluctuations that align with the varied growth rates. These studies highlight how market dynamics and seasonal variations contribute to the observed increases in soybean prices. Singh *et al.* (2017) he concludes that the annual compound growth rate of arrivals was comparatively higher than the market Price.

The comparison of Compound Annual Growth Rates (CAGR per cent) for soybean arrivals

and prices across the major APMC markets in Maharashtra from 2011 to 2023 reveals contrasting trends. While Latur, Dharashiv, and APMC Washim showed strong positive growth in both arrivals (9.4per cent, 7.1per cent, and 4.8per cent, respectively) and prices (0.52per cent, 0.70per cent, and 0.53per cent, respectively), Nanded APMC exhibited minimal growth in arrivals (0.95per cent) but moderate growth in prices (0.52per cent). Buldhana was the only market to record a decline in arrivals (- 1.3per cent) while showing moderate price growth (0.55per cent). Notably, APMC Latur and Dharashiv demonstrated robust growth in both parameters, while APMC Nanded and Buldhana showed inconsistencies, highlighting varied market dynamics across the region.

2. Price volatility of Soybean in major APMCs of Maharashtra

Agricultural commodity prices are influenced by various factors, including market intermediaries, supply-demand imbalances caused by the cobweb phenomenon, biological delays in production, weather and climate conditions, etc. These elements contribute to the dynamic nature of price fluctuations. Achieving sustainable growth requires higher production growth with minimal instability. Analyzing price fluctuations in commodities is essential for understanding the underlying supply and demand conditions. Two matrices that is Coefficient of Variation (CV) and the Cuddy-Della Vella Index (CDVI). These metrics are essential for understanding the consistency and disturbances in soybean arrivals, offering valuable insights into market stability.

The Coefficient of Variation (CV)is a statistical measure used to assess the relative variability of data. It is expressed as a percentage and calculated as the ratio of the standard deviation to the mean. In the context of agricultural markets, CV is commonly used to measure the instability of arrivals and prices. The Cuddy-Della Valle Index (CDVI)is a refined measure of instability, especially useful in timeseries data. It adjusts the CV by accounting for the trend in the data, making it more accurate for assessing instability over time. The value of CDVI ranges from 0 to 100. Depending on the magnitude of CDVI, Price and arrival series are classified as Low, medium, and high. The criteria are as following if CDVI ranges from 0 to 30 it is treated as low. If the CDVI value falls between 31 to 70 is called medium and if itfalls under 71 to 100 it is assumed as high.

2.1 Instability (volatility) in arrivals of soybean in major APMCs in Maharashtra

Table3 revealed that, in Nanded market, arrivals of soybean were moderately instable the value of CV and CDVI was 47.16 per cent. Latur has higher variability (CV 53.27 per cent)but less severe disturbances (CDVI 40.51 per cent). Washim is the most stable with thelowestCV (32.31per cent) and CDVI(26.33 percent). APMC Dharashiv exhibits the highest instabilitywith extreme CV (102.25 per cent) and CDVI(96.53 per cent), indicating significant disruptions. APMC Buldhana has the lowest values for both metrics (CV and CDVI at 24.81 per cent), reflecting the highest stability and minimal disturbances in arrivals as measured by both methods from 2011-2012 to 2022-23.

Overall analysis of CV and CDVI revealed that APMC Dharashiv experiences the greatest instability in soybean arrivals, marked by the highest CV and CDVI. This indicates high variability and absolute instability. Conversely, APMC Buldhana shows the lowest instability, with the lowest values for both CV and CDVI, highlighting themost consistent arrival patterns. Washim and Nanded fall in between, with moderate instability levels, while Latur shows higher variability but less absolute instabilitythan APMC Dharashiv. This detailed analysis helps in understanding the stability and predictabilityof soybean arrivals across different markets, which is crucial for market planning and risk management.

Table3:Instability in arrival of soybean in major APMC markets of Maharashtra

Sr.No.	Markets	CV(Percent)	CDVI(per cent)
1	APMCNanded	47.16	47.16
2	APMCLatur	53.27	40.51
3	APMCWashim	32.31	26.33
4	APMCDharashiv	102.254	96.53
5	APMCBuldhana	24.81	24.81

2.2 Instability (volatility) in prices of soybean in major APMCs in Maharashtra

Table 4 examines the instability in soybean prices across major APMC markets in Maharashtra. Were estimated Coefficient of Variation (CV) and the Cuddy- Della Vella Index (CDVI) to assess price fluctuations and disturbances. The Nanded APMC shows a CV of (32.36 per cent) and a CDVI of (23.48 per cent), indicating a moderate level of price variability and relatively low disturbance. Latur APMC present a CV of (32.73 per cent) and a CDVI of (24.19 per cent), reflecting a slightly higher degree of instability compared to Nanded APMC, with a marginal increase in both price variability and disturbance. Washim APMC records a CV of (32.96 per cent) and a CDVI of (23.69 per cent), showing similar levels of instability, though with a slight increase in variability. Dharashiv APMC has the highest CV at (38.64 per cent) and a CDVI of (25.05 percent),pointing to the most significant price fluctuations and disturbances among the markets analyzed. This higher variability suggests that Dharashiv APMC experiences the most pronounced instability in soybean prices.Buldhana APMC reports the lowest CV at (32.13 per cent) and a CDVI of (23.08 per cent), indicating the most stable price conditions with minimal disturbances.

Overall, the analysis revealed that while most APMC exhibit moderate levels of price instability, APMC Dharashiv stands out with the highest volatility, whereas Buldhana APMC demonstrates the greatest price stability. These findings highlight the varying degrees of price stability across different APMC markets, which can impact market performance and the effectiveness of price stabilization strategies.

Divyanshu *et al*. (2022) reported that low instability in prices of tea market of India. More and Katkhede (2016) reported similar results.

Table 4: Instability in prices of soybean in major APMC markets of Maharashtra

Sr.No.	Markets	CV (Percent)	CDVI (Percent)
1	APMCNanded	32.36	23.48
2	APMCLatur	32.73	24.19
3	APMCWashim	32.96	23.69
4	APMCDharashiv	38.64	25.05
5	APMCBuldhana	32.13	23.08

Price volatility of soybean in selected markets of Maharashtra

The Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models are powerful tools used in time series analysis to model and forecast volatility. These models capture the persistence and clustering of volatility, which are common characteristics in financial and commodity markets. In this study, ARCH and GARCH models were appliedusing EViews 12 (student version) to analyze the volatility patterns in soybean prices across selected markets during the period 2011 to 2023. The results provide insights into market risk, volatility dynamics, and the predictability of price movements,which are critical for effective market decision-making and risk management.

1. Pricevolatilityinsoybeanprices

The presence of price volatility in the prices of soybean in Nanded, Latur, Washim, Dharashiv and Buldhana analyzed with ARCH-GARCH model. The sum of Alpha and beta (α+β), showed the ARCH and GARCH effect for selected markets. The parameters Alpha (α) and Beta (β) are key indicators of the volatility dynamics within each market. The ARCH component (α) represents the coefficient for the lagged squared returns, reflecting the immediate impact of past shocks on current volatility. Table-5 it revealed that, Alpha values are notably high across all markets, with Nanded APMC (0.85) and Latur APMC (0.83) exhibiting the highest sensitivities to past volatilityshocks, followed byWashim APMC (0.80), Dharashiv APMC (0.60), and Buldhana APMC (0.64). This suggests that historical volatility has a pronounced effect on current volatility, particularly in Nanded APMC and Latur APMC. The GARCH term B(β)measures the persistence of volatility by capturing the effect of previous periods' volatility on current volatility. The Beta values for all markets are also substantial, ranging from (0.34)

in Washim to (0.38) in Latur. This indicates a consistent level of volatility persistence across the markets. The sum of Alpha and Beta (α+β) assesses the overall persistence of volatility. Values exceeding1 for Nanded APMC (1.22), Latur APMC (1.21), and Dharashiv APMC (1.14) implythat volatility is highly persistent, suggesting a tendency for volatility shocks to have long-lasting effects. In contrast, Washim APMC (0.96) and Buldhana APMC (0.99) have sums below 1, indicating that their volatility is less persistent and reverts more rapidly to the mean. This analysis highlights varying degrees of volatility persistence and sensitivity to past shocks among the markets. Hence the hypothesis proposed prices of soybean are volatile in all selected markets of Maharashtra accepted.

Table 5: Results of ARCH-GARCH analysis for soybean prices of selected markets

Parameters	Nanded	Latur	Washim	Dharashiv	Buldhana
Alpha(α)	0.85	0.83	0.80	0.60	0.64
Beta(β)	0.37	0.38	0.34	0.36	0.35
Sum(α+β)	**1.22**	**1.21**	**0.96**	**1.14**	**0.99**

Conclusion

Result concluded that, the comparison of Compound Annual Growth Rates (CAGR per cent) for soybean arrivals and prices across the major APMC markets reveals contrasting trends. While Latur, Dharashiv, and Washim showed strong positive growth in both arrivals (9.4 per cent, 7.1 per cent, and 4.8 per cent, respectively) and prices (0.52per cent, 0.70per cent, and 0.53per cent, respectively), Nanded exhibited minimal growth in arrivals (0.95per cent) but moderate growth in prices (0.52per cent). Buldhana was the only market to record a decline in arrivals (- 1.3 per cent) while showing moderate price growth (0.55per cent). Notably, Latur and Dharashiv demonstrated robust growth in both parameters, while Nanded and Buldhana showed inconsistencies, highlighting varied market dynamics across the region. These varying growth rates underscore distinct market dynamics, with Latur experiencing the most dramatic expansion, while Buldhana exhibited a contraction in soybean arrivals. In case of volatility in arrival, CV and CDVI revealed that APMC Dharashiv experiences the greatest instability in soybean arrivals, marked by the highest CV and CDVI. This indicates high variability and absolute instability. Conversely, APMC Buldhana shows the lowest instability, with the lowest values for both CV and CDVI, highlighting themost consistent arrival patterns. Washim and Nanded fall in between, with moderate instability levels, while Latur shows higher variability but less absolute instabilitythan Dharashiv. In case of volatility in prices most markets (Nanded, Latur and Washim) exhibit moderate levels of price in stability, Dharashivst and sout with the highest volatility, whereas Buldhana demonstrates the greatest price stability. These findings highlight the varying degrees of price stability across different APMC markets, which can impact market performance and the effectiveness of price stabilization strategies. This detailed analysis helps in understanding the stability and predictabilityof soybean arrivals across different markets, which is crucial for market planning and risk management.

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A Comprehensive Study on Land Use Shifting and Cropping Pattern in Chhattisgarh

Devendra Kumar Kurrey[1]* and G N Narnaware[2], Nagpure S.C.[3]

1.Ph.D. Agricultural Economics,IGKV Raipur(CG) 2. Assistant Professor, CDT, Pusad (MH) 3.Dr.Panjabrao Deshmukh Krishi Vidyapeeth,Akola(M.S.)

*Correspondence: drdevendrakurrey95@gmail.com

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ABSTRACT

The present study has been conducted to explore the land use shifting and changes in cropping patterns in Chhattisgarh state. Some statistical tools were used to derive the result. Changes in land use classification have been seen in secondary data. Changes in Land use can have an impact on the ecosystem's water flow vis-à-vis. The data revealed that the net sown area decreased by -4.4191 percent. Forest coverage was observed at around 46 percent, which increased by 0.031 percent every year from 2000 to 2021. Net sown Area of Chhattisgarh state was in a negative trend as it is decreasing 0.07 percent every year. The Gross cropped Area of Chhattisgarh had insignificant positive growth. Cropping intensity was increased by around 0.31 percent over the years. we have calculated the percentage change in land use classification from the year 2000 to 2021 in which we analyzed the Net sown area of the state changed 4 percent negatively. The highest 10 percent positive change was observed for the cropping intensity of the state. Non-agriculture use of land and Culturable waste land also increased by 8 and 5 percent, respectively. Forest cover and gross crop increased positively by 2 and 5 percent, respectively. According to the average numbers for three years from 2019 to 2021, the area and production of paddy crops in the main crops share 74 and 84 percent, respectively. Regarding area and production, paddy is leading on the first rank. For production, maize, gram, wheat, and Lathyrus contribute 4, 2, and 1 percent, respectively. In over 21 years, the cropping pattern has changed substantially in the state. The proportion of area under paddy has increased. The Lathyrus crop area was reduced by 2.5 percent from 2015-2020. Gram crop area was 1 percent increased from 2015-2020. Other cereals and millet were reducing year after year. The various sectoral drivers of land-use change discussed above are strongly linked within and between levels of organization of human-environment systems. The results of this study could help governments, policymakers, and land use planners who are looking for good ways to manage available land.

Keywords: *Land Use Pattern, Cropping Pattern, Chhattisgarh land, Cropping system, Area*

INTRODUCTION

Shifting of land use patterns and climate change both are related to impacting the well-being of farmers. Land use has a clear impact on the environment. In particular, the water availability cuase changes in land use. These changes are mostly because more people are living in cities and there are fewer bodies of water, forests, and empty land. (Verma S, et al.,2023). A study from Karnataka analyzed the impact of climate change on water resources, and cropping patterns in Karnataka. Researcher found that between the two river basins (Krishna and Kaveri) the increase in runoff and decrease in evapotranspiration is greater in the Krishna basin, which means that the Krishna basin is prone to high water stress and droughts. Crops prevalent in both the river basins such as rice, banana and sugarcane (water loving crops) will be adversely affected in future by the increase in water pressure,

reduction in yield due to change in cropping pattern (Gadad et al.,2015).Changes in Land use can have an impact on the ecosystem's water flow. This leads to a lack of water, a higher risk of flooding, and soil erosion, all of which help to cropping pattern. Shifting in land use is connected to planning and managing water resources, as well as the hydrological processes that affect the agricultural production process. It can be very dynamic, especially in countries that are developing quickly and have an economy based on agriculture(Kiros G. et al., 2015).Land-use change is caused by some interconnected factors, including limited resources that put more pressure on resources for production, changing market opportunities, outside policy interference, loss of the ability to adapt, and changes in social structure and attitudes. When people change how land is used, the goods and services that ecosystems provide change. These changes affect the people who change how land is used.(Eric F., 2003). Land-use change is linked to climate change because it both causes climate change and is a major way that its effects are shown. The way land is used affects the flow of land utilisation, and when the patterns of land cover change, these flows also change. Changes in the climate that are expected will have an impact on land cover patterns at different time and space scales. However, people's use of the land is likely to cancel out many of these effects.(Verginia H. Dale,1997).

Chhattisgarh state is based on the tropical monsoon climate, due to this irregularities and uncertainty of the rain have adverse effects on production, which also affects the HYV seeds, fertilizers agricultural equipment, and the sources of irrigation. The region hasan excess of tropical deciduous vegetation, the Pat and plateaus region found in the state. The red-yellow and laterite soil is broadly distributed in the region which is coming under the infertile soil category, due to the uncertainty of rainfall, 10.38 percent of the total area is under the net area. About 13 percent of the area is irrigated, while the highest irrigated area is the highest of 6.5 the part is in Janjgir and Raigarh district which is under the Mahanadi River and Mand River. Chhattisgarh also realized affect of climate change on available resource, there is a high possibility of rise in the frequency and severity of drought and flood like situation cuasing land use pattern. To examine regional climate changes in the state of Chhattisgarh and their effects on agriculture, studies were carried out and it has been found that the scale of variability is not the same in the entire state. In some areas, the rainfall decreased by 30-35%, while in some other areas, the rainfall decreased by just 0-5 percent. Agriculture is influenced by rainfall variability in a number of ways, including its fluctuations, heavy rainfall, floods, droughts and changes in food nutritional quality. The impact of the climate change has been noticed by decreasing/increasing of production of various crops in Chhattisgarh. While, these changes may cause gains in some crops, in some regions of the state, yet the overall impacts of climate change on agriculture are expected to be negative and threatening food security of the people of Chhattisgarh. Therefore, it is worth studying the effect of the climate change on production of major crops of Chhattisgarh (Sastri, 2010).After all, the study area is tribal and primitive tribes dominated state, traditional agriculture has been adopted. Therefore its study on shifting in land use patterns makes it more important.

METHODOLOY

This study used secondary sources of data. The district-level data was used. while the number of cross-section data is used in the state-level data set.The statistics are categorized as secondary data because they were derived from the Directorate of Economics and Statistics, Government of India. And other publications the data is gathered from 2000 to 2020. To analyze, the shifting of land use various statistical tools in Excel have been used. The diversity of land use and cultivation area is presented in Table 1.

Table1. Overview of cultivation and land use of Chhattisgarh (In Hectares)

Districts	Total Cereals And Millets	Total Pulses	Total Food Grains	Total Sugar	Total Condiments And Spices	Total Fruits	Total Vegetables	Total Fruits And Vegetable	Total Food Crop	Total Oilseeds	Total Fibres	Total Non Food Crop	Total Cropped Area	Area Sown More Than Once	Net Area Sown
1.balod	198527	34562	233089	430	111	81	2093	2174	235806	1856	5	1906	237712	57739	179973
2.baloda bazar	248460	5249	253709	58	302	349	3818	4167	258236	2173	57	2281	260517	19784	240733
3.balrampur	142049	10712	152761	1167	750	368	4386	4754	159432	17759	433	18201	177633	21906	155727
4.bastar	155577	3977	159554	414	878	1617	3628	5245	166091	2979	64	4607	170698	7115	163583
5.bemetara	262732	113287	376019	4018	1221	2073	8288	10361	391716	7077	1759	8922	400638	174673	225965
6.bijapur	79328	831	80159	-	39	195	377	572	80770	55	89	144	80914	54	80860
7.bilaspur	190627	4743	195370	95	245	234	2208	2442	198152	433	63	496	198648	23400	175248
9.dantewada	86227	1124	87351	-	48	254	661	915	88314	454	7	464	88778	433	88345
10.dhamtari	184712	18861	203573	14	171	152	1487	1639	205397	1337	-	1379	206776	65241	141535
11.durg	159740	27217	186957	275	318	1307	11645	12952	200654	6263	989	7430	208084	59465	148619
12.gariyaband	151489	5736	157225	27	25	133	477	610	157887	610	3	639	158526	27453	131073
13.gaurella-pendra-marwahi	63055	3440	66495	3	28	3	453	456	66982	1004	2	1022	68004	4644	63360
14.janjgir-champa	285770	1212	286982	18	99	17	3094	3111	290210	943	-	943	291153	30197	260956
15.jashpur	195769	22224	217993	93	922	850	9513	10363	229371	24360	76	24436	253807	11569	242238
16.kabirdham	155425	112035	267460	22821	111	266	4711	4977	295369	9562	-	9562	304931	118800	186131
17.kanker	193990	8004	201994	17	37	32	1192	1224	203272	325	34	359	203631	18126	185505
18.kondagaon	131971	12783	144754	10	400	206	2725	2931	148095	889	19	1609	149704	8400	141304
19.korba	116588	4174	120762	-	57	41	1082	1123	121942	1492	-	1492	123434	2138	121296
20.korea	87226	10901	98127	-	395	88	1832	1920	100442	4712	46	4758	105200	9964	95236
21.mahasamund	290300	9288	299588	12	198	243	1472	1715	301513	2836	20	2888	304401	43310	261091
22.mungeli	135174	80737	215911	658	255	156	1559	1715	218539	1752	64	1816	220355	91650	128705
23.narayanpur	23236	1711	24947	1	30	20	83	103	25081	34	-	34	25115	236	24879
24.raigarh	245461	18921	264382	105	1201	709	4604	5313	271001	8561	118	8679	279680	26570	253110
25.raipur	177028	7681	184709	123	386	666	3296	3962	189180	3352	256	3742	192922	28001	164921
26.rajnandgaon	383853	139838	523691	100	362	497	8780	9277	533430	21333	629	22055	555485	185076	370409
27.sukma	92202	1760	93962	-	23	256	681	937	94922	2024	13	2052	96974	553	96421
28.surajpur	134545	11057	145602	2999	1510	475	5407	5882	155993	10467	133	10609	166602	14391	152211
29.surguja	135105	12515	147620	3201	1123	954	8546	9500	161444	11951	127	12079	173523	21991	151532
total	4706166	684580	5390746	36659	11245	12242	98098	110340	5549241	146593	5006	154604	5703845	1072879	4630966

Source: Directorateof Economics and Statistics, Government of India, 2020-21

RESULTS AND DISCUSSION

3.1 Changes in the classification of land use in Chhattisgarh

Figure number1, presents the percent-wise land use classification of Chhattisgarh state. The cropping intensity of Chhattisgarh was observed at 116 percent in the year 2000-01, which increased 0.31 percent over the years. The cropping intensity of Chhattisgarh was observed around 123 percent in the year 2021. Forest coverage was observed at around 46 percent, which increased by 0.031 percent every year from 2000 to 2021. Net sown Area of Chhattisgarh state was in a negative trend as it is decreasing 0.07 percent every year. The Gross cropped Area of Chhattisgarh had insignificant positive growth.

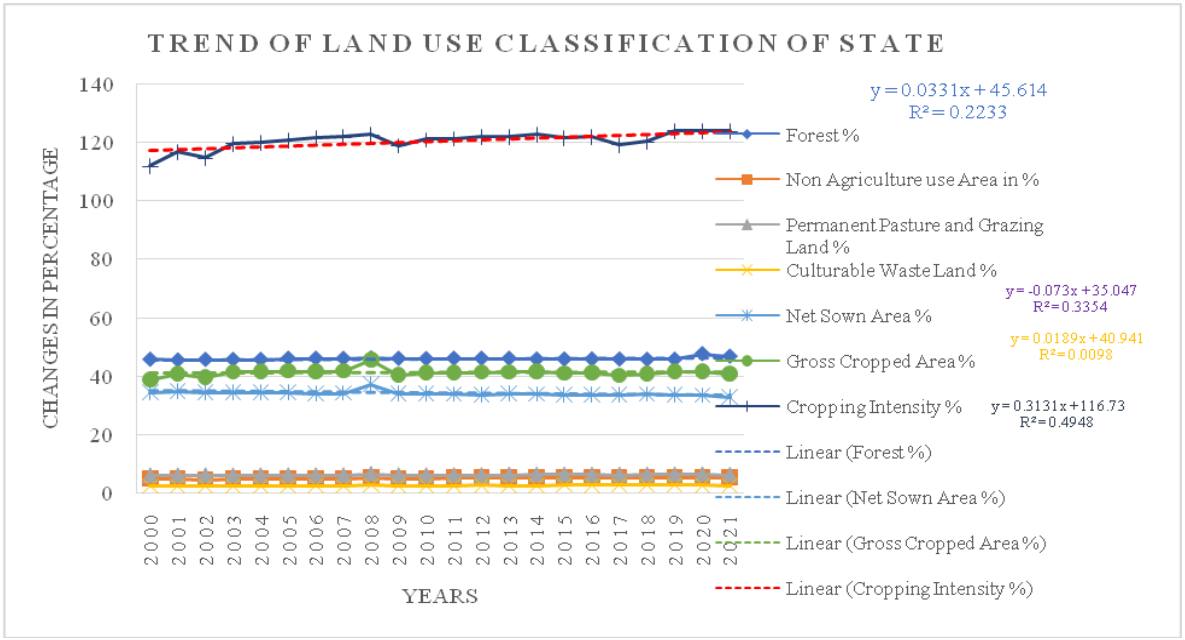

Figure 2. Trend of land use pattern and land classification of Chhattisgarh state

Figure number 2 revealed the percentage change in land use classification from the year 2000 to 2021. Net sown area of the state changed 4 percent negatively. Where highest 10 percent positive change was observed for cropping intensity of the state. Non-agriculture use of land and Culturable waste land also increased by 8 and 5 percent, respectively. Forest cover and gross crop increased positively by 2 and 5 percent, respectively.

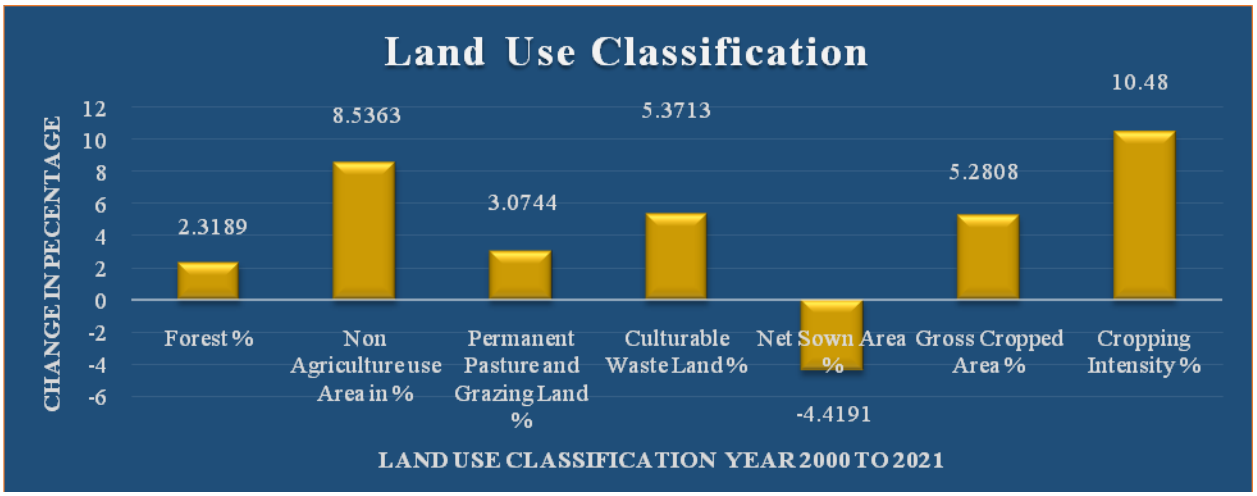

Figure 2.Percentage change in land use pattern and land classification of Chhattisgarh state

The data revealed that the net sown area decreased by -4.4191 percent. The majority of households depend on agricultural production for their livelihood, If there is a change or decrease in the netsown area, then farmers and families primarily dependent on agriculture may incur losses. According to the data, the net sownarea decreased primarily as a result of the expansion of non-agricultural land and cultivable wastelands. It has decreased due to the rapid expansion of industry and non-agricultural work in modern times. According to the data, the forest cover has increased by 2%, which may be positive effects of various programs such as the Green India mission, the CAMPA project, etc., and it creates the conditions for adaptation and mitigation of climate change. The Land Surface Temperature (LST) of vegetation including cropping areas and water bodies was 2° to 7° Celsius less than urban sprawl.Land Use

Change (LUC) and Land Surface Temperature (LST) have a significant relationship. Consequently,the government must enact a policy to halt the expansion of Wasteland and Permanent Pastureland and take the necessary steps to expand the net sown area and forest area. (Jaiswal T. et al.,2023).

3.2 Changes in the cropping pattern and area of the crop from 2000 to 2021

According to the average numbers for three years from 2019 to 2021, the area and production of paddy crops in the main crops share 74 and 84 percent, respectively. Regarding area and production, paddy is leading on the first rank. For production, maize, gram, wheat, and Lathyrus contribute 4, 2, and 1 percent, respectively. After the paddy crop, the area under gram, Lathyrus maize, and urad are highest in Chhattisgarh state, which contributes 6, 3, 2, 2, and 1 percent, respectively.

Table 2 Production and area of major crops in Chhattisgarh

S.No.	Crops	Production ('000 tonnes)			Area('000Hectares)			AVG % Share in T.P	AVG % Share in GCA	Rank (Production)	Rank (Area)
		2018-19	2019-20	2020-21	2018-19	2019-20	2020-21				
1	Paddy	6509.43	8569.3	9249.6	4140.97	4192.23	4339.26	85.17	74.23	1	1
2	Wheat	166.97	135.89	259.51	99.97	116.27	167.50	1.97	2.25	4	5
3	Maize	303.60	406.82	522.76	118.20	130.40	147.20	4.32	2.32	2	4
4	Small Millets	22.23	14.49	20.17	62.81	46.44	41.33	0.20	0.88	13	8
5	Gram	345.47	105.82	258.80	330.93	419.93	314.85	2.49	6.24	3	2
6	Redgram	29.96	22.47	23.90	62.78	35.77	39.89	0.27	0.81	11	9
7	Black Gram	26.98	24.84	28.77	82.39	76.06	76.95	0.28	1.38	10	6
8	Lathyrus	124.23	60.91	121.63	177.70	188.60	171.60	1.07	3.15	5	3
9	Groundnut	78.05	33.68	34.41	23.65	22.10	22.76	0.51	0.40	9	14
10	Niger	10.70	6.68	5.94	55.56	36.32	29.30	0.08	0.71	16	10
11	Soybean	52.20	83.00	47.34	81.56	75.11	64.50	0.64	1.30	8	7
12	Rapeseed Mustard	18.96	15.69	16.46	38.85	35.03	31.84	0.18	0.62	14	12
13	Sugarcane	93.38	69.90	74.23	43.30	31.20	32.20	0.83	0.63	6	11

Source: Agricultural Statistics Table (Year 2019, 2020 and 2021): O/o Commissioner Land and Revenue, Government of Chhattisgarh

As Chhattisgarh is known as the bowl of paddy, which is supported by the fact that, in terms of area and production, paddy is the most cultivated crop in the state, small millets, niger mustard, and black gram cover more area in Chhattisgarh. But when it comes to production, they are unable to maintain their position, as sugarcane provides the state of Chhattisgarh with more yield despite covering less land.In this situation of climate change, there is a need for crop diversification, with increased production way of mixed cropping, intercropping, poly vegetable farming, and intensive cultivation, as it creates an adaptation situation.

Data of average area are presented over the gross cropped area, change in the cropping pattern, and area in Chhattisgarh state are presented in Table 3.Paddy

was a major crop in the state for 21 years, constituting 68,69,69 and 72 percent of area cover during 2000-04,2005-09,2010-2014,2015-2020 year respectively. Lathyrus crop covered the second most cultivated area during three average periods up to the year 2014. Gram increased in the area during 2015-2020 and led as the second crop cultivated during the period. Gram contributed 5.75 percent area during 2015-2020. During 2005-2014 millets and other cereals are mainly cultivated and about 4.74 percent. Lathyrus crop was the third most cultivated crop in the state and shared around 3.64 percent during 2015-2020. The gram crop was shifted to the fourth highest cultivated area, followed by maize, wheat, and soybean contributed 1.72, 1.71, and 0.34 percent, respectively, from 2000 to 2004. Millets and Other cereals contributed 3.52 percent during 2005-2014. Maize was cultivated in fourth fourth-highest area in the state from 2015-2020.

In over 21 years,the cropping pattern has changed substantially in the state. The proportion of area under paddy has increased. The Lathyrus crop area was reduced by 2.5 percent from 2015-2020. Gram crop area was 1 percent increased from 2015-2020. Other cereals and millet were reducing year after year, Year 2023 is celebrating as international year of millets therefore its area may be increased.

Table 3. Cropping area and pattern over 21 years in Chhattisgarh

(Area in Hectares)

Year	Cropping Area and Land Use Pattern over 21 Years						
	1	**2**	**3**	**4**	**5**	**6**	**7**
2000-2004	PADDY	LATHYRUS	OTHER CEREALS AND MILLETS	GRAM	MAIZE	WHEAT	SOYABEAN
AVG AREA	3806255	381412	263311	184634	95513	94974	19122
PERCENT	68.48	6.86	4.74	3.32	1.72	1.71	0.34
2005-2009	PADDY	LATHYRUS	GRAM	OTHER CEREALS AND MILLETS	SOYABEAN	MAIZE	WHEAT
AVG AREA	388914	405404	259514	195820	126461	110768	109081
PERCENT	69.87	7.29	4.67	3.52	2.27	1.99	1.96
2010-2014	PADDY	LATHYRUS	GRAM	OTHER CEREALS AND MILLETS	MAIZE	WHEAT	SOYABEAN
AVG AREA	3976473	338420	272222	138115	115515	103883	95149
PERCENT	69.43	5.9	4.75	2.41	2.02	1.81	1.66
2015-2020	PADDY	GRAM	LATHYRUS	MAIZE	WHEAT	SOYABEAN	OTHER CEREALS AND MILLETS
AVG AREA	4122603	328717	208061	127029	115632	83074	72317
PERCENT	72.16	5.75	3.64	2.22	2.02	1.45	1.26

Source: Directorate of Economics and Statistics,Government of India

The cultivation of paddy, lathyrus, millets, gram, maize, wheat, and soybean was greater in the past, whereas the area of paddy, gram, lathyrus, maize, wheat, soybean, and small military area has decreased significantly. Only 32% of the net sown area in Chhattisgarh is irrigated, yet farmers cultivate 75% of paddy in Kharif. Paddy crop is detrimental to climate change because it emits methane gas, and 86% of farmers depend on its production. If a change impacts the paddy crop, the farmer's livelihood will

be impacted as well, although crop insurance and weather best agro advisory and forecasting can adopt to impact.

Improved crop production can be achieved with less water in Utera agriculture, which is better suited to rainfed agriculture. Millets is the crop with the third-largest area cultivated, which is currently its lowest ranking but It is becoming very popular with the advent of the Millets mission and International Year of Millets etc, which is a commendable move by the government. However, there is a need for a policy that includes, in addition to farmer millets, varieties of local varieties of paddy and traditional crops that are on the verge of extinction, and Policies can be promoted and formulated based on agroclimatic zones of Chhattisgarh.

The crop keshari or lathyrus also known as poorman's pulses, was cultivated on the second rank after paddy around the year 2000 and even earlier, but the area devoted to this crop was drastically reduced due to the presence of neurotoxic compounds. This crop can be grown in semi-arid, underdeveloped nations, flood-prone, drought, and l water-logged conditions, making it a crucial crop for adaptation to climate change. This crop requires fewer inputs (irrigation, pesticides, fertilizer, etc.) than other pulses and is more economical; its price is nearly half that of Pigeonpea. In 2014, the ICMR and the National Institute of Nutrition surveyed 18000 individuals in Raipur Durg and Bilaspur, Chhattisgarh, who consume 45 grams of pulses per day in the form of roti and gravy. The survey was conducted, but no significant results were discovered, nor was there a direct link to paralysis; consequently, the Chhattisgarh government lifted its ban in 2015, as have the governments of Maharashtra and West Bengal; its cultivation and promotion are now legal. However, the government should be aware that the crop product is also used to produce a variety of snacks, flour, and other value-added products, and that 2% of it is blended with pulses. The state and federal government should promote it as a climate-resilient crop and pulse. The outcome of long-term research finding can be used as per need of the area and crops. The change in crops and use of new varieties, improved agronomical practices will help to overcome these issues. The use of resource management technology and a change from sole production to a diversified system of agriculture are strongly justified. More support needs to be given to horticulture and agro-forestry (Joshi et al., 2009)

CONCLUSION

The productivity of each crop varies from place to place and hence identifying efficient cropping area with best use of available natural resources leads to optimum yield per unit area. Through analysis of efficient cropping zones, we can identify the area suitable for any particular crops. If a crop does not fall in an efficient cropping zone, then that crop can be replaced with the other crop, which has good potential to obtain optimum yield (Thavaprakaash et al. 2008). Land use has a clear impact on the environment. In particular, the changes in land use cause streamflow to rise and evapotranspiration (ET) to drop. These changes are mostly because more people are living in cities and there are fewer bodies of water, forests, and empty land in the Mahanadi Reservoir catchment. The effects of climate change and land use shifts together show how complicated their interactions are. (Verma S, et al.,2023).The various sectoral drivers of land-use change discussed above are strongly linked within and between levels of organization of human-environment systems. They interact directly, are linked via feedback, and thus often have synergetic effects. Any land manager also constantly makes trade-offs between different land-use changes(Lambin EF et al. 2001).

The land use data of state to district has been examined for the shifting of land investigation. The investigation revealed numerous key characteristics of the land use change and cropping pattern, which can be applied to agricultural management.Changing climatic parameters like increases in temperatureand changes in the pattern of rainfall allow for the planning of the cropping system.Land use analysis is essential for crop planning and building farm ponds, tanks, and irrigation projects.The results of this study could help governments, policymakers, and land use planners who are looking for good ways to manage available land. When it comes to climate change and changes in land use and land cover in ecological areas.

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Impact of Minimum Support Prices (MSP) Prices on Area, Production and Productivity of Jowar In India

R D Vaidkar*,U.T.Dangore*,V K Khobarkar*and N V Shende,**
*Asstt Professor ** Head , PGI, Dr. PDKV, Akola, Maharashtra
Correspondence:-rajeshvaidkar@yahoo.com
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ABSTRACT

The present study aimed to analyze the impact of various prices on area, production and productivity of Jowar in India. The Secondary data on Minimum support prices (MSP) of Jowar were collected from Indiaagristat website, Directorate of Marketing and Inspection and Commission for Agricultural Cost and Prices for the period 2001-02 to 2020-21 (20 years). The results shows that the impact of MSP, on jowar, the values of elasticity per cent indicating that previous year price influences current year's area of major jowar growing states The overall trend reveals that the linear regression models for jowar crop area, production and productivity in different states tend to perform better during period II and for the overall period compared to period I. This improvement signifies a heightened understanding of the impact of MSP, on jowar area, production and productivity as time progresses.

Keywords: *Minimum support prices, Regression*

INTRODUCTION

Agriculture is characterized by a wide range in the cost and price of the main agricultural commodities, which leads to changes in the choice of the farmer. The analysis gives details on how prices and costs for the crop chosen would vary from year to year. Such details help farmers understand how market prices behave so they can make the appropriate decisions about sowing and selling. It will be crucial to understand how the minimum support price, farm harvest price and wholesale price will affect area, production, and productivity since it will help you understand how prices from the prior year affect how much area is allocated for production. Minimum support prices (MSP) are fundamental components of agricultural price policy of India. It targets to corroborate support price to economy.

The major objectives of MSP are to support farmers from distress sales at severely low prices and to procure food grains for public distribution. Ideally, the market price will always remain higher than the MSP fixed by the government. With government guarantee, the farmer can always sell at the MSP if he/she cannot procure a better price elsewhere. Thus, MSP becomes a very important benchmark for the producer because it helps him estimate the revenue, aiding the financial planning and also influencing borrowing decisions and encourage production by the Government of India.

METHODOLOY

The study based on the secondary data collected for the period 2001-2002 to 2020-21 years comprises of three periods that is Period I: 2001-02 to 2010-11, Period II: 2011-12 to 2020-21 and Overall: 2001-02 to 2020-21.The secondary data on minimum support prices (MSP) for hybrid jowar were systematically gathered from a range of authoritative Government publications and websites. Additionally, wholesale prices of jowar were meticulously sourced from government websites, focusing on the major markets of the states as follows:

Table 1. Name of the major markets for wholesale prices of jowar in selected states

Sr.No	Name of states	Major markets
1	Maharashtra	Mumbai
2	Karnataka	Bijapur
3	Rajasthan	Jaipur
4	Tamil Nadu	Salem

Impact of various Prices on area, production and productivity

To study the impact of minimum support prices (MSP) on the acreage allocation, production and productivity of jowar were estimated for period I: (2001-02 to 2010-11), period II: (2011-12 to 2020-21), overall: (2001-02 to 2020-21).

1. Linear regression equation:

a. $A_t = a + bPr_{t-1}$

b. $P_t = a + bPr_{t-1}$

c. $Y_t = a + bPr_{t-1}$

2. Logarithmic regression equation:

a. Log $A_t = \log a + bPr_{t-1}$

b. Log $P_t = \log a + bPr_{t-1}$

c. Log $Y_t = \log a + bPr_{t-1}$

Where,

A_t = Area of jowar at $(t)^{th}$ period,
P_t = Production of jowar at $(t)^{th}$ period,
Y_t = Productivity of jowar at $(t)^{th}$ period,

Pr_{t-1} MSP of Jowar taken in per quintal at $(t-1)^{th}$ period

RESULTS AND DISCUSSION

Impact of MSP on area of jowar crop in India

The numerical coefficients within the linear function related to jowar notably exhibit a significant R^2 value at the 1 per cent significance level. This outcome substantiates the conclusion that the fluctuations in Jowar cultivation area can be attributed to the explanatory variable i.e., previous year's minimum support prices of the jowar across period I, period II, and the overall. Across multiple states, the R^2 values during period II surpass those observed in period I. Similarly, the R^2 values for the overall duration tend to exceed those of both period I and period II across most states.

Table 2 highlights the distribution of variance in cultivation area for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 71 per cent, 70 per cent, and 90 per cent variation in area of jowar and the value of elasticity has found as -0.0001, -0.92 and -0.0001 in the area explained by the independent variable (lagged MSP) for period I, period II, and the overall, respectively. Similarly, in Karnataka, the corresponding variation percentages are 67, 75 and 87 and value of elasticity has found as -0.0003,-0.0001 and -0.0001 for the same periods.

Table 2. State-wise impact of MSP on area of Jowar crop in India
(A_t = Area, Pr_{t-1} = MSP)

Name of states	Equation fitted	Period I		
		R^2	S.E. of R	Equation
Maharashtra	Log linear	0.71	0.020	Log A_t=3.766-0.0001Pr_{t-1}
Karnataka	Log linear	0.67	0.034	Log A_t=3.351-0.0003Pr_{t-1}
Rajasthan	Linear	0.16	70.47	A_t =524.76+0.17Pr_{t-1}
Tamil Nadu	Log Linear	0.70	0.044	Log A_t=2.712-0.0004Pr_{t-1}
		Period II		
Maharashtra	Linear	0.70	348.64	A_t =4369.27-0.92Pr_{t-1}
Karnataka	Log linear	0.75	0.037	Log A_t=3.204-0.0001Pr_{t-1}
Rajasthan	Linear	0.003	56.71	A_t =607.07-0.005Pr_{t-1}
Tamil Nadu	Linear	0.61	56.77	A_t =108.19+0.12Pr_{t-1}
		Overall		
Maharashtra	Log linear	0.90	0.046	Log A_t =3.760-0.0001Pr_{t-1}
Karnataka	Log linear	0.87	0.040	Log A_t =3.263-0.0001Pr_{t-1}
Rajasthan	Log linear	0.05	0.045	Log A_t =2.804-1.385Pr_{t-1}
Tamil Nadu	Linear	0.19	65.75	A_t =266.04+0.04Pr_{t-1}

In the case of Rajasthan, the independent variable accounts for 16 per cent, 0.3 per cent, and 5 per cent variation in the area and value of elasticity has found as 0.17,-0.005 and -1.39

during period I, period II and the overall respectively. For Tamil Nadu, the variation figures stand at 70 per cent, 61 per cent, and 9 per cent and value of elasticity has found as -0.0004, 0.12 & 0.04 for the respective periods.

This analysis underscores the varying degrees to which the lagged MSP variable contributes to explaining cultivation area fluctuations across different regions and timeframes. The values of elasticity per cent indicating thereby that previous year price influences current year's area of major jowar growing states.

Impact of MSP on production of Jowar crop in India

The numerical values of the linear function for jowar indicates that R^2 is significant at 1 per cent level and supports that variation in production of jowar is explained by the explanatory variable, i.e., previous year's minimum support prices of the jowar across period I, period II, and the overall. Across multiple states, the R^2 values during period II surpass those observed in period I. Similarly, the R^2 values for the overall duration tend to exceed those of both period I and period II across most states. The higher R^2 values for the overall period suggest that the linear regression equations derived from combined data points capture a more comprehensive view of the relationship between the variables.

Table 3 highlights the distribution of variation in production of jowar for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 4 per cent, 37 per cent, and 78 per cent variation and value of elasticity has found as -0.42, -0.57 and -1.24 in the production explained by the independent variable (lagged MSP) for period I, period II, and the overall, respectively. Similarly, in Karnataka, the corresponding variation percentages are 11, 36, and 36 and value of elasticity has found as 0.57, -7.90, and -0.24 for the same periods.

Table 3. State-wise impact of MSP on production of Jowar crop in India

(P_t = Production, Pr_{t-1} = MSP)

Name of states	Equation fitted	Period I		
		R^2	S.E. of R	Equation
Maharashtra	Linear	0.04	337.99	$P_t = 3919.75 - 0.42 Pr_{t-1}$
Karnataka	Linear	0.11	284.31	$P_t = 1056.78 + 0.57 Pr_{t-1}$
Rajasthan	Linear	0.02	164.33	$P_t = 200.42 + 0.16 Pr_{t-1}$
Tamil Nadu	Linear	0.14	25.86	$P_t = 281.05 - 0.06 Pr_{t-1}$
		Period II		
Maharashtra	Linear	0.37	428.39	$P_t = 2890.99 - 0.57 Pr_{t-1}$
Karnataka	Log linear	0.36	0.060	$\text{Log } P_t = 3.167 - 7.90 Pr_{t-1}$
Rajasthan	Linear	0.32	76.18	$P_t = 254.96 + 0.09 Pr_{t-1}$
Tamil Nadu	Linear	0.23	130.22	$P_t = 164.56 + 0.12 Pr_{t-1}$
		Overall		
Maharashtra	Linear	0.78	488.11	$P_t = 4262.35 - 1.24 Pr_{t-1}$
Karnataka	Linear	0.36	236.53	$P_t = 1533.56 - 0.24 Pr_{t-1}$
Rajasthan	Linear	0.28	120.99	$P_t = 237.56 + 0.1 Pr_{t-1}$
Tamil Nadu	Linear	0.47	90.86	$P_t = 174.29 + 0.16 Pr_{t-1}$

In the case of Rajasthan, the independent variable accounts for 2 per cent, 32 per cent, and 28 per cent variation and value of elasticity has found as 0.16, 0.09 and 0.1 in the production during period I, period II, and the overall respectively. For Tamil Nadu, the variation figures stand at 14 per cent, 23 per cent, and 47 per cent and value of elasticity has found as -0.06, 0.12 & 0.16 for the respective periods. This suggests that the relationship between MSP and jowar production becomes more evident and stronger over time. The elasticity for these variables is significant at 1 per cent level in case of production of jowar.

The overall trend reveals that the linear regression models for jowar crop production in different states tend to perform better during Period II and for the overall period compared to period I. This improvement signifies a heightened understanding of the impact of MSP on jowar production as time progresses.

Impact of MSP on productivity of Jowar crop in India

The numerical values of the linear function for jowar indicates that R^2 is significant at 1 per cent level and supports that variation in productivity of jowar is explained by the explanatory variable, i.e., previous year's minimum support prices of the jowar. Across most states, there's a notable decrease in the R^2 values from period I to period II. This implies that the linear regression models developed for period II explain a smaller proportion of the variance in jowar crop productivity compared to the models in period I. The R^2 values for the overall period are generally lower than those for period I in most states. This indicates that the linear regression models established for the entire duration provide less explanatory power compared to the models for individual periods.

Table 4 State-wise impact of MSP on productivity of Jowar crop in India

(Y_t= Productivity, Pr_{t-1} = MSP)

Name of states	Equation fitted	Period I		
		R^2	S.E. of R	Equation
Maharashtra	Linear	0.25	76.83	$Y_t = 660.02 + 0.25 Pr_{t-1}$
Karnataka	Linear	0.37	221.02	$Y_t = 346.02 + 0.97 Pr_{t-1}$
Rajasthan	Linear	0.02	225.34	$Y_t = 344.89 + 0.19 Pr_{t-1}$
Tamil Nadu	Linear	0.32	118.23	$Y_t = 540.69 + 0.46 Pr_{t-1}$
		Period II		
Maharashtra	Linear	0.01	143.83	$Y_t = 651.66 + 0.02 Pr_{t-1}$
Karnataka	Linear	0.13	119.76	$Y_t = 902.85 + 0.08 Pr_{t-1}$
Rajasthan	Linear	0.36	129.80	$Y_t = 404.73 + 0.17 Pr_{t-1}$
Tamil Nadu	Log linear	0.20	0.191	$\text{Log } Y_t = 2.246 - 0.05 Pr_{t-1}$
		Overall		
Maharashtra	Linear	0.14	122.49	$Y_t = 832.19 - 0.06 Pr_{t-1}$
Karnataka	Linear	0.14	195.92	$Y_t = 872.16 + 0.10 Pr_{t-1}$
Rajasthan	Linear	0.41	173.86	$Y_t = 346.50 + 0.2 Pr_{t-1}$
Tamil Nadu	Log linear	0.37	0.135	$\text{Log } Y_t = 2.297 + 0.0001 Pr_{t-1}$

The reduced R^2 values for the overall period suggest that there might be certain complexities or fluctuations in the relationship between MSP and jowar crop productivity when considering data across both periods.

Table 4 highlights the distribution of variance in productivity for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 25 per cent, 1 per cent, and 14 per cent variation and value of elasticity has

found as 0.25, 0.02 and -0.06 in the productivity explained by the independent variable (lagged MSP) for period I, period II, and the overall respectively.

Similarly, in Karnataka, the corresponding variation percentages are 37, 13, and 14 and value of elasticity has found as 0.97, 0.08, and 0.10 for the same periods. In the case of Rajasthan, the independent variable accounts for 2 per cent, 36 per cent, and 41 per cent variation and value of elasticity has found as 0.19, 0.17 and 0.2 in the productivity during period I, period II, and the overall, respectively. For Tamil Nadu, the variation figures stand at 32 per cent, 2 per cent, and 37 per cent and value of elasticity has found as 0.46, -0.05 & 0.0001 for the respective periods. This suggests that the relationship between MSP and jowar productivity becomes more evident and stronger over time. The elasticity for these variables is significant at 1 per cent level in case of productivity of jowar.

CONCLUSION

The impact of MSP of jowar, the values of elasticity per cent indicating that previous year price influences current year's area of major jowar growing states The overall trend reveals that the linear regression models for jowar crop production and productivity in different states tend to perform better during period II and for the overall period compared to period I. This improvement signifies a heightened understanding of the impact of MSP on jowar area, production and productivity as time progresses. The increase in MSP over the previous year brought additional area under food crops, but the impact was nominal.Higher demand due to more procurement for central part than supplies does not allow the market prices to fall below MSP.

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Production, Marketing, and Resource Use Constraints in Potato Cultivation: Challenges and Recommendations for Farmers in Surguja District, Chhattisgarh

Ankita Mukherjee[1*], Hulas Pathak[2] and Payal Jaiswal[3]

[1]Research Scholar, Department of Agricultural Economics, College of Agriculture, IGKV, Raipur, Chhattisgarh.
[2]Professor, Department of Agri - Business and Rural Management, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh.
[3]Assistant Professor, College of Agriculture & Research Station, Gariaband, IGKV, Raipur, Chhattisgarh.
*Corresponding: mukherjeankita@gmail.com
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ABSTRACT

Potato (Solanum tuberosum L.) is a critical crop in Indian agriculture, contributing significantly to food security and rural incomes. This study investigates the marketing patterns and constraints in potato cultivation in the Surguja district of Chhattisgarh, focusing on production and marketing challenges across different farm sizes. The key objectives are: (1) to examine the marketing patterns of potatoes in the region, and (2) to identify constraints in production and marketing, with policy recommendations to address these issues. Primary data were collected from 250 farm households during the 2022-23 agricultural season, categorized into small, medium, and large farms.

The findings reveal that farmers face considerable challenges, including high input costs, limited availability of quality seeds, inefficient irrigation practices, and dependence on traditional techniques. In marketing, price volatility, limited access to organized markets, lack of cold storage facilities, and exploitation by middlemen are major issues. Garrett's ranking method highlights variations in the severity of constraints across farm sizes, with small farmers particularly affected by input costs and market accessibility.

The study emphasizes the need for targeted interventions, such as establishing local cold storage units, promoting direct marketing channels, providing subsidies for quality seeds and irrigation systems, and strengthening extension services. These measures are essential to enhance productivity, profitability, and sustainability in potato farming, ensuring better livelihoods for farmers in the Surguja district.

Keywords: *Potato cultivation, Marketing constraints, Surguja district, Farm profitability, Policy recommendations.*

INTRODUCTION

Potato (Solanum tuberosum L.) is a crucial crop globally, ranking fourth in importance after maize, rice, and wheat. Known for its adaptability and nutritional value, it plays a vital role in food security and rural livelihoods. India is the world's second-largest potato producer, contributing 12% of global production, with diverse agro-climatic conditions supporting its cultivation, particularly during the Rabi season. Potatoes significantly enhance the nation's agricultural economy, contributing approximately 2.86% to agricultural GDP.

Chhattisgarh, traditionally not a major potato-producing state, has made remarkable progress in recent years, with the Surguja district emerging as a key production hub. In 2022-23, Surguja accounted for 15.6% of Chhattisgarh's potato production, with 102,417 tons harvested across 7,420 hectares. Favorable topography, climate, and research initiatives such as the Potato Research Centre in Mainpat have contributed to this success.

Despite these advancements, Surguja's potato farmers face significant challenges, including high input costs, limited access to quality seeds and fertilizers, pest outbreaks, inadequate storage facilities, and market inefficiencies. These issues negatively affect productivity, profitability, and sustainability in potato farming.

The objectives of this study are to identify production, marketing and resource use efficiency challenges and suggest appropriate policy interventions to address these challenges. By identifying the key issues and suggesting targeted solutions, this research aims to enhance the economic viability and sustainability of potato cultivation in the Surguja district.

METHODOLOY

Study Area

This study was conducted in Surguja district, Chhattisgarh, which has become a significant hub for potato cultivation in the state. During the 2022-23 agricultural season, Surguja produced 102,417 tons of potatoes across 7,420 hectares, contributing 15.6% to the state's total production. The district's topography, including fertile valleys and undulating terrain, along with its subtropical climate, provides favorable conditions for potato farming. The establishment of the Potato Research Centre in Mainpat has further supported advancements in potato cultivation practices.

Sampling Procedure

A multistage random sampling method was employed to ensure the representativeness of the study. Surguja district was purposively selected due to its significant role in potato cultivation within Chhattisgarh. Within this district, Ambikapur and Mainpat blocks, recognized for their substantial contribution to potato production, were chosen as the study areas. From these blocks, two villages each were selected: Narbadapur and Sarbhanja in Mainpat, and Karji and Gadaghat in Ambikapur. The final sample consisted of 250 potato farmers, who were categorized based on their landholding size into three groups: small farmers with holdings of 1–2 hectares (75 respondents), medium farmers with holdings of 4–10 hectares (110 respondents), and large farmers with holdings exceeding 10 hectares (65 respondents). This sampling approach ensured a comprehensive representation of the constraints faced by farmers across varying scales of potato cultivation.

Data collection

Comprehensive data collection was undertaken to ensure a thorough analysis of the constraints in potato cultivation and marketing. Primary data were gathered through structured interviews and questionnaires administered during the 2022-23 agricultural season. The information collected encompassed various aspects of farming, including input usage such as seeds, fertilizers, labor, and irrigation, as well as farming practices like land preparation, planting, and pest management. Additionally, farmers were asked to identify constraints in production, such as limited availability of quality inputs, water scarcity, and lack of technical knowledge, alongside marketing challenges like price volatility, inadequate storage facilities, and dependency on middlemen. Secondary data were obtained from the Department of Horticulture, Government of Chhattisgarh, covering the period from 2004-05 to 2022-23. These time-series data on potato area, production, and productivity provided essential insights into long-term trends and supported the contextual analysis of potato cultivation in Surguja district.

Analytical Tools

1. **Garrett's Ranking Technique**:

This method was employed to prioritize the constraints perceived by farmers in production and marketing. Farmers assigned ranks to identified constraints, which were converted into scores using the formula: Here is the formula in a copyable text format:

Percent Position = ((Rij - 0.5) / Nj) × 100

Where:

Rij = Rank given for the i-th factor by the j-th individual.

Nj = Number of factors ranked by the j-th individual.

Scores were averaged for each constraint, and results were arranged in descending order to highlight the most critical issues.

2. **Tabular Analysis**:

Tabular presentation was used to summarize data on constraints and compare their severity across small, medium, and large farms. Statistical measures such as averages and percentages facilitated interpretation and analysis.

RESULTS AND DISCUSSION

This study evaluates the constraints faced by potato growers in the Surguja district, categorizing them under production, marketing, and resource utilization challenges. Using Garrett's ranking technique, data from 250 respondents—categorized into small, medium, and large farmers—were analyzed to determine the severity of these

constraints. The findings highlight significant differences in the challenges faced by farmers of varying scales, as detailed below.

Constraints in Potato Production

The production challenges varied in intensity across farm sizes. For small farmers, the non-availability of quality seeds (mean score: 83.12) was the most severe constraint, limiting their capacity to achieve optimal yields. Medium and large farmers also reported seed shortages, but the issue was compounded by labor shortages (76.53), especially during peak planting and harvesting seasons. Untimely rainfall (73.25) emerged as a critical challenge for all farmer categories, particularly small farmers who rely heavily on rain-fed irrigation. Additional constraints included high costs of cultivation, which disproportionately affected small and medium farmers, and limited availability of mechanized harvesters (68.32), which posed greater challenges for larger farms requiring efficient operations over vast areas. The lack of timely institutional credit (62.36) was a notable issue for small farmers, restricting their ability to purchase inputs on time.

Policy Recommendations for Production Constraints

1. Seed Availability: Introduce subsidized seed distribution programs for small farmers, establish local seed banks, and promote regional seed production to ensure timely access.
2. Labor Management: Provide machinery subsidies for small and medium farmers and introduce cooperative ownership models for harvesters to support larger farms.
3. Water Management: Invest in irrigation infrastructure, including drip and sprinkler systems, and offer weather forecasting services tailored to local conditions.
4. Cost Reduction: Subsidize fertilizers, machinery, and pest management tools, with a focus on small and medium farmers.
5. Credit Access: Simplify institutional credit procedures and ensure the timely availability of Kisan Credit Cards (KCC), especially for small farmers.
6. Mechanization Support: Establish machinery rental hubs for small and medium farmers, and provide training on advanced machinery for larger farms.

Table 1: Percentage Position and Garrett Value

Rank	Formula	Percentage Position (%)	Garrett Value
1	100 * (1 - 0.5) / 7	7.14	83.12
2	100 * (2 - 0.5) / 7	21.43	76.53
3	100 * (3 - 0.5) / 7	35.71	73.25
4	100 * (4 - 0.5) / 7	50.00	71.32
5	100 * (5 - 0.5) / 7	64.29	69.25
6	100 * (6 - 0.5) / 7	78.57	68.32
7	100 * (7 - 0.5) / 7	92.86	62.36

Table 2: Constraints in Potato Production

S. No.	Factor	Mean Score	Rank
1	Non-availability of seeds	83.12	I
2	Non-availability of labour	76.53	II
3	Untimely rainfall	73.25	III
4	High cost of cultivation and production	71.32	IV
5	High fluctuations in price	69.25	V
6	Less availability of potato harvester	68.32	VI
7	Lack of timely institutional credit facility	62.36	VII

Constraints in Potato Marketing

The marketing constraints also revealed variations across farm sizes. Small farmers identified the lack of regulated markets (mean score: 75.10) as their primary challenge, as they depend on intermediaries for selling their produce. For medium farmers, the lack of cold storage facilities (72.85) emerged as a critical issue, while larger farms were most affected by price fluctuations and low market prices (71.50). Transportation challenges (68.90) were significant for all categories, particularly for small farmers in remote areas, while the dependency on middlemen (66.20) and limited marketable surplus (64.75) added to the marketing inefficiencies.

Policy Recommendations for Marketing Constraints

1. Market Regulation: Develop regulated markets tailored for small and medium farmers to ensure fair pricing and reduce middlemen exploitation.
2. Cold Storage Infrastructure: Establish storage units in key locations for medium and large farmers to reduce post-harvest losses.
3. Price Stability: Enforce MSP policies and introduce price stabilization funds to protect all farmers against market volatility.
4. Transportation Improvements: Enhance rural transportation facilities, with a focus on small farmers in remote areas.
5. FPO Development: Strengthen Farmer Producer Organizations to increase bargaining power, particularly for small and medium farmers.
6. Market Commission Reform: Reduce commission charges in markets to ensure
7. Higher returns for all categories of farmers.

Table 3: Constraints in Potato Marketing

S. No.	Factor	Mean Score	Rank
1	Lack of regulated markets for potatoes	75.10	I
2	Lack of cold storage facilities	72.85	II
3	Price fluctuations and low market prices	71.50	III
4	Lack of transportation facilities	68.90	IV
5	Dependency on middlemen/market intermediaries	66.20	V
6	Small marketable surplus	64.75	VI

Constraints in Resource Use Efficiency of Potato Cultivation

The study also highlighted resource utilization constraints, which vary by farm size. Small farmers face significant water management challenges due to their reliance on rain-fed systems, while medium and large farmers struggle with inefficient irrigation systems. Fragmented landholdings limit mechanization and optimal land use, particularly for small and medium farmers. Additionally, inadequate access to credit restricts all farmer categories from adopting resource-efficient practices.

Policy Recommendations for Resource Utilization

1. Water Management: Promote drip and sprinkler irrigation systems for medium and large farms, and rainwater harvesting for small farms.
2. Land Consolidation: Encourage cooperative farming models to optimize land use and mechanization, particularly for small and medium farmers.
3. Credit Access: Ensure streamlined access to institutional credit, especially for small farmers, through enhanced KCC schemes.

CONCLUSION

This study provides a comprehensive analysis of the challenges faced by potato farmers in the Surguja district of Chhattisgarh, particularly in production, marketing, and resource use efficiency. The findings highlight that small, medium, and large farmers encounter distinct constraints, necessitating targeted policy interventions. The most pressing production issues include the non-availability of quality seeds, labor shortages, untimely rainfall, high cultivation costs, and limited mechanization, all of which significantly impact farm productivity and profitability. Similarly, in the marketing domain, farmers face challenges such as price fluctuations, lack of regulated markets, inadequate cold storage facilities, and dependence on intermediaries, which limit their bargaining power and income stability. Additionally, inefficiencies in resource utilization, including irrigation constraints, land fragmentation, and restricted access to institutional credit, further hinder sustainable farming practices.

Addressing these constraints requires a multi-pronged policy approach. Strengthening seed distribution networks, providing mechanization support, and enhancing irrigation infrastructure can alleviate production bottlenecks. For marketing improvements, the establishment of regulated markets, better transportation facilities, and the development of cold storage units will reduce post-harvest losses and stabilize farmer incomes. Furthermore, improving access to institutional credit and promoting cooperative farming models will enhance resource efficiency and support sustainable agricultural growth.

By implementing these recommendations, policymakers can significantly improve the economic viability of potato farming in Surguja district. Strengthening farmer support systems, ensuring better market linkages, and promoting resource-efficient technologies will not only increase productivity and profitability but also contribute to the long-term sustainability of potato cultivation in the region. Future research should focus on evaluating the effectiveness of these interventions and exploring innovative strategies to further enhance the resilience of potato farmers in Chhattisgarh.

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Growth and instability in area, production and productivity of Pigeonpea in Maharashtra

R. D. Shelke[1*], S.H.Kamble[2] and G.M.Bodakhe[3]

1& 2 Associate Professor, Department of Agricultural Economics, College of Agriculture,Latur
3.Ph.D. student, Department of Agricultural Economics, College of Agriculture,Parbhani
*Correspondence: rajesh.shelke25@gmail.com
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ABSTRACT

Pulses are highly nutritious and are an excellent source of protein, dietary fiber, vitamins, and minerals. In the country's total area coverage and production of tur has been about 4.7 MH and 4.1 MT respectively.Growth and instabilityin area, production and yield of pulses were analysed at district level. Secondary time series data were used for estimating objectives for the years from 1990-91 to 2019-20. Growth rate and instability were computed for three sub-periods and overall period. Period-I consisted from the year 1990-91 to 1999-00, period-II was from the year 2000-01 to 2009-10, period-III from 2010-11 to 2019-20 and overall period comprises from the year 1990-91 to 2019-20. To examine the stability, mean, standard deviation and Coefficient of Variation (CV) were workedout. Cuddy-Della Valle Indexwas used as a measure of variabilityin time series data analysis and estimation of instability in area, production and yield of pulses for the present investigation. The districts with the largest rates of increase in pigeon pea area were Yavatmal (1071.70 hectares),which was followed by Amravati (858.80 hectares). The compound growth rate of area for pigeon pea in Yavatmal districts were found to be positively significant at 5 per cent and rest Amravati and Latur, district were found to be positively non significant. Among all the districts of the study area for the Pigeon pea. It also revealed that, Amravati district showed a positive compound growth rate with minimum instability index (4.84) for the pigeon pea crop.Growth and instability in the pulses area of theMaharashtra state during Period II (2000-01 to 2009-10).The highest increasing trendin area was recorded in Yavatmal district i.e. 1190.30 hectares, followed by Amravati district i.e. 946.30 hectares for the pigeon pea. Growth and instability in the pulses area of the Maharashtra state during Period III(2010-11to2019-20).The highest increasing trend in area was recorded in Yavatmal district i.e. 1256.41 hectares, followed by Amravati district i.e. 1136.82 hectares for the pigeon pea.Growth and instability in the pulses area of the Maharashtra state during overall period (1990-91 to 2019-20). The highest increasing trend in area was recorded in Yavatmal districti.e.1172.80hectares, followed by Amravati districti.e.980.64 hectares for pigeon pea.

Keywords: *Instability, Coefficient of Variation, Cuddy-Della Valle Index, CGR, standard deviation*

INTRODUCTION

The word "pulse" is derived from the *Latin* words pulsorpultis, which imply "thick soup". They have been a staplefood in various cultures for thousands of years and play a significant role in global cuisine. Pulses are highly nutritious and are an excellent source of protein, dietary fiber, vitamins, and minerals. The origin of pulses dates to ancient times, with their cultivation and consumption traced to multiple regions around the world. Pulses such as pigeon peas (tur dal), mung beans, and chickpeas have been cultivated in the Indian subcontinent for

thousands of years.

Pigeon peas, scientifically known as *Cajanus cajan*, are a type of pulse witha stimulating origin. They have been an essential crop in India for ages and are called by numerous names, including "toor dal" or "arhar dal."

In India, total pulse area and production has been more than 26 MH and 22MT respectively. Out of the total areamore than 6 MH is confined to Madhya Pradesh alone, earning a prime status in pulse production commodity contributing a remarkable 21 per cent of the country's pulse area with 25 per cent production, thereby ranking first both in area and production followed by Rajasthan, Maharashtra and Uttar Pradesh with 16per cent, 15 per cent and 10per cent.More than90percentoftotal pulseproductionhas beencontributedby10 statesofMadhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka, Andhra Pradesh, Gujarat, Jharkhand, Tamilnadu and Odisha.

In the country"s total area coverage and production of tur has been about 4.7 MH and 4.1 MT respectively. Karnataka ranked first (>1.3 MH) contributes 29 per cent in area and 24 per cent in production, whereas, Maharashtra has contributed 27 per cent of area and 28 per cent of total production.About than 96 per cent of Arhar production of the country during the period under report has been realized by10states of Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh, Gujarat, Telangana, Jharkhand, Odisha and Andhra Pradesh.

Objective

1. To examine the growth rate in area, production and productivity of pigeon pea in Maharashtra

METHODOLOGY

Analyticaltoolsandtechniques

Districts are the lowest administrative unit at which reliable agricultural data is available in Maharashtra, hence growth and instability in area, production and yield of pulses were analysed at district level. Secondary time series data were used for estimating the above-mentioned objectives for the years from 1990-91 to 2019-20. Growth rate and instability were computed for three sub-periods and overall period. Period-I consisted from the year 1990-91 to 1999-00, period-II was from the year 2000-01 to2009-10,period-III from 2010-11to2019-20 and overall period comprises from the year1990-91to2019-20.

Compound growth rate is a crucial indicator to measure agricultural growth and can be used for finding the area/production/productivity *etc*. of pulses. It plays a vital role in agricultural policy making, therefore, estimated value of growth rateneeds to be very accurate, so that appropriate policies can be embraced accordingly. Accuracy of estimated value of growth rate largely depends on proper statistical procedures followed to estimate it. Compound growth rate is simply a compounding of annual growth rates over period. It can be easilycalculated usingtwo data points with constant returns as in case of fixed deposits. Growth rate is a value which shows an increase or decrease per unit over the constant values. The growth rate of area, production and productivity, of selected crops were estimated for three sub periods. The growth rates were estimated using following models

Linear-trendequation

The linear growth rate of pulses in terms of area, production and productivity was estimated with the help of the following linear function.

$$Y_t = a+bt + u$$

In order to work out the compound growth of area, production and productivity.

The following exponential function was used which is follows:

$$Y_t = ab^t$$

Measure of instability in pulse production

To examine the stability, mean, standard deviation and CV were worked out. Standard deviation (σ) is positive square root of arithmetic mean of the square of deviations of the given observation from their arithmetic mean. Standard deviation is an absolute measure of dispersion, given by formula.

$$\sigma \sqrt{\frac{1}{(\sum(X-X)^2}}$$

In order to study the variability in area, production and productivity of major pulses in Maharashtra State, an instability index by Cuddy and Della (1978) was used.

Instability index= CV X $\sqrt{1-R^2}$

The present research comprises both primary and secondary data, whichwas collected for accomplishing the objective oriented results. The collected data was subjected to statistical analysis and the results so obtained were discussed and presented in the tables, figures, graphs and their interpretation under the followingfive sections.

Results and Discussion

Growth rate in area, production and productivity of pigeonpea in Maharashtra

The secondary data was collected for the period from 1990-91 to 2019-2020 for thirtyyears and were divided into threeperiods that are Period I, Period II and Period III Compound Growth rate and Instability was calculated for Area, Production and Productivity for Period I, Period II, Period III and overall period of various districts of Maharashtra state.

The relative changes in Area, Production, and Productivity of pigeonpea over time will help to illustrate the scale of agricultural development in the district of Maharashtra State.

Growth and instability in area, production and productivity of pigeon pea in Amravati district

An attempt was made to estimate the growth rates of area, production and productivity of pigeon pea with the help of growth rate model explained in methodology. The results obtained are shown below, Compound growth rates of area under pigeon pea in Amravati district was analyzed and is presented in Table 1.The growth performance of pigeon pea has been analyzed for the different period's viz., period-I (1990-91 to 1999-00), period-II (2000-01 to 2009-10), period- III(2010-11to2019-20) and the overall period(1990-91to2019-20).The growth rate of pigeon pea crops over the period 1990-91 to 2019-20 in the state have been shown in the Table 1. It was observed from Table 1 that, the growth rate of area was found non significant in period-I period-II and period-III. The overall period, the growth rate was found 1.22 per cent which is significant at 1 per cent level. It indicates that, the area under Pigeon pea was decrease. The average area of Pigeonpea in Overall study period was 08.58 lakh ha. The C.D. Vella values were ranging between from 4.77 to 8.63. Lower variation in the area were observed in second period. The instability in the area was observed low in the all sub period and overall also.

It was observed that, the growth rates in case of production for period-Iwas5.96 per cent which is significant at 10 per cent level. In period-II, the growth ratewas found 1.88 per cent which is significant at 10 per cent level and the period-III growth rate of production was found non significant. In overall period, it was 1.65per cent which is significant at 1 per cent level. From this, it indicates that, the production is significant in Amravati district has been bought by the increased yield in which the returns were made possible due to adoption of modern techniques. The instability index were ranging between from 11.75 to 34.38. The production was unstable in overall research period.

It is most important criteria of measuring the growth of any crop output. The success or failure of any improvement in the art of agriculture is measured by the resultant increase or decrease in the productivity. The average crop yield in the overall period was 864.90 kg per ha.The average yield increased to 839.56 to 885.57 kg per ha.It was seen that, the growth rate of productivity of pigeonpea for the period-I was5.57 per cent which was significant at 5 per cent level and the period-II was 2.11 per cent which was significant at 10 per cent level. In period-III, it was found non significant. In overall period, it was 0.42 percent which was significant at 10 percent level. The growth of area, production and productivity in period-I was greater than period-II and period-III.

Growth and instability in area, production and productivity of pigeon pea in Latur district

The result of growth and instability analysis for the Latur district were presented in the Table 2. Over the period 1990-91 to 2019-20, The growth in the area of Pigeon pea were positive and significant. The growth rate of area was found non significant in period-I period-II and period-III. During overall period the growth in area was 2.37 per cent which is significant at 1 per cent level. The average area in the first period was 06.73 lakh ha. which was increased up to 11.03 lakh ha. in the third period. The average area of pigeonpea was 8.42lakhha.The C..D.Vellavalues was ranging between from 4.41 to 10.17. The C.D. Vella index value for overall period was 11.69, which shows low instability in the area.

Growth in production were positively significant in overall study period. The growth in production was non-significant in period-I and Period-III. In period-II, the growth rate was found 12.10 per cent which is significant at 05 per cent level. Overall production was increased by 7.48 per cent by compound growth. From this, it indicates that, the production is significant in Latur district has been bought by the increased yield in which the returns were made possible due to adoption of modern techniques. The average production was 754.06 lakh tonnes. During research period instabilityin production were moderate to high. Maximum instabilitywas observed in third period (83.91 per cent). The production was unstable in overall research period.

The average crop yield in the first period

was 500.17 kg per ha. which was increasedupto1160.10kgperha.inthirdperiod.Theovera llperiodcropyieldis823.69.The growth in yield werepositivelysignificant in overall studyperiod. It was seen that, the growth rate of productivity of pigeon pea for the period-I was 13.48 per cent which was found non significant and the period-II was 10.39 per cent which was significant at 5 per cent level. In overall period, it was 4.99 per cent which was significant at 1 per cent level. The C.D. vella values was higher in the third period indicating higher fluctuation of yield of the crop..The C.D.value were ranged from31.13 to 73.74 percent.

Growth and instability in area, production and productivity of Pigeon pea in Solapur district

The result of growth and instability analysis for the Solapur district were presented in the Table-3.Over the period1990-91to2019-20,the growth in Pigeon pea were negative and non-significant. The growth rate of area was found non-significant inperiod-II and period-III. During overall period the growth in area was-1.31percent which is non-significant. The average area in the first period was 3.77 lakh ha. which was decrease upto 1.78 lakh ha. in the secondperiod. The average area of pigeon pea was 2.80 lakh ha. The C..D. Vella values were ranging betweenfrom15.83to49.01.TheC.D.Vellaindexvaluefo roverallperiodwas42.84, which shows high instability in the area.

Growth in production were positively significant in overall study period. The growth in production was non-significant in period-I, period-II and period-III. In period-II, the growth rate was found 8.10 per cent which is highest but non- significant. Overall production was increased by 1.00 per cent by compound growth. From this, it indicates that, the production is significant in Solapur district has been boughtbytheincreased yieldinwhichthereturns weremadepossibleduetoadoption of modern techniques. The average production was 93.24 lakh tonnes. Duringresearch period instability in production were moderate to high. Maximum instability was observed in second period (67.76 per cent). The production was unstable in overall research period.

The average crop yield in the first period was 248.41 kg per ha. which was increasedupto409.12kg per ha.inthirdperiod.Theoverallperiodcropyieldis330.09.T he growth in yield werepositivelysignificant in overall studyperiod. It was seen that, the growth rate of productivity of pigeon pea for the period-I was 3.85 per cent which was found non significant and the period-II was 5.12 per cent which was non-significant. In over all period, it was 2.35 per cent which was significant at 1 per cent level. The C.D. vella values was higher in the third period indicating higher fluctuation of yield of the crop. In general the fluctuation in yield was moderate to high. The C.D. value were ranged from 35.30 to 41.06 per cent.

Growth and instability in area, production and productivity of pigeon pea in Yavatmal district

The result of growth and instability analysis for the Yavatmal district were presented in the Table 4. Over the period 1990-91 to 2019-20, The growth in the area of Pigeon pea were positive and significant. The growth rate of area was found significant in period-I period-II and period-III. During overall period the growth in area was 0.81 per cent which is significant at 1 per cent level. The average area in the first period was 10.71 lakh ha. which was increased upto 12.56 lakh ha. in the third period. The average area of pigeon pea was 11.72 lakh ha. The C..D. Vella values were ranging between from 5.47 to 13.26 The C.D.Vella index value for overallperiod was 11.79, which shows low instability in the area.

Growth in production were negative significant in overall study period. The growth in production was significant in period-I and Period-II. In period-III was non- significant The growth ratewas found 8.05 per cent which is significant at 05 percent level in period-I. Overall production was decrease by -0.67 per cent by compound growth. The average production was 1010.90 lakh tonnes. During research period instabilityin production were moderate to high. Maximum instabilitywas observed in third period (53.87 per cent). The production was unstable in overall research period.

The average crop yield in the first period was 854.31 kg per ha. which was increased upto 906.08 kg per ha.in second period. The overall period crop yield is 850.79.The growth in yield were negativelynon-significant in overall study period. It was seen that, the growth rate of productivity of pigeonpea for the period-Iwas5.17 per cent which was found significant at 05 per cent level in period-Iand the period-II was -5.19 per cent which was significant at 5 per cent level. In period-III, it was found non significant. In over all period, it was -0.87 per cent which was non- significant. The C.D. vella values was higher in the third period indicating higher fluctuation of yield of the crop. In general the

fluctuation in yield was moderate to high. The C.D.value were ranged from 21.75 to 41.87 per cent.

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Table1:Growth and instability in area, production and productivity of pigeon pea in Amravati district

Estimates	Sub-Periods			Overall
	I	II	III	
Area(000'ha)				
CGR	0.36	-0.23	-0.80	1.22***
Mean	858.80	946.30	1136.82	980.64
SD	43.01	47.82	97.61	134.83
CV	5.01	5.05	8.59	13.75
CDVella	4.84	4.77	8.50	8.63
Production(000'MT)				
CGR	5.96*	1.88*	2.49	1.65***
Mean	725.00	821.09	1007.12	851.07
SD	193.69	100.34	373.55	268.81
CV	26.72	12.22	37.09	31.59
CDVella	24.94	11.75	34.38	27.88
Productivity(kg/ha)				
CGR	5.57**	2.11*	3.31	0.42*
Mean	839.56	869.58	885.57	864.90
SD	199.77	113.34	332.28	225.86
CV	23.79	13.03	37.52	26.11
CDVella	21.84	12.50	34.78	26.07

Note:

Period-I:1990-91 to 1999-00

Period-II :2000-01 to 2009-10

Period-III : 2010-11 to 2019-20

*****Significant at 01percentlevel of Significance**

**** Significant at 05 per cent level of Significance**

*** Significant at 10 per cent level of Significance**

Table 2. Growth and instability in area, production and productivity ofpigeon pea in Latur district

Estimates	Sub-Periods			Overall
	I	II	III	
Area(000'ha)				
CGR	0.89	1.54	1.69*	2.37***
Mean	673.60	751.70	1103.13	842.81
SD	52.65	81.64	95.35	204.58
CV	7.82	10.86	8.64	24.27
CDVella	7.98	10.17	4.41	11.69
Production(000'MT)				
CGR	14.49	12.10**	0.93	7.48***
Mean	340.90	615.53	1305.76	754.06
SD	257.34	278.42	1159.93	795.36
CV	75.49	45.23	88.83	105.48
CDVella	56.69	30.56	83.91	89.82
Productivity(kg/ha)				
CGR	13.48	10.39**	-0.84	4.99***
Mean	500.17	810.49	1160.10	823.69
SD	368.43	335.27	912.12	640.61
CV	73.66	41.37	78.62	77.78
CDVella	56.48	31.13	73.74	68.79

Note:
Period-I:1990-91 to 1999-00 ***Significant at 01percentlevel of Significance
Period-II :2000-01 to 2009-10 ** Significant at 05 per cent level of Significance
Period-III : 2010-11 to 2019-20* Significant at 10 per cent level of Significance

Table 3. Growth and instability in area, production and productivity of pigeon pea in Solapur district

Estimates	Sub-Periods			Overall
	I	II	III	
Area(000'ha)				
CGR	-3.80*	2.83	5.60	-1.31
Mean	377.40	178.80	284.62	280.27
SD	69.12	93.18	115.17	122.90
CV	18.32	52.12	40.47	43.85
CDVella	15.83	49.01	38.70	42.84
Production(000'MT)				
CGR	-0.10	8.10	4.31	1.00*
Mean	93.70	65.83	120.18	93.24
SD	46.67	47.18	81.17	62.62
CV	49.80	71.67	67.54	67.16
CDVella	46.80	67.76	65.82	66.39
Productivity(kg/ha)				
CGR	3.85	5.12	-1.31	2.35**
Mean	248.41	332.73	409.12	330.09
SD	102.49	117.51	171.08	145.21
CV	41.26	35.32	41.82	43.99
CDVella	41.06	35.30	39.60	38.64

Note:

Period-I:1990-91 to 1999-00 ***Significant at 01percentlevel of Significance
Period-II :2000-01 to 2009-10 ** Significant at 05 per cent level of Significance
Period-III : 2010-11 to 2019-20 * Significant at 10 per cent level of Significance

Table4 Growth and instability in area, production and productivity of pigeonpea Yavatmal district

Estimates	Sub-Periods			Overall
	I	II	III	
Area(000'ha)				
CGR	2.75**	-2.12**	3.00*	0.81***
Mean	1071.70	1190.30	1256.41	1172.80
SD	111.31	105.71	200.07	160.55
CV	10.39	8.88	15.92	13.69
CDVella	8.51	5.47	13.26	11.79
Production(000'MT)				
CGR	8.05**	-7.21***	0.55	-0.67
Mean	927.50	1082.50	1022.69	1010.90
SD	281.38	296.24	588.36	404.29
CV	30.34	27.37	57.53	39.99
CDVella	25.13	19.38	53.87	39.52
Productivity(kg/ha)				
CGR	5.17**	-5.19*	-2.37	-0.87
Mean	854.31	906.08	791.99	850.79
SD	206.57	228.53	356.99	266.93
CV	24.18	25.22	45.08	31.37
CDVella	21.75	22.57	41.87	30.98

Note:

Period-I:1990-91 to 1999-00 ***Significantat01percentlevelofSignificance Period-II
:2000-01 to 2009-10 ** Significant at 05 per cent level of Significance Period-III :
2010-11 to 2019-20 * Significant at 10 per cent level of Significance

Impact of Farm harvest prices (FHP) prices on area, production and productivity of Jowar in India

R D Vaidkar*, U.T.Dangore*,V K Khobarkar* andN V Shende,**

PGI, Dr PDKV, Akola, Maharashtra

*Correspondence: rajeshvaidkar@yahoo.com

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ABSTRACT

The present study aimed to analyze the impact of Farm harvest prices on area, production and productivity of Jowar in India. The Secondary data on Farm harvest prices (FHP)of Jowar were collected from Indiaagristat website, Directorate of Marketing and Inspection and Commission for Agricultural Cost and Prices for the period 2001-02 to 2020-21 (20 years). The results shows that the impact FHP of jowar, the values of elasticity per cent indicating that previous year price influences current year's area of major jowar growing states The overall trend reveals that the linear regression models for jowar crop area, production and productivity in different states tend to perform better during period II and for the overall period compared to period I. This improvement signifies a heightened understanding of the impact of FHP on jowar area, production and productivity as time progresses.

Keywords: Farm harvest prices, Regression

INTRODUCTION

Agriculture is characterized by a wide range in the cost and price of the main agricultural commodities, which leads to changes in the choice of the farmer. The analysis gives details on how prices and costs for the crop chosen would vary from year to year. Such details help farmers understand how market prices behave so they can make the appropriate decisions about sowing and selling. It will be crucial to understand how the minimum support price, farm harvest price and wholesale price will affect area, production, and productivity since it will help you understand how prices from the prior year affect how much area is allocated for production. Farm harvest prices (FHP) are fundamental components of agricultural price policy of India. It targets to corroborate support price to economy.

The major objectives of FHP are to support farmers from distress sales at severely low prices and to procure food grains for public distribution. Ideally, the market price will always remain higher than the MSP fixed by the government. With government guarantee, the farmer can always sell at the MSP if he/she cannot procure a better price elsewhere.

METHODOLOGY

The study based on the secondary data collected for the period 2001-2002 to 2020-21 years comprises of three periods that is Period I: 2001-02 to 2010-11, Period II: 2011-12 to 2020-21 and Overall: 2001-02 to 2020-21.The secondary data on farm harvest prices (FHP) for hybrid jowar were systematically gathered from a range of authoritative Government publications and websites. Additionally, wholesale prices of jowar were meticulously sourced from government websites, focusing on the major markets of the states as follows:

Table 1. Name of the major markets for wholesale prices of jowar in selected states

Sr.No	Name of states	Major markets
1	Maharashtra	Mumbai
2	Karnataka	Bijapur
3	Rajasthan	Jaipur
4	Tamil Nadu	Salem

Impact of various Prices on area, production and productivity

To study the impact of farm harvest prices(FHP) on the acreage allocation, production and productivity of jowar were estimated for period I: (2001-02 to 2010-11), period II: (2011-12 to 2020-21), overall: (2001-02 to 2020-21).

1. Linear regression equation:

a. A_t = a + bPr_{t-1}

b. P_t = a + bPr_{t-1}

c. Y_t = a + bPr_{t-1}

2. Logarithmic regression equation:

a. Log A_t = log a + bPr_{t-1}

b. Log P_t = log a + bPr_{t-1}

c. Log Y_t = log a + bPr_{t-1}

Where,

A_t = Area of jowar at $(t)^{th}$ period,

P_t = Production of jowar at $(t)^{th}$ period,

Y_t = Productivity of jowar at $(t)^{th}$ period,

Pr_{t-1} FHP of Jowar taken in per quintal at $(t-1)^{th}$ period

RESULTS AND DISCUSSION

Impact of FHP on area of Jowar crop in India

The numerical coefficients within the linear function related to jowar notably exhibit a significant R^2 value at the 1 per cent significance level. This outcome substantiates the conclusion that the fluctuations in jowar cultivation area can be attributed to the explanatory variable i.e., previous year's farm harvest prices of the jowar across period I, period II, and the overall. Across multiple states, the R^2 values during period II surpass those observed in period I. Similarly, the R^2 values for the overall duration tend to exceed those of both period I and period II across most states.

Table 1 State-wise impact of FHP on area of Jowar crop in India
(A_t = Area, Pr_{t-1} = FHP)

Name of states	Equation fitted	Period I		
		R^2	S.E. of R	Equation
Maharashtra	Log linear	0.62	0.023	Log A_t=3.747-0.0001 Pr_{t-1}
Karnataka	Log linear	0.74	0.03	Log A_t=3.265-0.0001 Pr_{t-1}
Rajasthan	Log linear	0.24	0.045	Log A_t=2.728-0.0001 Pr_{t-1}
Tamil Nadu	Log linear	0.67	0.045	Log A_t=2.633-0.0002 Pr_{t-1}
		Period II		
Maharashtra	Log linear	0.44	0.084	Log A_t=3.853-0.0002 Pr_{t-1}
Karnataka	Linear	0.03	166.16	A_t =1074.91-0.02 Pr_{t-1}
Rajasthan	Log linear	0.02	0.041	Log A_t =2.746+1.68 Pr_{t-1}
Tamil Nadu	Linear	0.50	64.81	A_t =95.36+0.11 Pr_{t-1}
		Overall		
Maharashtra	Linear	0.88	375.18	A_t = 5527.21-1.51 Pr_{t-1}
Karnataka	Linear	0.69	115.1	A_t =1817.62-0.40 Pr_{t-1}
Rajasthan	Linear	0.014	66.5	A_t =633.76-0.014 Pr_{t-1}
Tamil Nadu	Linear	0.11	69.03	A_t =276.25+0.03 Pr_{t-1}

Table 1 highlights the distribution of variance in cultivation area for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 62 per cent, 44 per cent, and 88 per cent variances and the value of elasticity has found as -0.0001, -0.0002 and -1.51 in the area explained by the independent variable (lagged FHP) for period I, period II, and the overall, respectively. Similarly, in Karnataka, the variation corresponding percentages are 74, 3, and 69 and value of elasticity has found as -0.0001, -0.02 and -0.40 for the same periods. In the case of Rajasthan, the independent variable accounts for 24 per cent, 2 per cent, and 1.4 per cent variation in the area and

value of elasticity has found as –0.0001, 1.68 and -0.014 during period I, period II, and the overall, respectively. For Tamil Nadu, the figures stand at 67 per cent, 50 per cent, and 11 per cent and value of elasticity has found as -0.0002, 0.11 & 0.03 for the respective periods.

This analysis underscores the varying degrees to which the lagged FHP variable contributes to explaining cultivation area fluctuations across different regions and timeframes. The elasticity for these variables is significant at 1 per cent level in case of area of jowar. The values of elasticity percent indicating thereby that previous year price influences current year's area of major jowar growing states.

Impact of FHP on production of Jowar crop in India

The numerical coefficients within the linear function related to jowar notably exhibit a significant R^2 value at the 1 per cent significance level. This outcome substantiates the conclusion that the fluctuations in jowar production can be attributed to the explanatory variable i.e. previous year's farm harvest prices of the jowar across period I, period II, and the overall. Across multiple states, the R^2 values during period II surpass those observed in period I. Similarly, the R^2 values for the overall duration tend to exceed those of both period I and period II across most states.

Table 2 highlights the distribution of variance in production of jowar for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 6.7 per cent, 35 per cent, and 83 per cent variation in production of jowar and value of elasticity has found as -0.41, -0.0003 and -1.43 in the production explained by the independent variable (lagged FHP) for period I, period II, and the overall, respectively. Similarly, in Karnataka, the corresponding percentages are 7, 0.9, and 22 and value of elasticity has found as 6.40, -0.049, and -0.19 for the same periods. In the case of Rajasthan, the independent variable accounts for 1 per cent, 12 per cent, and 21 per cent variation and value of elasticity has found as 0.02, 9.47 and 0.12 in the production during period I, period II, and the overall, respectively. For Tamil Nadu, the figures stand at 7.4 per cent, 20 per cent, and 43 per cent and value of elasticity has found as -0.02, 0.11 & 0.10 for the respective periods. This suggests that the relationship between FHP and jowar production becomes more evident and stronger over time.

The overall trend reveals that the linear regression models for jowar crop production in different states tend to perform better during period I and for the overall period compared to period II. This improvement signifies a heightened understanding of the impact of FHP on jowar production as time progresses.

Table 2 State-wise impact of FHP on production of Jowar crop in India

(P_t = Production, Pr_{t-1} = FHP)

Name of states	Equation fitted	Period I		
		R^2	S.E. of R	Equation
Maharashtra	Linear	0.07	333.81	$P_t = 3947.22-0.41\ Pr_{t-1}$
Karnataka	Log linear	0.07	0.103	$\text{Log } P_t = 3.093+6.40\ Pr_{t-1}$
Rajasthan	Linear	0.01	165.89	$P_t = 254.02+0.02\ Pr_{t-1}$
Tamil Nadu	Linear	0.07	26.79	$P_t = 262.4-0.02\ Pr_{t-1}$
		Period II		
Maharashtra	Log linear	0.35	0.118	$\text{Log } P_t = 3.748-0.0003\ Pr_{t-1}$
Karnataka	Linear	0.01	184.79	$P_t = 1164.77-0.049\ Pr_{t-1}$
Rajasthan	Log linear	0.12	0.09	$\text{Log } P_t = 2.461+9.47\ Pr_{t-1}$
Tamil Nadu	Log linear	0.19	0.193	$\text{Log } P_t = 2.210+0.0002\ Pr_{t-1}$
		Overall		
Maharashtra	Linear	0.83	432.53	$P_t = 4583.70-1.43\ Pr_{t-1}$
Karnataka	Linear	0.22	262.57	$P_t = 1492.42-0.19\ Pr_{t-1}$
Rajasthan	Linear	0.21	125.58	$P_t = 215.04+0.12\ Pr_{t-1}$
Tamil Nadu	Linear	0.43	93.82	$P_t = 170.25+0.1\ Pr_{t-1}$

Impact of FHP on productivity of Jowar crop in India

The numerical values of the linear function for jowar indicates that R^2 is significant at 1 per cent level and supports that variation in productivity of jowar is explained by the explanatory variable, i.e., farm harvest prices of the jowar. Across most states, there's a notable decrease in the R^2 values from period I to period II. This implies that the linear regression models developed for period II explain a smaller proportion of the variance in jowar crop productivity compared to the models in period I. The R^2 values for the overall period are generally lower than those for period I in most states. This indicates that the linear regression models established for the entire duration provide less explanatory power compared to the models for individual periods.

Table 3 State-wise impact of FHP on productivity of Jowar crop in India
(Y_t= Productivity, Pr_{t-1} = FHP)

Name of states	Equation fitted	Period I		
		R^2	S.E. of R	Equation
Maharashtra	Linear	0.16	80.97.	$Y_t = 702.90 + 0.16\ Pr_{t-1}$
Karnataka	Linear	0.33	228.08	$Y_t = 680.09 + 0.37\ Pr_{t-1}$
Rajasthan	Linear	0.001	227.58	$Y_t = 441.29 + 0.02\ Pr_{t-1}$
Tamil Nadu	Linear	0.39	111.98	$Y_t = 614.38 + 0.28\ Pr_{t-1}$
		Period II		
Maharashtra	Linear	0.02	142.78	$Y_t = 807.01 - 0.06\ Pr_{t-1}$
Karnataka	Linear	0.002	128.41	$Y_t = 1077.9 - 0.02\ Pr_{t-1}$
Rajasthan	Linear	0.10	153.51	$Y_t = 464.15 + 0.15\ Pr_{t-1}$
Tamil Nadu	Linear	0.001	280.49	$Y_t = 1166 - 0.01\ Pr_{t-1}$
		Overall		
Maharashtra	Linear	0.22	116.37	$Y_t = 871.96 - 0.094\ Pr_{t-1}$
Karnataka	Log linear	0.18	0.09	$\text{Log } Y_t = 2.904 + 6.39\ Pr_{t-1}$
Rajasthan	Linear	0.30	188.48	$Y_t = 311.40 + 0.23\ Pr_{t-1}$
Tamil Nadu	Linear	0.32	218.6	$Y_t = 719.92 + 0.18\ Pr_{t-1}$

The reduced R^2 values for the overall period suggest that there might be certain complexities or fluctuations in the relationship between FHP and jowar crop productivity when considering data across both periods.

Table 3 highlights the distribution of variance in productivity for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 16 per cent, 2 per cent, and 22 per cent variation in productivity of jowar and value of elasticity has found as 0.16, -0.06 and -0.094 in the productivity explained by the independent variable (lagged FHP) for period I, period II, and the overall, respectively. Similarly, in Karnataka, the corresponding percentages are 33, 0.2, and 18 and value of elasticity has found as 0.37, -0.02, and 6.39 for the same periods. In the case of Rajasthan, the

independent variable accounts for 0.1 per cent, 10 per cent, and 30 per cent variation and value of elasticity has found as 0.02, 0.15 and 0.23 in the productivity during period I, period II and the overall, respectively. For Tamil Nadu, the variation figures stand at 39 per cent, 0.01 per cent, and 32 per cent and value of elasticity has found as 0.28, -0.01 & 0.18 for the respective periods.

Conclusion and Policy Implications

The impact of FHP of jowar, the values of elasticity per cent indicating that previous year price influences current year's area of major jowar growing states The overall trend reveals that the linear regression models for jowar crop production and productivity in different states tend to perform better during period II and for the overall period compared to period I. This improvement signifies a heightened understanding of the impact of FHP on jowar area, production and productivity as time progresses.

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Marketing of White Onion in Raigad District

P. J. Kshirsagar[1], S. R. Torane[2], A. S. Akhare[3], A. V. Naik[4]

[1]Deputy Director of Research (Agricultural Economics), DBSKKV, Dapoli.
[2]Professor and Head, Department of Agricultural Economics, DBSKKV, Dapoli.
[3]Ph.D. Scholar, Department of Agricultural Economics, DBSKKV, Dapoli.
[4]MSc Student, Department of Agricultural Economics, DBSKKV, Dapoli.
*Correspondence: aishwaryaakhare2397@gmail.com
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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 (98.97%), which was followed by Channel-II (80.65%), Channel-III (74.60%) and Channel-IV (74.06%). The marketing efficiency was highest in Channel-I (88.56%), followed by Channel-II (35.97%), Channel-III (22.98%) and Channel-IV (19.65%).

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 appealable. 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 (9.22%) and high protein (1.165%), fat (0.80%), fiber (2.18%), quecertin (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 (35.00%) 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 (41.12%), where white onion were sold through wholesaler followed by Channel-III (33.70%) where produce was sold through village trader, Channel-II (14.33%) sold through retailer and Channel-I (10.85%) 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)

SN	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:

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 (%)	98.97	80.65	74.60	74.06
16.	Marketing efficiency (%)	88.56	35.97	22.98	19.65

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 (98.97%) which was followed by Channel-II (80.65%), Channel-III (74.60%) and Channel-IV (74.06%).

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.

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 (21.05%) followed by Channel-IV (20.85%) and Channel-II (16.57%).

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 88.56%, for Channel-II it was 35.97%, for Channel III it was 22.98% and for Channel-IV it was 19.65%. 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 (98.97%), which was followed by Channel-II (80.65%), Channel-III (74.60%) and Channel-IV (74.06%). This further indicated that involvement of intermediaries decreased the producer's share in consumer rupee. The marketing efficiency was highest in Channel-I (88.56%), followed by Channel-II (35.97%), Channel-III (22.98%) and Channel-IV (19.65%). 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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Market Participation of Smallholder Vegetable Growers in Northern Hills of Chhattisgarh: A Logistic Regression Approach

Payal Jaiswal[1], VK Choudhary[2] and Ankita Mukherjee[3]

[1]Assistant Professor, College of Agriculture& Research Station,Gariaband, IGKV, Raipur, Chhattisgarh.

[2]Prof. and Head, Department of Agricultural Economics, College of Agriculture, IGKV, Raipur, Chhattisgarh.

[3]Research Scholar, Department of Agricultural Economics, College of Agriculture, IGKV, Raipur, Chhattisgarh.

*Correspondence: payaljaiswal130@gmail.com

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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%, Nagelkerke R Square: 82.5%). 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-fivehouseholds from both the districts were randomly selected. Thus, a total of 150households 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 $\text{Ln}\left(\frac{Pi}{1-Pi}\right) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \ldots\ldots + \beta_nX_n + \varepsilon$

The Odd ratio is given by

$$\frac{Pi}{1-Pi} = e^{\beta 0 + \beta 1X1 + \beta 2X2 + \cdots + \beta nXn + \varepsilon}$$

The probability that the i[th] household sells vegetables is given by

$$P_i = \frac{e^{\beta 0 + \beta 1X1 + \beta 2X2 + \cdots + \beta nXn + \varepsilon}}{1+e^{\beta 0 + \beta 1X1 + \beta 2X2 + \cdots + \beta nXn + \varepsilon}}$$

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

Xi's is the prediction variable

β_1, β_2, ……. β_n are theslope coefficients to be estimated

ε is the random error term

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

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

RESULT AND DISCUSSION

General characteristics of sample households

The general characteristics of the sample households are presented in Table1. 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. Averagefamily member in medium farm households was considerably large (4.24) as compared tomarginal farm households (3.61). The literacy rate in the selected households was 62.23 per cent. Average size of holding was 1.11hectares. The sample households comprised predominantlyof 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

Thetable 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.

Table5presents 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 marketparticipation (Ayodele et al., 2020). This may be because as age increases productivity ofleafy vegetable farmers decreases, as does the intensity ofparticipation 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 thatthe 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, 55.5% 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, 82.5% 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.

CONCLUSION

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: 55.5%, Nagelkerke R Square: 82.5%). 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. N.	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)

S. N.	Particulars	Marginal	Small	Medium	Overall
	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 %)	Small Per Farm (in %)	Medium Per Farm (in %)	Overall Per Farm (in %)
(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 No. 3: Categorical Variable Information

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

Table No. 4: Continuous Variable Information

Particulars		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 No. 5: Results of Logistic Regression Model on Market Participation

Variable	Coef.	Std. Error	P- value
AGE	-.038	.0271	.004***
EDUCATION	-.040	.0614	.080*
FAMILYSIZE	-.323	.325	.320
INCOME	-.612	.3813	.136
FARMSIZE	-1.333	.442	.003***
AREAUNDERVEGETABLE	3.718	1.965	.059*
LANDOWNERSHIP	.986	1.485	.507
GENDER	1.323	1.283	.302
DISTANCEFROMMARKET	-.499	.114	.000***
ACCESSTOTRANSPORTATION FACILITY	1.635	2.038	.423
ROADCONDITION	.863	.927	.352
MARKETINFORMATION	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 No. 6: Logistic Regression Model Fitness Attributes

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

Impact of Wholesale Prices (WSP) Prices on Area, Production and Productivity of Jowar in India

R D Vaidkar*,V K Khobarkar*U.T.Dangore*and N V Shende**
PGI, Dr PDKV, Akola, Maharashtra
Correspondence:-rajeshvaidkar@yahoo.com
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ABSTRACT

The present study aimed to analyze the impact of various prices on area, production and productivity of Jowar in India. The Secondary data on Wholesale prices (WSP) of Jowar were collected from Indiaagristat website, Directorate of Marketing and Inspection and Commission for Agricultural Cost and Prices for the period 2001-02 to 2020-21 (20 years).The results shows that the impact of WSP on jowar, the values of elasticity per cent indicating that previous year price influences current year's area of major jowar growing states The overall trend reveals that the linear regression models for jowar crop area, production and productivity in different states tend to perform better during period II and for the overall period compared to period I. This improvement signifies a heightened understanding of the impact of WSP on jowar area, production and productivity as time progresses.

Keywords: Wholesale prices, Regression

INTRODUCTION

Agriculture is characterized by a wide range in the cost and price of the main agricultural commodities, which leads to changes in the choice of the farmer. The analysis gives details on how prices and costs for the crop chosen would vary from year to year. Such details help farmers understand how market prices behave so they can make the appropriate decisions about sowing and selling. It will be crucial to understand how the minimum support price, farm harvest price and wholesale price will affect area, production, and productivity since it will help you understand how prices from the prior year affect how much area is allocated for production. Wholesale prices (WSP) are fundamental components of agricultural price policy of India. It targets to corroborate support price to economy.

The major objectives of WSP are to support farmers from distress sales at severely low prices and to procure food grains for public distribution. Ideally, the market price will always remain higher than the MSP fixed by the government. With government guarantee, the farmer can always sell at the MSP if he/she cannot procure a better price elsewhere

METHODOLOGY

The study based on the secondary data collected for the period 2001-2002 to 2020-21 years comprises of three periods that is Period I: 2001-02 to 2010-11, Period II: 2011-12 to 2020-21 and Overall: 2001-02 to 2020-21.The secondary data on for hybrid jowar were systematically gathered from a range of authoritative Government publications and websites. Additionally, wholesale prices of jowar were meticulously sourced from government websites, focusing on the major markets of the states as follows:

Table 1. Name of the major markets for wholesale prices of jowar in selected states

Sr.No	Name of states	Major markets
1	Maharashtra	Mumbai
2	Karnataka	Bijapur
3	Rajasthan	Jaipur
4	Tamil Nadu	Salem

Impact of various Prices on area, production and productivity

To study the impact of wholesale prices(WSP) on the acreage allocation, production and productivity of jowar were estimated for period

I: (2001-02 to 2010-11), period II: (2011-12 to 2020-21), overall: (2001-02 to 2020-21).

1. Linear regression equation:

a. A_t= a + bPr_{t-1}

b. P_t = a + bPr_{t-1}

c. Y_t = a + bPr_{t-1}

2. Logarithmic regression equation:

a. Log A_t= log a + bPr_{t-1}

b. Log P_t = log a + bPr_{t-1}

c. Log Y_t = log a + bPr_{t-1}

Where,

A_t = Area of jowar at $(t)^{th}$ period,

P_t = Production of jowar at $(t)^{th}$ period,

Y_t = Productivity of jowar at $(t)^{th}$ period,

Pr_{t-1} WSP of Jowar taken in per quintal at $(t-1)^{th}$ period

RESULTS AND DISCUSSION

Impact of WSP on area of Jowar crop in India

The numerical coefficients within the linear function related to jowar notably exhibit a significant R^2 value at the 1 per cent significance level. This outcome substantiates the conclusion that the fluctuations in jowar cultivation area can be attributed to the explanatory variable i.e., previous year's wholesale prices of the jowar across period I, period II, and the overall. Across multiple states, the R^2 values during period II surpass those observed in period I. Similarly, the R^2 values for the overall duration tend to exceed those of both period I and period II across most states.

Table 1 highlights the distribution of variance in cultivation area for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 35 per cent, 83 per cent, and 85 per cent variance and the value of elasticity has found as -3.65, -1.04 and -1.05 in the area explained by the independent variable (lagged WSP) for period I, period II, and the overall, respectively. Similarly, in Karnataka, the corresponding percentages are 66, 35, and 82 and value of elasticity has found as -7.32, -0.27 and -0.33 for the same periods. In the case of Rajasthan, the independent variable accounts for 14 per cent, 14 per cent, and 4 per cent variance in the area and value of elasticity has found as -6.49, 0.06 and -0.02 during period I, period II, and the overall, respectively. For Tamil Nadu, the figures stand at 81 per cent, 41 per cent, and 14 per cent and value of elasticity has found as -0.0002, 0.06 & 0.03 for the respective periods.

This analysis underscores the varying degrees to which the lagged WSP variable contributes to explaining cultivation area fluctuations across different regions and timeframes.

Table 1 State-wise impact of WSP on area of Jowar crop in India

(A_t = Area, Pr_{t-1} = WSP)				
Name of states	**Equation fitted**	**Period I**		
		R^2	**S.E. of R**	**Equation**
Maharashtra	Log linear	0.35	0.030	Log A_t=3.698-3.65Pr_{t-1}
Karnataka	Log linear	0.66	0.034	Log A_t=3.267-7.32Pr_{t-1}
Rajasthan	Log linear	0.14	0.048	Log A_t=2.745-6.49Pr_{t-1}
Tamil Nadu	Log linear	0.81	0.034	Log A_t=2.707-0.0002Pr_{t-1}
		Period II		
Maharashtra	Linear	0.83	260.38	A_t =5522.91-1.04Pr_{t-1}
Karnataka	Linear	0.35	134.3	A_t =1732.36-0.27Pr_{t-1}
Rajasthan	Linear	0.14	71.1	A_t =549.42+0.09Pr_{t-1}
Tamil Nadu	Linear	0.41	70	A_t =168.3+0.06Pr_{t-1}
		Overall		
Maharashtra	Linear	0.85	417.35	A_t = 5679.55 -1.05Pr_{t-1}
Karnataka	Linear	0.82	133.03	A_t =1897.10-0.33Pr_{t-1}
Rajasthan	Linear	0.04	55.64	A_t =545.56-0.02Pr_{t-1}
Tamil Nadu	Linear	0.14	67.56	A_t =274.42+0.03Pr_{t-1}

Impact of WSP on production of Jowar crop in India

The numerical coefficients within the linear function related to jowar notably exhibit a significant R^2 value at the 1 per cent significance level. This outcome substantiates the conclusion that the fluctuations in jowar production can be attributed to the explanatory variable i.e., previous year's wholesale prices of the jowar across period I, period II, and the overall. Across multiple states, the R^2 values during period II surpass those observed in period I. Similarly, the R^2 values for the overall duration tend to exceed those of both period I and period II across most states.

Table 2 highlights the distribution of variance in production of jowar for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 7 per cent, 38 per cent, and 72 per cent variation in production of jowar and value of elasticity has found as -0.16, -0.0002 and -0.95 in the production explained by the independent variable (lagged WSP) for period I, period II, and the overall, respectively. Similarly, in Karnataka, the variation corresponding percentages are 3, 33, and 26 and value of elasticity has found as 0.08, -0.30, and -0.17 for the same periods.

Table 2 State-wise impact of WSP on production of Jowar crop in India

Name of states	Equation fitted	Period I		
		R^2	S.E. of R	Equation
Maharashtra	Linear	0.07	331.85	$P_t = 3859.08 - 0.16 Pr_{t-1}$
Karnataka	Linear	0.03	296.98	$P_t = 1320.24 + 0.08 Pr_{t-1}$
Rajasthan	Linear	0.01	165.84	$P_t = 251.89 + 0.05 Pr_{t-1}$
Tamil Nadu	Linear	0.07	26.92	$P_t = 267.08 - 0.03 Pr_{t-1}$
		Period II		
Maharashtra	Log linear	0.38	0.11	$\text{Log } P_t = 3.692 - 0.0002 Pr_{t-1}$
Karnataka	Linear	0.33	152.25	$P_t = 1834.2 - 0.30 Pr_{t-1}$
Rajasthan	Log linear	0.01	0.09	$\text{Log } P_t = 2.556 + 2.84 Pr_{t-1}$
Tamil Nadu	Linear	0.11	139.4	$P_t = 245.9 + 0.05 Pr_{t-1}$
		Overall		
Maharashtra	Linear	0.72	550.8	$P_t = 4626.25 - 0.95 Pr_{t-1}$
Karnataka	Linear	0.26	255.13	$P_t = 1566.81 - 0.17 Pr_{t-1}$
Rajasthan	Log linear	0.20	0.218	$\text{Log } P_t = 2.269 + 0.0002 Pr_{t-1}$
Tamil Nadu	Linear	0.39	97.46	$P_t = 191.74 + 0.07 Pr_{t-1}$

(P_t = Production, Pr_{t-1} = WSP)

In the case of Rajasthan, the independent variable accounts for 1 per cent, 1 per cent, and 20 per cent variation in production of jowar and value of elasticity has found as 0.05, 2.84 and 0.0002 in the production during period I, period II, and the overall, respectively. For Tamil Nadu, the variation figures stand at 7 per cent, 11 per cent, and 39 per cent and value of elasticity has found as -0.03, 0.05 & 0.07 for the respective periods. This suggests that the relationship between WSP and jowar production

becomes more evident and stronger over time. The elasticity for these variables is significant at 1 per cent level in case of production of jowar.

The overall trend reveals that the linear regression models for jowar crop production in different states tend to perform better during period II and for the overall period compared to period I. This improvement signifies a heightened understanding of the impact of WSP on jowar production as time progresses.

Impact of WSP on productivity of Jowar crop in India

The numerical values of the linear lag function for Jowar indicates that R^2 is significant at 1 per cent level and supports that variation in productivity of jowar is explained by the explanatory variable, i.e., previous year's wholesale prices of the jowar. Across most states, there's a notable decrease in the R^2 values from period I to period II. This implies that the linear regression models developed for period II explain a smaller proportion of the variance in jowar crop productivity compared to the models in period I. The R^2 values for the overall period are generally lower than those for period I in most states. This indicates that the linear regression models established for the entire duration provide less explanatory power compared to the models for individual periods.

The reduced R^2 values for the overall period suggest that there might be certain complexities or fluctuations in the relationship between WSP and jowar crop productivity when considering data across both periods.

Table 3 highlights the distribution of variance in productivity for different regions during distinct periods. Specifically, it demonstrates that for Maharashtra, there is a 5 per cent, 1 per cent, and 12 per cent variation inproductivity of jowar and value of elasticity has found as 0.03, 0.03 and -0.05 in the productivity explained by the independent variable (WSP) for period I, period II, and the overall, respectively. Similarly, in Karnataka, the corresponding variation percentages are 24, 0.01, and 18 and value of elasticity has found as 0.20, 0.04, and 0.10 for the same periods. In the case of Rajasthan, the independent variable accounts for 1 per cent, 0.2 per cent, and 29 per cent variation and value of elasticity has found as 0.05, 0.03 and 0.18 in the productivity during period I, period II, and the overall, respectively. For Tamil Nadu, the variation figures stand at 45 per cent, 4 per cent, and 21 per cent and value of elasticity has found as 0.34, -0.06 & 0.11 for the respective periods.

Table 3 State-wise impact of WSP on productivity of Jowar crop in India

Name of states	Equation fitted	Period I		
		R^2	S.E. of R	Equation
Maharashtra	Log linear	0.06	0.05	Log Y_t=2.885+1.92Pr_{t-1}
Karnataka	Linear	0.24	242.36	Y_t =698.47+0.20Pr_{t-1}
Rajasthan	Linear	0.01	227.13	Y_t =415.13+0.05Pr_{t-1}
Tamil Nadu	Log linear	0.46	0.06	Log Y_t =2.743-0.0002Pr_{t-1}
		Period II		
Maharashtra	Linear	0.01	143.59	Y_t =618.54+0.03Pr_{t-1}
Karnataka	Linear	0.001	128.53	Y_t =1039.29+0.04Pr_{t-1}
Rajasthan	Linear	0.002	161.51	Y_t =647.95+0.03Pr_{t-1}
Tamil Nadu	Linear	0.04	275.10	Y_t =1292.47-0.06Pr_{t-1}

		Overall		
Maharashtra	Linear	0.12	123.68	Y_t =848.94-0.05Pr_{t-1}
Karnataka	Log linear	0.19	0.097	Log Y_t =2.887+5.37Pr_{t-1}
Rajasthan	Linear	0.29	190.43	Y_t =315.38+0.18Pr_{t-1}
Tamil Nadu	Linear	0.21	235.92	Y_t =791.83+0.11Pr_{t-1}

(Y_t= Productivity, Pr_{t-1} = WSP)

Conclusion and Policy Implications

The impact of WSP on jowar, the values of elasticity per cent indicating that previous year price influences current year's area of major jowar growing states The overall trend reveals that the linear regression models for jowar crop production and productivity in different states tend to perform better during period II and for the overall period compared to period I. This improvement signifies a heightened understanding of the impact of WSP on jowar area, production and productivity as time progresses. The increase in MSP over the previous year brought additional area under food crops, but the impact was nominal.Higher demand due to more procurement for central part than supplies does not allow the market prices to fall below MSP.

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Cost and Returns of Summer Crops in Chandrapur District

J.K.Gundawar[1], V.K.Khobarkar[2], S.C.Nagpure [3]

1. M.Sc. Student, 2. Associate Professor, 3. Professor, Department of Agricultural Economics and Statistics, Post Graduate Institute, Dr. P. D. K. V., Akola.
Correspondence: vanita.econ@gmail.com
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ABSTRACT

This study investigates the cost and returns of selected summer crop in Chandrapur district. The district was selected purposively by considering the potential area under summer crop cultivation. Total of 90 farmer was selected 30 farmers of summer paddy, 30 farmers of summer mung bean and 30 farmers of summer sesame were selected. The economics of summer crops i,e. paddy, mung, sesame crops estimated through standard cost concept developed by CACP . Per qtl cost of production of summer mung was Rs. 6064.26 . The per cent share of cost A_2 and cost B_2 were 50.27 and 72.98 per cent in total cost and the per ha yield was 8.73 qtl. respectively. Per qtl cost of production of summer paddy was Rs 1596.22. The per cent share of cost A_2 and cost B_2 were 50.42 and 76.39 per cent in total cost and the per ha yield was 43.88 qtl respectively. Per qtl cost of production of summer sesame was Rs. 4188.65 . The per cent share of cost A_2 and cost B_2 were 49.15 and 73.98 per cent in total cost and the per ha yield was 9.21 qtl respectively.

Keywords: *Cost, Returns, Yield, Summer crops etc.*

INTRODUCTION

Summer crops are becoming an increasingly important component of cropping system. These crops are grown were water is abundance. Paddy is the world's second most important cereal crop . Nearly 510 million metric tons of milled rice were produced worldwide. . In crop year 2021, there were around 165.25 million hectares of rice cultivated area worldwide. China and India are considered as the main producers of rice worldwide. India was estimated to be the leading global producer of rice and to harvest about 45 million hectares of rice. India is ranked second with 108.5 million metric tons of rice consumed in the same period.

India is the major producer of green gram in the world, and it is grown in almost all the states. It is grown on about 40.38 lakh hectares with a total production of 31.5 lakh tonnes with a productivity of 783 kg/ha and contributes 11% to the total pulse production in the year 2021-22. According to 1 st advance estimates during 2022-23, green gram was grown in 0.08 lakh hectares with a production of 0.04 lakh tonnes and productivity was 493 kg/ha. India is one of the major producers and exporters of sesame in the world. The total area under sesame in 2021-2022 is 1627.04 .The state west bengal is the largest producer of sesame in India I,e (254.35 , followed by Gujarat ,Madhya Pradesh , Rajasthan and uttarpradesh . the production of sesame in India during the year 2021-2022 was estimated to be around 788.74 and productivity is 485 kg/ha. The major varieties of sesame grown in India are Black, Brown, and White. Sesame is an important crop in the Indian agriculture sector, providing income and employment opportunities to millions of farmers and farm laborers. It is used for oil extraction, as a condiment in food, and as an ingredient in bakery and confectionery products.

Objectives

To estimate the cost and returns of selected summer crop

METHODOLOGY

The present study was undertaken in Chandrapur district of Vidarbha region. Three tahsils were selected namely Warora, Brahmapuri, and sindewahi for mungbean, paddy and sesame respectively. In each tahsils three villages and 10 irrigation available farmer were randomly selected from the list obtained from agriculture technology management agency (ATMA) office of chandrapur

district. Thus, total of 90 farmer were selected. The data were collected using pre tested schedule by interviewing the farmer. The data was analyse using standard cost concept.

Cost concepts

Cost A_1 = All actual expenses in cash and kind incurred in production by the producer.

Cost A_2 = Cost A_1 + Rent paid for leased in land

Cost B_1 = Cost A_1 + Interest on value of owned capital assets (excluding land).

Cost B_2 = Cost B_1 + Rental value of owned land (net land revenue) less land revenue + Rent paid for leased in land.

Cost C_1 = Cost B_1 + Imputed value of family labour.

Cost C_2 = Cost B_2 + Imputed value of family labour.

Cost C_3 = Cost C_2 + 10 percent of Cost C_2 on account of managerial functions performed by farmers.

RESULTS AND DISCUSSION

Table 1. Per ha cost of cultivation of summer paddy

(Rs/ha)

	Particulars		Units	Units required	Price per unit	Cost in Rs	Percent to total
1	Hired human labour	Male	Days	17.46	305.00	5325.30	9.71
		Female	Days	24.64	230.31	5674.84	10.35
		Total	Days	42.10	267.66	11268.28	20.55
2	Bullock labour	Hired	Days	3.90	895.33	3491.79	6.37
		Total	Days	3.90	895.33	3491.79	6.37
3	Machine	Hired	Days	1.49	1036.33	1544.13	2.82
		Owned	Days	-	-	-	
		Total		1.49	1036.33	1544.13	2.82
4	Seed		Kgs.	24.72	122.25	3022.02	5.51
5	Manure		Tones	15.63	131.03	2048.00	3.73
6	Fertilizer	N	Kgs.	24.35	20.00	487.00	0.89
		P	Kgs.	20.63	25.21	520.08	0.95
		K	Kgs.	17.46	24.46	427.07	0.78
		Total				1434.15	2.62
7	Irrigation		Rs			1370.55	2.50
8	Incidental		Rs			249.18	0.45
9	Insecticides		Rs			554.25	1.01
10	Repairs		Rs			453.73	0.83
11	Working capital		Rs			25436.08	46.39
12	Depreciation		Rs			1662.75	3.03
13	Land revenue		Rs			87.91	0.16
14	Int on working capital (6%)		Rs			381.54	0.70
15	Cost A_1		Rs			27568.28	50.27
16	Rent paid for leased in land		Rs				0.00
17	Cost A_2		Rs			27568.28	50.27
18	Int on fixed capital (10%)		Rs			806.11	1.47
19	Cost B_1		Rs			28374.39	51.74
20	Rental value of land		Rs			11645.24	21.24
21	Cost B_2					40019.63	72.98
	Family human	Male	Days	20.36	305.72	6224.46	11.35
	Labour	Female	Days	15.00	240.48	3607.20	6.58
		Total		35.36	278.04	9831.66	17.93

	Particulars		Units	Units required	Price per unit	Cost in Rs	Percent to total
22	Cost C_1					38206.05	69.67
23	Cost C_2					49851.29	90.91
24	Cost C_3		Rs			54836.42	100.00
25	Yield	Main	Qtls	8.73	7860.25	68619.98	
		Byproduce	Qtls	14.56	130.18	1895.42	
26	Gross value		Rs			70515.40	
27	Per qtl cost of production					6064.26	

It is observed from the table that farmers incurred an expenditure (cost A_2) of Rs 27568.28 per hectare in cultivation of summer mung . The per hectare cost B_2 and C_3 was Rs 40019.63 and Rs 54836.42 respectively. Among the direct expenses the share hired human labour was highest in total cost (20.55%) followed by bullock labour (6.37%), seed (5.51 %) etc . These share of cost A_2 in total cost was highest (50.27%). In cost B_2 the highest share in total cost was rental value of land (21.24%) followed by interest on fixed capital (1.47%). The cost B_2 is accounted for (72.98 %) of the total cost. The share of family labour in total cost was (17.93 %). The per quintal cost of main produce is Rs 6064.26.

Table 2. Per ha cost of cultivation of summer paddy

(Rs/ha)

Sr no	Particulars		Units	Units required	Price per unit	Cost in Rs	Percent to total
1	Hired human labour	male	days	18.50	310.06	5736.11	7.39
		female	days	42.75	216.16	9240.84	11.90
		total	days	61.25	244.52	14976.95	19.29
2	Bullock labour	Owned	days	2.43	805.21	1956.66	2.52
		Hired	days	…….	…….	…….	……
		Total	days	2.43	805.21	1956.66	2.52
3	Machine	Hired	days	12.65	609.43	7709.29	9.93
		Owned	days	1.53	550.00	841.50	1.08
		Total		14.18	603.44	8550.79	11.01
4	Seed		kgs	61.20	63.93	3912.52	5.04
5	Manure		tonns	2.59	428.50	1109.81	1.43
6	Fertilizer	N	kgs	79.05	12.14	959.67	1.24
		P	kgs	41.50	25.21	1046.22	1.35
		K	kgs	20.62	24.60	507.25	0.65
		Total				2513.14	3.24
7	Irrigation		R_S			1726.11	2.22
8	Incidental		R_S			113.35	0.15
9	Insecticides		R_S			742.29	0.96
10	Repairs		R_S			239.39	0.31
11	Working capital		R_S			35841.01	46.15
12	Depriciation		R_S			2523.81	3.25
13	Land revenue		R_S			77.42	0.10
14	Int on working capital (6%)		R_S			716.82	0.92
15	Cost A_1		R_S			39159.06	50.42
16	Rent paid for leased in land		R_S			----------	……
17	Cost A_2		R_S			39159.06	50.42
18	Int on fixed capital (10%)		R_S			1834.28	2.36

Sr no	Particulars		Units	Units required	Price per unit	Cost in Rs	Percent to total
19	Cost B_1		R_S			40993.34	52.79
20	Rental value of land		R_S			18330.39	23.60
21	Cost B_2					59323.73	76.39
	Family human	Male	days	25.34	310.06	7856.92	10.12
	Labour	Female	days	15.97	214.15	3419.97	4.40
		Total		41.31	176.15	11276.89	14.52
22	Cost C_1					52270.23	67.31
23	Cost C_2					70600.62	90.91
24	Cost C_3		R_S			77660.68	100.00
25	Yield	Main	qtls	43.88	2343.19	102828.36	
		Byproduce	qtls	60.57	125.78	7618.49	
26	Gross value		R_S			110446.85	
27	Per qtl cost of production					1596.22	

The cost of cultivation of summer paddy is presented in table 2 . It is observed from the table that farmer incurred and expenditure of cost A_2 was Rs 39159.06 per ha in the cultivation of summer paddy. The per ha cost B_2 and cost C_3 was Rs is 59323.73 and 77660.68 respectively. Among the direct expenses the share of hired human labour was (19.29 %) followed by machine hours (11.01 %), seed (5.04%) and fertilizer expenses (3.24%) . The share of cost A_2 in total cost was (50.42%). In the cost B_2 the highest share in total cost was rental value of land (23.60 %) followed by int on fixed capital (2.36%). The cost B_2 is accounted for (76.39%) of the total cost .The share of family labour in total total cost was 14.52 per cent .The per qtl cost of main produce is Rs 1596.22.

Table 3. Per ha cost of cultivation of summer Sesame

(Rs/ha)

Sr no	Particulars		Units	Units required	Price per unit	Cost in Rs	Percent to total
1	Hired human labour	Male	Days	20.21	303.33	6130.30	10.29
		Female	Days	28.21	230.21	6494.22	10.90
		Total	Days	48.42	233.33	12624.52	21.18
2	Bullock labour	Hired	Days	…….	……..	…….	……..
		Owned	Days	1.67	1265.00	2112.55	3.54
		Total	Days	1.51	1265.00	2112.55	3.54
4	Seed		Kgs	5.26	220.33	1158.94	1.94
5	Manure		Tonns	10.40	161.13	1675.75	2.81
6	Fertilizer	N	Kgs	51.58	20.35	1049.65	1.76
		P	Kgs	29.85	25.21	752.52	1.26
		K	Kgs	28.12	19.60	551.15	0.92
		Total			19.18	2353.32	3.95
7	Irrigation		Rs			3888.06	6.52
8	Incidental		Rs			935.54	1.57
9	Insecticides		Rs			1032.96	1.73
10	Repairs		Rs			547.15	0.92
11	Working capital		Rs			26328.79	44.18
12	Depriciation		Rs			2341.23	3.93
13	Land revenue		Rs			95.64	0.16
14	Int on working capital (6%)		Rs			526.58	0.88
15	Cost A_1		Rs			29292.24	49.15
16	Rent paid for leased in land		Rs				0.00

Sr no	Particulars		Units	Units required	Price per unit	Cost in Rs	Percent to total
17	Cost A_2		Rs			29292.24	49.15
18	Int on fixed capital (10%)		Rs			1980.66	3.32
19	Cost B_1		Rs			31272.90	52.47
20	Rental value of land		Rs			12815.16	21.50
21	Cost B_2					44088.07	73.98
	Family human	Male	Days	24.08	303.33	7304.19	12.26
	Labour	Female	Days	12.11	230.21	2787.84	4.68
		Total				10092.03	16.93
22	Cost C_1					41364.93	69.41
23	Cost C_2					54180.09	90.91
24	Cost C_3		Rs			59598.10	100.00
25	Yield	Main	Qtls	9.21	8243.83	75925.67	
		byproduce	Qtls	13.37	115.12	1539.15	
26	Gross value		Rs			77464.83	
27	Per qtl cost of production					4188.65	

It could be seen from the table that the total cost of cultivation (cost C_3) in Rs 59598.10. Whereas cost B_2 is 44088.07 and A_2 is 29292.24. Among the direct expenses the share of hired human labour was highest (21.18 %) followed by irrigation (6.52%) and fertilizer expenses (3.95 %) . The share of cost A_2 in total cost cost was (49.15%) in cost B_2 the highest share in total cost was rental value of land (21.50%). The cost B_2 is accounted for (73.98%) of the total cost. The share of family labour in total cost was (16.93%). The per qtl cost of main produce is Rs 4188.65 .

Table 4. Comparative economics of selected summers crop cultivation

(Rs/ha)

Sr.no	Particulars	Mung	Paddy	Sesame
1	Main produce (q/ha)	8.73	43.88	9.21
2	Value of main produce	7860.25	102828.36	75925.67
3	By produce(q/ha)	14.56	60.57	13.37
4	Value of by produce	1895.42	7618.49	1539.15
5	Gross value	70515.4	110446.85	77464.83
6	Total cost			
	Cost A_1	27568.28	39159.06	29292.24
	Cost A_2	27568.28	39159.06	29292.24
	Cost B1	28374.39	40993.34	31272.90
	Cost B_2	40019.63	59323.73	44088.07
	Cost C_1	38206.05	52270.23	41364.93
	Cost C_2	49851.29	70600.62	54180.09
	Cost C_3	54836.42	77660.68	59598.10
5	Net return over			
	Cost A_1	42947.12	71287.79	48172.59
	Cost A_2	42947.12	71287.79	48172.59
	Cost B_1	42141.01	69453.51	46191.93
	Cost B_2	30495.77	51123.12	33376.76
	Cost C_1	32309.35	58176.62	36099.90

Sr.no	Particulars	Mung	Paddy	Sesame
	Cost C_2	20664.11	39846.23	23284.74
	Cost C_3	15678.98	32786.17	17866.73
6	Input output ratio			
	Cost A_1	2.56	2.82	2.64
	Cost A_2	2.56	2.82	2.64
	Cost B_1	2.49	2.69	2.48
	Cost B_2	1.76	1.86	1.76
	Cost C_1	1.85	2.11	1.87
	Cost C_2	1.41	1.56	1.43
	Cost C_3	1.29	1.42	1.30

Table 4 presents the per hectare cost and return from Summer mung is the total cost (Cost "C_3") which worked out to Rs 54836.42 whereas the net return over cost C_3 was Rs 15678.98 The input-output ratio at Cost C_3 it was 1: 1.29. The per hectare cost and return from Summer paddy is the total cost (Cost "C_3") which worked out to Rs 77660.68 whereas the net return over cost C_3 was Rs 32786.17. The input-output ratio at Cost C_3 was 1: 1.42. The per hectare cost and return from Summer sesame is the total cost (Cost "C_3") which worked out to Rs 59598.10 whereas the net return over cost C_3 was Rs 17866.73. The input-output ratio at Cost C_3 was 1: 1.30 .

CONCLUSIONS

The input - output ratio of summer mung at cost 'C_3 ' 1.29, for summer paddy the input - output ratio of at cost 'C_3 was 1.42 and for summer sesame it was 1.30. This indicates that, Cultivation of summer crop was economically profitable.

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An Economic Analysis of Marketing of Bajra (*Pennisetum glaucum*) in Solapur District, Maharashtra, India

S. N. Ingle, P. D. Peshattiwar, P. B. Sable, V. M. Gedam, J. B. Durge
Shri Shivaji Agriculture College, Amravati (M.S)
Correspondence:-inglesn@yahoo.com
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ABSTRACT

The study was conducted in the year 2021 – 2022 to study the "Marketing of Bajra in Solapur district of Maharashtra". The producer's share I consumer's rupee was highest in channel I (97.81 per cent) as compared to other channels and the net price received by producer is highest in channel I i.e. Rs 2298.50 Rs/qt. hence selling of Bajra through channel I by Bajra grower was found more remunerative than other channels in study area. The major problems faced by Bajra grower were scarcity of labour, high wage rate in production of Bajra and price fluctuation, malpractices in weighing in marketing of Bajra.
Keywords: *Marketing cost; marketing margin; price spread; constraints.*

INTRODUCTION

Pearl millet (*Pennisetum glaucum*L.) belongs to the family Gramineae. It is popularly known as bajra. The origin of bajra has been traced to tropical Africa, cultivation subsequently spread to East and Southern Africa and Southern Asia. It is the most widely grown type of millet, under the millet group. African countries are the largest consumers of millets globally[1]. Pearl millet has a number of advantages that have made it the traditional staple cereal crop in subsistence or low resource agriculture in hot semiarid regions like the West Africa Sahel and Rajasthan in North Western India. It is well adapted to the production system characterized by drought, low soil fertility and high temperature. It performs well in soils with high salinity or low pH. In Solapur district of Maharashtra, the area under Bajra crop is 63400 ha. with production of 76100 ton and productivity of 12 qt. / ha. (NARP and District Agriculture Office, Solapur)**.** Ultimately area under Bajra is expected to increase and it would be possible to bring low fertile land of drought prone area which is large in proportion can be brought under Bajra cultivation in addition to present area. The increased demand may lead increase in prices of Bajra and farmers may be benefited. Keeping in view the above aspects, the present study has been under taken to study the marketing and to analyse the constraints in production and marketing of Bajra.

METHODOLOGY

Sampling design: The multistage sampling design was used for the selection of district, tehsils, villages and growers. In all 90 Bajra growers were selected to collect data on production cost, returns, marketing channel, marketing cost etc. the data collected for the year 2021-22.

Selection of district: Based on the potential area and production of Bajra, Solapur district was purposively selected for the present study.

Selection of tehsils: Two tehsils Malshiras and Mangalvedha were selected on the basis of maximum area under the study crop.

Selection of villages: Three viz., Malshiras, Goradwadi, Pushivade were selected from Malshiras tehsil, similarly Redde, Bhose and Padolkarwadi from Mangalvedha tehsil.

Selection of Bajra grower: 15 Bajra growers were selected from each village randomly. In all 90 growers were considered for the study.

Selection of Wholesaler/commission agents: In Malshiras and Mangalvedha Bajra market, 10 wholesalers in each market were selected.

Selection of retailers: In Malshiras and Mangalvedha Bajra market, 10 retailers for each commodity were selected.

Selection of village trader: Ten village level traders were selected for present study from Malshiras and Mangalvedha.

Analysis of Data

Marketing Cost: The total cost incurred on marketing by various intermediaries involved in the sale and purchase of the commodity till it reaches the ultimate consumer can be computed as follows:

$$C=C_f+ C_{m1}+C_{m2}+C_{m3}+\ldots..+C_{mn}$$

Where, C= Total cost of marketing

C_f = Cost borne by the producer- farmer for the cost production, and

C_{mn} = Cost incurred by the i^{th} middlemen in the process of buying and selling.

Market margin

It refers difference between the prices prevailing as successive stages of marketing at given period of time. The absolute value of marketing margin varies from channel to channel, market to market

Price spread: Price spread is the difference between the price paid by the consumer and the price received by the producer for an equivalent quantity of the farm produce.

$$\text{Price spread} = \frac{\text{(Consumers price – Net price of producer)}}{\text{Consumers price}} \times 100$$

Garrett's ranking technique: In Garrett's scoring technique, the respondents were asked to rank the factors or problems and these ranks were converted into percent position by using the formula

$$\textit{Percent position} = \frac{100(R_{ij} - 0.50)}{N_{ij}}$$

R_{ij} = Rank given for the i^{th} variable by j^{th} respondent

N_j= Number of variable ranked by j^{th} respondent

RESULTS AND DISCUSSIONS

Channels of Distribution

Marketing channels are the root through which produce move from producer to consumer. Following important channels of distribution have been observed from while studying the marketing of Bajra under study area.

Channel I: Producer→Consumer

Channel II: Producer →Village trader →Consumer

Channel III: Producer →Village trader →Wholesaler →consumer

Channel IV: Producer →Village trader →Wholesaler →Retailer →consumer

During the study it was observed that, Channel II i.e. producer- village trader – consumer is the major channel of distribution. In channel I i.e. producer – consumer quantity sold was low and this channel was mainly maximum when less intermediaries are included.

Marketing Cost of Bajra

It is seen from Table 1. The maximum marketing cost of Rs.63 incurred by the producer out of the total cost of marketing was Rs.353.50 in channel IV in marketing of per quintal Bajra. In channel III Rs. 62 marketing cost incurred by producer and total cost of marketing is Rs. 273.50. Marketing cost incurred by producer in channel II was Rs. 60 out of total marketing cost of Rs. 165 and in channel I it was low as compared to others channels as Rs 51.50.

Table 1: Marketing cost of Bajra. (Rs./qt.)

Sr. No.	Particulars	Total Price			
		Channel I	Channel II	Channel III	Channel IV
A	**Marketing cost incurred by producer**				
1	Cost of gunny bags	16.50	21.00	22.00	23.50
2	Cost of packing	4.00	4.00	4.00	4.00
3	Cost of loading	3.00	3.00	3.00	3.00
4	Transportation	15.00	9.00	10.00	9.50
5	Weighing charges	3.00	3.00	3.00	3.00
6	Hamali	8.00	8.00	8.00	8.00
7	Commission	-	10.00	10.00	10.00
8	Unloading	2.00	2.00	2.00	2.00
9	Marketing cost	51.50	60.00	62.00	63.00
10	Selling price of producer	2350.00	2300.00	2260.00	2232.00
B	**Marketing cost incurred by Village trader**				
1	Storage		12.00	12.00	12.00
2	Cost of packing		17.00	21.00	19.00
3	Cost of loading		6.00	6.00	6.00
4	Cost of Transportation		49.00	53.00	58.00
5	Weighing charges		3.00	3.00	3.00
6	Hamali		8.00	8.00	8.00
7	Commission		10.00	9.50	8.50

Sr. No.	Particulars	Total Price			
		Channel I	Channel II	Channel III	Channel IV
8	Marketing cost		105.00	112.00	114.00
9	Marketing margin		135.00	157.50	163.50
10	Selling price of village trader		2540.00	2530.00	2510.00
C	**Marketing cost incurred by wholesaler**				
1	Storage			10.00	10.00
2	Transportation			56.00	63.00
3	Labour charges			10.00	10.00
4	Cost of packing			10.00	10.00
5	Loading charges			2.00	2.00
6	Weighing charges			3.00	3.00
7	Hamali			8.00	8.00
8	Market cess fund			10.00	10.00
9	Marketing cost			99.00	99.00
10	Marketing margin			111.00	99.00
11	Selling price of wholesaler			2740.00	2725.00
D	**Marketing cost incurred by retailer**				
1	Transportation				25.00
2	Labour charges				9.00
3	Shop rent				5.00
4	Hamali				8.00
5	Weighing charges				3.00
6	Packaging				10.00
7	Marketing cost				60.00
8	Marketing margin				125.00
9	Selling price of retailer				2910.00
	Consumer price	2350.00	2540.00	2740.00	2910.00
	Total marketing cost	51.50	165.00	273.50	353.50
	Total margin	-	135.00	268.50	387.50

Channel wise price spread of Bajra

The detailed about price spread and producers share in consumer's rupee were presented in Table 2. The net price received by producer in channel I. Channel II Channel III and Channel IV was Rs. 2298.50, Rs. 2240, Rs. 2198 and 2168.50 per qt. respectively.

The producer's share I consumer's rupee was highest in channel I (97.81 per cent) as compared to other channels and the net price received by producer is highest in channel I i.e. Rs 2298.50 Rs/qt. hence selling of Bajra through channel I by Bajra grower was found more remunerative than other channels in study area.

Table 2. Price spread in marketing of Bajra through various channels

Sr. No.	Particulars	Total Price			
		Channel I	Channel II	Channel III	Channel IV
A	**Producer**				
1	Gross price received by producer	2350.00 **(100.00)**	2300.00 **(91.63)**	2260.00 **(82.48)**	2232.00 **(64.70)**
2	Marketing cost incurred	51.50 **(1.98)**	60.00 **(2.43)**	62.00 **(2.26)**	63.00 **(2.32)**
3	Net price received by producer	2298.50 **(97.81)**	2240.00 **(89.19)**	2198.00 **(80.22)**	2168.50 **(79.16)**
B	**Village trader**				
1	Purchase price		2300.00 **(91.63)**	2260.00 **(0.82)**	2232.00 **(76.70)**

Sr. No.	Particulars	Total Price			
		Channel I	**Channel II**	**Channel III**	**Channel IV**
2	Marketing cost incurred		105.00 **(3.82)**	113.00 **(4.72)**	104.00 **(3.99)**
3	Net margin		135.00 **(5.31)**	157.00 **(5.53)**	162.00 **(5.37)**
4	Selling price		2540.00 **(100)**	2530.00 **(92.34)**	2510.00 **(86.25)**
C	**Wholesaler**				
1	Purchase price			2530.00 **(92.34)**	2510.00 **(86.25)**
2	Marketing cost incurred			99.00 **(3.61)**	118.00 **(3.99)**
3	Net margin			111.00 **(4.05)**	97.00 **(3.33)**
4	Selling price			2740.00 **(100.00)**	2725.00 **(93.64)**
D	**Retailer**				
1	Purchase price				2725.00 **(93.64)**
2	Marketing cost incurred				60.00 **(2.06)**
3	Net margin				125.00 **(4.30)**
4	Selling price				2910.00 **(100.00)**
E	**Consumer**				
1	Purchase price	2350.00	2540.00	2740.00	2910.00
2	Net price received by producer	2298.50	2240.00	2198.00	2169.00
3	Price spread	51.50	300.00	542.00	741.50
4	Producer's share in consumer rupee	97.81	88.19	80.22	74.54

(Figures in the parenthesis indicate percentage to consumer)

Marketing Efficiency

In Table 3. revealed that in marketing of Bajra the market efficiency in channel I was 45.63, in channel II it was 15.39, in channel III it was 10.02 and in channel IV it was 8.23.

Table 3. Channel wise market efficiency

Sr. No.	Channel	Market efficiency
	Producer →Consumer	45.63
	Producer →Village trader →Consumer	15.39
	Producer →Village trader →Wholesaler →consumer	10.02
	Producer →Village trader →Wholesaler →Retailer →consumer	8.23

Problems in Production and Marketing of Bajra growers

All the selected Bajra growers were interviewed for the problems they are facing while producing and marketing of Bajra. From the data depicted in table 4, the most important constraints in production of Bajra which rank first was scarcity of labour with 56.89 followed by high wages rate which rank II with 50.56 other constraints in production of bajra were non availability of credit, lack of technical information with 44.89, 44.72 and 42.33 respectively.

In regards to marketing of Bajra the most important constraints in marketing of Bajra which rank first was price fluctuation with 62.44 followed by malpractice in weighing which rank II with 59.78. Other constraints in marketing of Bajra were high

commission charges, transportation problem and irregular payment by intermediaries with 55.78, 51.83 and 51.0 respectively.

Table 4. Garret's rank and score on constrants encountered by growers in production and marketing of Bajra

Sr. No.	Particulars	Total mean (Score)	Rank
A	**Problems faced in production of Bajra**		
1	Scarcity of labour	56.89	I
2	High wage rate	50.56	II
3	Non availability of credit	44.89	III
4	Lack of technical information	44.72	IV
5	Lack of financial facility	42.33	V
B	**Problems faced in marketing of Bajra**		
1	Price fluctuation	62.44	I
2	Malpractices in weighing	59.78	II
3	High commission charges	55.78	III
4	Transporation problem	51.83	IV
5	Irregular payment by intermediaries	51.00	V

CONCLUSION

The maximum marketing cost of Rs.63 incurred by the producer out of the total cost of marketing was Rs.353.50 in channel IV in marketing of per quintal Bajra. The producers share in consumers rupee was highest in channel I (Producer →Consumer) i.e. 97.81 per cent followed by channel II (Producer → Village trader →Consumer) i.e. 88.19 per cent, channel II (Producer →Village trader →Wholesaler →Consumer) i.e. 80.22 per cent and channel IV (Producer →Village trader →Wholesaler →Retailer →Consumer) i.e. 74.54 per cent. It concluded that channel I was most profitable than other channels. The major problems faced by Bajra grower were scarcity of labour (56.89%), high wage rate (50.56%) in production of Bajra and price fluctuation (62.44%), malpractices in weighing (59.78%) in marketing of Bajra.

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Technical, Allocative, and Economic Efficiency of Red Gram Beneficiary and Non-Beneficiary Farmers Using Canal Irrigation and Associated Challenges.

A. M. Deshmukh[1], Dr. S. S. Thakare2, Dr.S. S. Lande[3], R.K. Patil[4].

1. PG Student, Agricultural Economics and Statistics Section, Shri. Shivaji Agriculture College, Amravati.
2. Head of Agricultural Economics and Statistics Section, Shri. Shivaji Agriculture College, Amravati.
3. Principal, Head of Agricultural Entomology Section. Shri. Shivaji Agriculture College, Amravati.
4. (Head of Agricultural Botany Section. Shri. Shivaji Agriculture College, Amravati.)

Correspondence1: ayushdeshmukh999@gmail.com

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ABSTRACT

This study examines the technical, allocative, and economic efficiency of red gram cultivation among beneficiary and non-beneficiary farmers using canal irrigation. The research also identifies the major challenges faced by these farmers. The study is based on efficiency analysis and problem assessment techniques.Data were collected from three tehsils: Morshi, Tiwasa and Dhamangaon Railway of30 farmers (15 beneficiary and 15 non-beneficiary) during the year 2023-24. The findings reveal that beneficiary farmers demonstrate higher technical efficiency 92.40 % compared to non-beneficiaries i.e. 83.60%, yet significant gaps exist in allocative and economic efficiency. Moreover, issues such as excess water flow, delayed irrigation, and poor canal maintenance affect beneficiary farmers, while non-beneficiaries struggle with price instability, high input costs, and labour shortages.

Keywords: *Technical Efficiency, Allocative Efficiency, Economic Efficiency, Red Gram, Canal Irrigation, Beneficiary Farmers, Non-Beneficiary Farmers,Agricultural Challenge*

INTRODUCTION

Red gram (*Cajanus cajan*), commonly known as pigeon pea, is one of the most important pulse crops cultivated in India, playing a crucial role in ensuring food security and enhancing rural livelihoods. As a major source of protein in Indian diets, red gram is widely cultivated across different agro-climatic regions, with its production heavily influenced by the availability and management of water resources. Efficient irrigation practices are fundamental to maximizing yield and economic returns for farmers, particularly in areas where water availability is limited or erratic.

Canal irrigation is one of the most significant irrigation sources in India, providing a reliable water supply to farmers. However, disparities exist between farmers who have access to canal irrigation (beneficiaries) and those who rely on alternative water sources or rain-fed systems (non-beneficiaries). While beneficiary farmers benefit from subsidized irrigation water, non-beneficiaries face challenges such as water scarcity, higher input costs, and dependence on rainfall. Understanding the efficiency levels of both groups can provide valuable insights into optimizing resource utilization and improving agricultural productivity.

This study aims to assess the technical, allocative, and economic efficiency of red gram cultivation among beneficiary and non-beneficiary farmers using canal irrigation. Technical efficiency refers to the ability of farmers to maximize output with given inputs, while allocative efficiency examines how well inputs are allocated to minimize costs. Economic efficiency, a combination of both,

determines overall farm profitability. In addition to efficiency assessment, the study identifies key challenges faced by both groups of farmers, including water management issues, input costs, market instability, and infrastructural constraints.

METHODOLOGY

Data Envelopment Analysis (DEA)

Technical, Allocative, and Economic Efficiency were estimated using Data Envelopment Analysis (DEA**)**, a Linear Programming Problem (LPP) that calculates efficiency levels within a group of farms by comparing each to the best-performing farm in the dataset.

- **Technical Efficiency (TE)** measures a farm's ability to maximize output given a set of inputs or minimize inputs for a given output.
- **Allocative Efficiency (AE)** evaluates a farm's ability to minimize production costs given input prices while being technically efficient.
- **Economic Efficiency (EE)** is the product of TE and AE, representing overall cost-effectiveness.

Mathematical Formulation

DEA efficiency is computed as follows:

$$\text{Min } \theta, \lambda\ \theta$$
$$\text{Subject to}$$
$$-yi + Y\lambda \geq 0$$
$$\theta Xi - X\lambda \geq 0$$
$$\lambda \geq 0$$

Where,

yi is a vector (m × 1) of output of the i^{th} Producing Farms (TPF (Total productivity factor),

xi is a vector (k × 1) of inputs of the i^{th} TPF, Y is an output matrix (n × m) for n TPFs, X is an input matrix (n × k) for n TPFs.

θ is the efficiency score, a scalar whose value will be the efficiency measure for the i^{th} TPF. If θ =1, TPF (Total productivity factor) will be efficient; If $\theta \neq 1$ it will be inefficient, and λ is a vector (n × 1) whose values are calculated to obtain the optimum solution.

Inputs and Outputs Considered

For efficiency estimation, four input variables were used: human labour (man-days), bullock labour (pair-days), machine labour (hours), and seed (kg)**,** while total output (yield) was the output variable. Efficiency calculations were conducted using **DEAP version 2.1** with an input-oriented approach.

Estimation of Cost and Allocative Efficiency

$$\text{Min } \lambda, Xi^* Wi Xi^*,$$

Subject to

$$-yi + Y\lambda \geq 0,$$
$$Xi^* - X\lambda \geq 0,$$
$$N1\ \lambda \geq 1$$
$$\lambda \geq 0$$

Where,

Wi is a vector of input prices for the I^{th} Producing Farms (TPF),

Xi is the cost minimizing vector of input quantities for the i^{th} TPF (which is calculated by the LP),Given the input prices Wi and the output levels Yi.

The total cost efficiency (CE) or economic efficiency of the I^{th} TPF would be calculated as CE = WiXi* / WiXi. i.e., the ratio of minimum cost to observed cost. One can then use equation 12 to calculate the allocative efficiency residually as AE= CE/TE.

Steps in DEA analysis.

1. Collect the pooled data on Output an Input quantities and their respective values for different DMU's
2. Download the open source DEAP software from the Centre for Efficiency and Productivity Analysis (CERA) portal.
3. Install the DEAP
4. Arrange the database as per the requirement of DEAP (output first followed by inputs) in*txt file.
5. Modify the inbuilt instruction file and compute the Technical Allocate and Economic efficiency.

In thatDEAP folder we have to create this type of txt file.

1 Instruction file – Eg1- ins.txt
2 Data file – Eg1-dta.txt
3 Output file- Eg1-out.txt

Instruction file: It can be modified according to our data taken for analysis whether it may single output with multiple input solution or multiple output with single or multiple input. For measuringallocative efficiency value of the inputs also have to mention

eg3-dta.txt DATA FILE NAME
eg3-out.txt OUTPUT FILE NAME
4 NUMBER OF FIRMS
1 NUMBER OF TIME PERIODS
1 NUMBER OF OUTPUTS
1 NUMBER OF INPUTS
0 0-INPUT AND 1-OUTPUT ORIENTATED
0 0-CRS AND 1-VRS
1 0-DEA (MULTISTAGE), 1=COST-DEA
2=MALNQUIST-DEA,3= DEA (1= STAGE),
4=(DEA 2 =STAGE)

2. Problems faced by selected respondents

The problems in production and marketing were analysed by Garrett's ranking

technique. The ranks given by each respondent was converted into percent position by using the formula:

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

Where,

R_{ij} = Rank given to i^{th} constraint by the j^{th} individual and

N_j = Number of constraints ranked by the j^{th} individual.

The mean score values estimated for each factor was arranged in the descending order. The problems with the highest mean value were considered as the most important ones and the others followed in that order.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads.

1. Technical, Allocative, and Economic Efficiency

1.1 Beneficiary Farmers

The technical efficiency analysis of beneficiary red gram farmers, as presented in Table 1, indicates that a significant proportion (60%) have achieved full technical efficiency (100%), suggesting no further improvements are required in production levels. However, a notable fraction of farmers falls within lower efficiency categories, including 13.33% in the 70.01-80% range and 26.67% in the 80.01-90% range. These figures highlight that while the overall technical efficiency is high, with a mean efficiency of 92.40% (ranging from 75.20% to 100%), there remains scope for optimization through improved input use and farm management practices.

Allocative efficiency, which reflects the optimal allocation of resources in relation to cost, is lower than technical efficiency. The mean allocative efficiency stands at 66.90%, with a minimum of 43.80% and a maximum of 100%. Notably, 12.50% of farmers have allocative efficiency below 50%, indicating considerable inefficiencies in resource utilization. Conversely, 16.67% of farmers have attained full allocative efficiency, demonstrating effective resource management.

Economic efficiency, which integrates both technical and allocative efficiency, follows a similar trend to allocative efficiency, with a mean of 67.60%. The distribution shows that 60% of farmers achieve 100% efficiency, effectively optimizing production and resource use for economic output. However, 37.50% of farmers fall within the 70-80% efficiency range, suggesting that enhancing resource allocation strategies could further improve overall farm profitability.

1.2 Non-Beneficiary Farmers

The technical efficiency analysis for non-beneficiary red gram farmers, as detailed in Table 2, exhibits a varied efficiency distribution, indicating significant room for improvement. While 33.33% of farmers have achieved 100% technical efficiency, another 26.67% fall within the 80.01-90% range, with an average efficiency of 85.25%. These farmers require a 14.75% increase in production to reach full efficiency. A considerable proportion (33.33%) operate within the 60.01-70% efficiency range, averaging 66.70%, necessitating a 33.30% improvement to reach the optimal level. Additionally, 6.67% of farmers are in the 70.01-80% range, requiring a 20% increase in production. The mean technical efficiency for non-beneficiary farmers is 83.60%, with efficiencies ranging from a minimum of 43.10% to a maximum of 100%, indicating that while some farms perform optimally, others require substantial adjustments to enhance productivity.

Allocative efficiency among non-beneficiary farmers is lower than technical efficiency, with an average of 78.80%. The minimum recorded allocative efficiency is 61.20%, while the maximum is 100%. Approximately 46.67% of farmers fall into the 70-80% efficiency range, signifying that although most farmers allocate resources relatively effectively, a substantial portion could still enhance cost-effectiveness through better management of inputs.

Economic efficiency, which combines technical and allocative aspects, is comparatively lower at 66.10%, highlighting an overall economic performance gap. The minimum economic efficiency recorded is 47.20%, while a small proportion of farmers achieve full efficiency (100%). This indicates that while some farmers optimize both production and resource use, many others could benefit from strategic improvements in either technical or allocative efficiency.

2. Challenges Faced by Farmers

2.1 Beneficiary Farmers

Beneficiary farmers utilizing canal irrigation encounter several challenges that hinder productivity. The most significant issue reported in the table 3 is crop damage due to excess water flow, affecting 68.60% of farmers. Additionally, improper canal cleaning (67.70%) and delayed water supply in the rabi and summer seasons (65.58%) contribute to inefficiencies in irrigation management. Procedural delays in water release (58.55%) and poor

maintenance of major and minor distributaries (57.82%) further exacerbate water management challenges. Additionally, a lack of cooperation from the water distribution society (57.83%) creates further difficulties in equitable water access and distribution.

2.2 Non-Beneficiary Farmers

Non-beneficiary farmers face a different set of challenges, shown in the table 4 i.e. primarily related to financial constraints and resource availability. Price instability is a significant concern, affecting 60.23% of farmers, followed closely by high costs of fertilizers and pesticides (59.93%). The unavailability of credit at crucial times (59.16%) further restricts farmers' ability to invest in essential inputs. Additionally, non-availability of labor and high wages (57.45%) poses challenges in farm operations. Issues related to infrastructure, such as delayed electricity supply (50.60%), long dry spells impacting crop growth (47.58%), lack of adequate storage facilities (45.06%), and high costs of quality seeds (42.65%), further limit the productivity and profitability of non-beneficiary farmers.

CONCLUSION

The analysis of technical, allocative, and economic efficiency among beneficiary and non-beneficiary red gram farmers highlights notable disparities in resource utilization and productivity. Beneficiary farmers exhibit higher technical efficiency, with 60% achieving full efficiency, while non-beneficiary farmers demonstrate a lower mean efficiency (83.60%), indicating scope for improvement in production practices. Allocative efficiency remains a concern for both groups, with beneficiary farmers averaging 66.90% and non-beneficiary farmers at 78.80%, suggesting suboptimal resource allocation. Consequently, economic efficiency is lower, at 67.60% for beneficiary farmers and 66.10% for non-beneficiary farmers, emphasizing the need for improved cost management and input utilization strategies.

The challenges faced by both groups further underscore the barriers to efficiency improvement. Beneficiary farmers struggle with irrigation management issues, including excessive water flow, delayed water supply, and poor canal maintenance. In contrast, non-beneficiary farmers face financial and infrastructural constraints, such as price instability, high input costs, credit unavailability, labour shortages, and inadequate storage facilities. Addressing these challenges through policy interventions, improved irrigation systems, financial support mechanisms, and enhanced farm management practices could significantly enhance efficiency, productivity, and profitability for both beneficiary and non-beneficiary farmers.

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Table 1. Distribution of sample farmers under different levels of technical, allocative and economic efficiencies in beneficiary farmers of red gram .

Score	Technical Efficiency				Allocative Efficiency				Economic Efficiency			
Efficiency (%)	No. of Farm	Percentage to total	Average	Percentage to increase production to achieve maximum efficiency	No. of Farm	Percentage to total	Average	Percentage to increase production to achieve maximum efficiency	No. of Farm	Percentage to total	Average	Percentage to increase production to achieve maximum efficiency
<10	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
10.01-20	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
20.01-30	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
30.01-40	0	0.00	0.00	0.00	0	0.00	0.00	0.00	3	12.50	37.63	0.00
40.01-50	0	0.00	0.00	0.00	3	12.50	47.70	52.30	4	16.67	44.20	55.80
50.01-60	0	0.00	0.00	0.00	8	33.33	56.93	43.07	9	37.50	55.70	44.30
60.01-70	0	0.00	0.00	100.00	7	29.17	64.70	35.30	5	20.83	62.10	37.90
70.01-80	2	13.33	75.00	25.00	1	4.17	77.80	22.20	1	4.17	79.70	20.30
80.01-90	4	26.67	83.80	16.20	0	0.00	0.00	0.00	1	4.17	81.90	18.10
90.01-99.99	0	0.00	0.00	0.00	4	16.67	94.30	5.70	0	0.00	0.00	0.00
1.00	9	60.00	100.00	0.00	1	4.17	100.00	0.00	1	4.17	100.00	0.00
Mean %	**92.40**				**66.90**				**67.60**			
Minimum %	**75.20**				**43.80**				**46.10**			
Maximum %	**100.00**				**100.00**				**100.00**			

Table 2 Distribution of sample farmers under different levels of technical, allocative and economic efficiencies in non- beneficiary farmers of red gram.

Score	Technical Efficiency				Allocative Efficiency				Economic Efficiency			
Efficiency (%)	No. of Farm	Percentage to total	Average	Percentage to increase production to achieve maximum efficiency	No. of Farm	Percentage to total	Average	Percentage to increase production to achieve maximum efficiency	No. of Farm	Percentage to total	Average	Percentage to increase production to achieve maximum efficiency
<10	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
10.01-20	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
20.01-30	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
30.01-40	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
40.01-50	0	0.00	0.00	0.00	0	0.00	0.00	0.00	2	13.33	47.65	0.00
50.01-60	0	0.00	0.00	0.00	1	6.67	59.60	40.40	5	33.33	55.54	0.00
60.01-70	5	33.33	66.70	33.30	2	13.33	64.25	35.75	4	26.67	65.15	0.00
70.01-80	1	6.67	80.00	20.00	7	46.67	76.22	23.78	1	6.67	70.90	29.10
80.01-90	4	26.67	85.25	14.75	3	20.00	87.36	12.64	1	6.67	89.40	10.60
90.01-99.99	0	0.00	0.00	0.00	1	6.67	98.10	1.90	1	6.67	98.10	1.90
1.00	5	33.33	100.00	0.00	1	6.67	100.00	0.00	1	6.67	100.00	0.00
Mean (%)	**83.60**				**78.80**				**66.10**			
Minimum (%)	**66.70**				**61.20**				**47.20**			
Maximum (%)	**100.00**				**100.00**				**100.00**			

Table 3.Problems faced by beneficiary farmers. (N=15)

Sr. No	Problems	Percentage to total farmer	Rank
1	Improper cleaning to canal	67.70	II
2	Late supply of water in rabi and summer season	65.58	III
3	Procedural delay in releasing water	58.55	IV
4	Crop damage due to excess flow	68.60	I
5	No proper maintenance of major and minor distributes	57.82	VI
6	Lack of cooperation from water distribution society to solve problems of irrigation	57.83	V
7	Improper gate to canal	39.57	IX
8	conflict among farmers	34.42	XI
9	Poor accessibility of information from irrigation officials	32.40	XII
10	Canal sedimentation	27.05	XIII
11	More flow of water in middle and head	56.85	VIII
12	Long duration to reach tail portion	57.70	VII
13	Illegal use of water from distributes	37.22	X

Table 4 Problems faced by non- beneficiary farmers (N=15)

Sr. No	Problems	Percentage to total farmer	Rank
1	Instability in price	60.23	I
2	Long dry spell	47.58	VI
3	Non availability of labour on time and high wages	57.45	IV
4	Non availability of electricity on time	50.60	V
5	Non availability of storage facility	45.06	VII
6	high prices for seed	42.65	VIII
7	high prices fertilizers and pesticides	59.93	II
8	Non availability of credit facility on time	59.16	III

Economic Analysis of Turmeric Processing in Maharashtra

Dr. D.J.Sanap[1] Dr.G.G.Joshi[2] and Kharat S.R[3]

1. Junior Research Assistant, Department of Agricultural Economics, MPKV, Rahuri, Maharashtra.
2.Asistant Professor, Department of Agricultural Economics, MPKV, Rahuri, Maharashtra.
3.M.Sc.Scholar, PGI, Department of Agricultural Economics, MPKV, Rahuri Dist.-Ahmednagar. Maharashtra

Correspondence 1: sanapdj@gmail.com

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ABSTRACT

The study on Kohinoor Turmeric Mill in Wai, Satara, conducted an economic analysis of the unit's performance and supply chain for the year 2022-23. Data collected from the General Manager included costs, returns, and economic indicators such as BCR, NPV, IRR, BEQ, PBP, marketing cost, marketing margin, price spread, and marketing efficiency. The unit employed 41 workers, with a breakdown of 24 male and 17 female workers. Capital investment was focused on building, machinery, and land, with key machinery including polish drums, weighing machines, and packaging machines. Production was impressive at 1337.30 tons of turmeric powder, resulting in gross returns of ₹ 2808.33 lakhs. Total cost was ₹ 1451.47 lakhs, leading to a net profit of ₹ 1356.86 lakhs. The unit's production exceeded the break-even quantity, with an NPV of ₹ 115.765 lakh, IRR of 28.19%, and BCR of 1.94. The payback period was 3 years and 2 months. Channel-II showed higher marketing efficiency than Channel-I. The study emphasizes the importance of efficient production, strategic marketing, and a strong supply chain for the economic viability and growth of units like Kohinoor Turmeric Mill.

Keywords: Economic Viability, BCR, NPV, IRR, BEQ, turmeric

INTRODUCTION

India, known as the "Spice Bowl of the World," produces 63 out of the 107 spices identified globally. Among these, turmeric stands out as one of the most important and ancient spices, extensively used in flavorful dishes across all classes.

Indian spices have historically played a crucial role in the country's economy, a role that continues to be significant today. Despite changes in the spice trade and production methods, their value and demand remain high, both within India and internationally. The demand for Indian spices, including turmeric, is not limited to India, with a substantial global market.

The global turmeric market is projected to reach a value of US$ 4,419.3 million by 2023, with sales expected to increase at a CAGR of 5.5% and surpass US$ 7,579.2 million by 2033. India is the largest producer, consumer, and exporter of turmeric globally. In 2021-22, India exported 1.37 lakh tonnes of turmeric, with major importing countries including Bangladesh, UAE, USA, Malaysia, Morocco, and Iran.

In India, turmeric is primarily grown in states like Maharashtra, Telangana, Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Odisha, Mizoram, Assam, and Gujarat. Maharashtra leads in turmeric production, with districts like Sangli and Satara being major centers. Sangli, known as the "Saffron City," has been a key trading hub for turmeric since the 1900s, known for its unique soil conditions that enhance the spice's color and aroma.

Kohinoor Mills in Wai, Satara, is a prominent player in the turmeric industry, offering a wide range of products and services. With a strong focus on customer satisfaction, the establishment aims to expand its offerings and reach a larger clientele in the future.

METHODOLOGY

Selection of the Study Area

Kohinoor Turmeric Mill Wai, Satara, will be purposively selected for the present study.

Collection of Data

Primary data for the year 2022-23 regarding the production, sales, financial information and marketing cost of the turmeric powder was collected through personal interview with special prepared questionnaire. For analysis of CAGR, the secondary data from 2012-13 to 2021-2022 (10 Years) for production and sales of turmeric powder will be collected from available records of the unit.

Sources of Data

The study contemplates to assess the performance of turmeric processing industry obviously; the data on various aspects was required.

The major aspects of data requirements were as under:

1. Primary information of the unit
2. Details of production and sale of turmeric powder.
3. Initial investment of the unit.
4. Fixed and operating cost of the unit.
5. Repairs and maintenance cost.
6. Fees, taxes, insurance and other relevant expenses.
7. Labours, supervisory staff and decision makers engaged with their bills, salaries and allowances.

Method of analysis

Production cost and returns

In order to calculate the Production of different masala products, percentages, averages and tabular analysis which were be used. The relative economic efficiency of the individual products were judged on the basis of its production cost and net returns.

Financial performance analysis

Break even analysis

The break-even point is where total revenue equals total costs, resulting in no profit or loss. Break-even analysis helps determine this point by comparing costs to the selling price per unit.

a. Physical term

$$BEP = \frac{\text{Fixed cost}}{\text{(Selling price per kg – Variable cost per kg)}}$$

b. Monetary term

$$BEP = \frac{\text{Fixed cost}}{\text{(1 - Variable cost per kg/selling price per kg)}}$$

Net present value

Net Present Value (NPV) is the difference between the present value of cash inflows and outflows over a period of time. It's a capital budgeting tool used to determine the profitability of an investment or project. If NPV is positive, the project is accepted; if negative, it's rejected.

$$NPV = \frac{P1}{[1+i]t1} + \frac{P2}{[1+i]t2} + \frac{Pn}{[1+i]tn} - C$$

Where,

P = Net cash flow
i = Discount rate
t = Time period
c = Initial cost of investment

Internal rate of return

The internal rate of return of an industry is the discount rate, which makes net present value equal to zero. The internal rate of return (IRR) is a metric used in financial analysis to estimate the profitability of potential investments. IRR is a discount rate that makes the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis. IRR calculations rely on the same formula as NPV does. It will calculated by using the formula,

$$IRR = \text{Lower discount Rate} + \text{Difference between two discount rate} \times \frac{\text{NPW at lower discount rate}}{\text{Difference between NPW at two discount rates}}$$

Benefit : cost ratio

The efforts were made to estimate benefit cost ratio to compare the relative economic efficiency of different brands. It is the ratio of total returns to total cost. Projects with a benefit-cost ratio greater than 1 have greater benefits than costs; hence they have positive net benefits.

$$B:C \text{ ratio} = \frac{Tr}{Tc}$$

Where,

B: C = Benefit cost ratio
Tr = Total return (₹)
Tc =Total cost (₹)

Payback period (Undiscounted measures)

Payback period (PBP) is the number of years it takes for a company to recover its original investment in a project, when net cash flow equals zero. In the calculation of the payback period, the cash flows of the project are estimated. The payback period is then a simple calculation.

$$PBP = \frac{\text{Total capital investment}}{\text{Average net return}}$$

Growth rate analysis

In order to study the trends in production and sales of turmeric powder. The functional form of the compound growth rate analysis is,

$$Y = ab^t \ldots\ldots (1)$$

Where,

Y = Dependent variable for which growth rate is estimated.

a = Intercept

b = Regression coefficient

t = Time variable

$$In\ Y = In\ a + t\ In\ b + Ut$$

The per cent compound growth rate (g) is derived using the relationship,

$$g = (Anti\ In\ of\ b\text{-}1) \times 100$$

Pattern of growth rates over the years will identify using the 'b' coefficient. If coefficient will statistically significant and positive then growth of the estimated parameters over the years will accelerating. If it is negative, it will implied that, growth will decelerating over the year.

Marketing cost and marketing margin

In order to calculate the marketing cost of turmeric powder, percentages, averages and tabular analysis was used. The relative economic efficiency of the individual brands will judged on the basis of its production cost and net returns.

Total marketing cost

Marketing costs are the all expenses that the company makes to market and sell its products and develop and promote its brand. These marketing costs or expenses include expenses incurred to change the title of goods, promotion of goods, inventory costs, distribution of goods etc. The marketing cost is also used to determine the risk associated with budgets.

To calculate the marketing cost of the unit some basic statistical tools will use to get exact result. The formula used to estimate the total marketing cost is given below. It is taken from the report Corporate finance and accounting report given by Chris murphy in 2019.

$$C = Cf + Cm1 + Cm2 + \ldots\ldots + Cmn$$

Where,

C = Total Marketing cost

Cf =Cost paid by the producer from the time the produce leaves the farm till he sells it.

Cmi =Cost incurred by ith middleman in the process.

Marketing margin

The marketing margin of a product is the difference between what a company pays for the product and what it charges for the product. The margin is influenced primarily by shifts in retail demand, farm supply and marketing input prices. But other factors also can be important, including time lags in supply and demand, market power, risk, technical change, quality and spatial considerations.

$$MT = \Sigma (Si\text{-}Pi)/Qi$$

Where,

MT = Total marketing margin

Si = Sale value of a product paid by ith firm

Pi = Purchase value of a product paid by ith firm

Qi = Quantity of product handled by ith firm.

Price spread

The difference between the price paid by the consumer and the price received by the producer for an equivalent commodity is known as price spread. It involves various costs incurred by various intermediaries and their margins. Marketing costs are the actual expenses required in bringing goods and services from the Producer to the consumer.

Price spread = Consumer price - Net Producer price

Marketing efficiency

Marketing efficiency is the ratio of the total value of goods marketed to the total marketing cost. The higher the ratio, higher is the efficiency. The marketing efficiency was worked out using Acharya's modified marketing efficiency which is as follows:

$$MME = \frac{FP}{(MC + MM)}$$

Where,

MME- Modified marketing efficiency

FP - Net price received by producer

MC - Marketing cost

MM - Marketing margin

RESULTS AND DISCUSSION

I. Production cost of turmeric powder

a) Capital investment

Table 1 provides information on the initial capital investment of Kohinoor Turmeric Mill. The total capital investment was ₹ 453.00 lakh. Building had the highest share (46.80 %), followed by machinery and equipment (23.40 %) and then land (23.18 %).

Table 1.Total capital investment of unit

Sr. No.	Particular	Amount (₹ Lakh)	Percentage (%)
1	Land	105.00	23.18
2	Building	212.00	46.80
3	Machinery and Equipment	106.00	23.40
4	Furniture and computers	4.30	0.95
5	Vehicles	25.70	5.67
	Total	**453.00**	**100.00**

b) Cost of different machinery

Table 2 provides information on the machinery of the unit and its cost. The total cost of different machineries was ₹ 106 lakh. The total cost of different machineries was ₹ 106 lakh. Highest share in cost belongs to Solar Power Plant (23.58 %), followed by Power Automatic Plant (18.87 %), then Greeding machine and Polish drum (15.09 per cent each), then Pulverizer (10.38 %), whereas share of other machineries is 16.99 per cent.

Table 2.Cost of different machinery

Sr. No.	Items	Quantity	Amount (₹ Lakh)	Percentage (%)
1	Polish drum	8	16.00	15.09
2	Weighing machine	8	0.80	0.75
3	Packaging machine	4	0.20	0.19
4	Pulverizer	2	11.00	10.38
5	Belt conveyor	2	5.00	4.72
6	Hoist	2	2.00	1.89
7	Greeding machine	2	16.00	15.09
8	Power automatic plant	1	20.00	18.87
9	Crain	1	5.00	4.72
10	Dust collector	1	5.00	4.72
11	Solar power plant	1	25.00	23.58
	Total	**32**	**106.00**	**100.00**

c) Total fixed cost of unit

From Table 3, it is evident that the total fixed cost of a unit for the 2022-23 year was ₹ 91.25 lakh. It was for Taxes: ₹ 27.42 lakh (30.05%), followed by Depreciation on building: ₹ 21.20 lakh (23.23%) and Interest on fixed capital: ₹ 21.10 lakh (23.12%)

Table 3.Total fixed cost of unit

Sr. No.	Particular	Amount ₹ (Lakh)	Percentage (%)
1	Opportunity cost of land @5%	5.25	5.75
2	Depreciation of building @10%	21.20	23.23
3	Depreciation of machinery @10%	10.60	11.62
4	Depreciation of Furniture and Computers@10%	0.43	0.47
5	Depreciation on vehicles @10%	2.57	2.82
6	Interest on fixed capital @10%	21.10	23.12
7	License fees	0.68	0.75
8	Insurance	2.00	2.19
9	Taxes	27.42	30.05
	Total fixed cost	**91.25**	**100.00**

d) Total operating cost of unit

Table 4 presents the total operating cost of the unit during 2022-23, amounting to ₹ 75.68 lakh. Salary constitutes ₹ 61.33 lakh, which is 81.04% of the overall operating cost.

Table 4.Total operating cost of unit

Sr. No.	Particular	Amount (₹ Lakh)	Percentage (%)
1	Salary	61.33	81.04
2	Fuel charges	1.90	2.51
3	Hamali charges	0.85	1.39
4	Repair and maintenance	2.00	2.64
5	Telephone expenses	0.10	0.13
6	Travelling expenses	1.89	2.50
7	Office expenses	1.17	1.55
8	Professional fees	1.08	1.16
9	Advertisement	1.80	2.38
10	Employee insurance	1.65	2.18
11	Miscellaneous expenses	1.91	2.52
	Total	**75.68**	**100.00**

e) Cost of raw material

From Table 5, it is evident that raw turmeric finger accounts for 100.00% of the cost for processing turmeric powder. With 1573.30 tons of raw material, 1337.30 tons of the final products are produced, indicating a recovery rate of 85%. The quantity of the final product being less than the quantity of raw material used in production is a common observation in processing industries due to losses during processing.

Table 5.Total cost of raw material for preparing turmeric powder

Sr. No.	Name of Product	Raw material (000 kg)	Rate per kg (₹)	Raw material total cost (₹ Lakh)	Final product (000 kg)
1.	Raw turmeric	1573.30 (100.00)	80	1258.64	1337.30 (85.00)

f) Costs of turmeric powder production

Table 6.Costs of turmeric powder production

Sr. No.	Particulars	Raw material total cost (₹ Lakh)	Quantity of final product (000 kg)	Raw material cost per kg (₹)
1	Raw Material	1258.64	1337.30	94.12
2	Fixed Cost	91.25	1337.30	6.82
3	Operating Cost	75.68	1337.30	5.66
4	Packaging Cost	25.90	1337.30	1.94

From Table 6, it is observed that the per kilogram raw material cost for Turmeric powder was ₹ 94.12, the fixed cost was ₹ 6.82 per kilogram, and the operating cost was ₹ 5.66 per kilogram. The total packaging cost for turmeric powder is not provided, but the per kilogram packaging cost is ₹ 1.94.

g) Per Kilogram total production cost and net returns

From Table 7, the total production cost per kilogram of turmeric powder was ₹108.54, while the net returns from one kilogram of turmeric powder were ₹101.46

Table 7.Per kilogram net returns from turmeric powder (₹)

Sr. No.	Name of product	Total cost of production per kg	Rate of final product per kg	Net return per kg
1	Turmeric powder	108.54	210.00	101.46

h) Total cost and total returns of turmeric powder

From Table 8, it can be seen that the total cost of production for turmeric powder was ₹1451.47 lakh, while the total returns from its sales amounted to ₹2808.33 lakh, resulting in a net profit of ₹1356.86 lakh

Table 11.Total cost and Total returns of turmeric powder (₹ Lakh)

Sr. No.	Name of product	Total cost	Quantity of final product (000 kg)	Total returns	Net returns
1	Turmeric powder	1451.47	1337.30	2808.33	1356.86

II. Financial performance

Exploring the break-even point (BEP), Net Present Worth (NPW), Internal Rate of Return (IRR), Benefit-to-Cost (B:C) ratio, and Payback Period (PBP) for the unit can provide valuable insights into its operations and financial viability. These metrics help assess the unit's profitability, efficiency, and financial health. If you have specific data or calculations related to these metrics, feel free to share them for further analysis and discussion.

a) Break-even analysis for turmeric powder

From Table 9, it is concluded that the actual production of turmeric powder is more than the break-even point in both physical and monetary terms. The unit appears to produce more than its break-even quantity, indicating that the unit is risk-free in turmeric powder production. The physical break-even point for turmeric powder is 82.79 tons, while the unit actually produces 1337.30 tons.

Table 9.Break-even point

Sr. No.	Name of product	Quantity of final product (000kg)	BEP (000 kg)	Total returns (₹ Lakh)	BEP (₹ Lakh)
1	Turmeric powder	1337.30	82.79	2808.33	173.85

b) Net present worth of unit

Net Present Value (NPV) is a crucial metric in investment analysis, representing the difference between the present value of cash inflows and outflows over the anticipated lifetime of an investment. NPV is calculated based on ten-year data related to total cash outflow of the unit from 2012-13 to 2021-22. The NPV is positive at discount factors of 15%, 20%, and 25%, indicating the project's profitability. This positive NPV leads to the acceptance of the project, as it signifies that the investment will yield returns higher than the initial investment.

c) Internal Rate of Return

The Internal Rate of Return (IRR) is a financial metric used to evaluate the profitability of an investment. It is the discount rate at which the Net Present Value (NPV) of all cash flows from the investment equals zero. In simpler terms, IRR is the rate at which an investment breaks even in terms of present value of cash inflows and outflows. A higher IRR typically indicates a more attractive investment opportunity.

$$IRR = \text{Lower discount Rate} + \text{Difference between two discount rate} \times \frac{\text{NPW at lower discount rate}}{\text{Difference between NPW at two discount rates}}$$

IRR = {25 + 5 x 115.765 / [115.765 – (-66.728)]}
IRR = {25 + 5 x 115.765 / 181.493}
IRR = {25 + 5 x 0.638}
IRR = {25 + 3.189}
IRR = {28.19}

The Internal Rate of Return (IRR) for the unit's production and sale of turmeric powder was calculated to be 28.19%. This means that for an initial investment of 100, the unit owner would receive 128.19 in return. The IRR study indicates that for the original investment of 1052.09 lakhs, the unit has the potential to deliver a return of 28.19% over its life. Since the IRR of 28.19% is higher than the bank interest rate, it suggests that the unit is profitable for the owner, encouraging further investment in the business.Similar results were found by (Mane S.P. 2023), Balgudi.p (2021)

d) Benefit-cost ratio

The B:C ratio for Turmeric powder was 1.94, which is greater than 1, this means that project have greater benefits than costs and hence they have positive net benefits and indicate that unit is running in a profitable manner.

III. Compound annual growth rate of production and sales of unit

The Compound Annual Growth Rate (CAGR) for production and sales of Kohinoor Turmeric Mill over ten years (2012-13 to 2021-22) was calculated to be 5.268% and 5.359%, respectively. These CAGR values indicate a consistent and substantial growth rate for both production and sales of the unit over the specified period, reflecting positively on the unit's performance and potential for future growth.

Table 10.CAGR of production and sales of unit

CAGR of production	5.268***
CAGR of sales	5.359***

*** Significant at 1 per cent level

IV. Total marketing cost, marketing margin and price spread

The study compared the marketing costs, margins, and price spreads of turmeric powder through two channels. Channel-I (Producer-Wholesaler-Retailer-Consumer) had a total marketing cost of ₹30.34 per kilogram, while Channel-II (Producer-Retailer-Consumer) had a lower cost of ₹26.54 per kilogram. In Channel-I, the marketing margins per kilogram were ₹78.42 for the producer, ₹26.50 for the wholesaler, and ₹36.20 for the retailer. In Channel-II, the margins were ₹78.42 for the producer and ₹36.50 for the retailer. The price spread, indicating the difference between the producer price and the consumer price, was ₹70/kg for Channel-I and ₹40/kg for Channel-II. This suggests that Channel-II is more cost-effective, with lower marketing costs and a smaller price spread, compared to Channel-I.

Table 11.Marketing cost of Turmeric powder **(Rs/qtl)**

Sr. No.	Particular	Channel – I (P-W-R-C)		Channel –II (P-R-C)	
		500 g	1000 g	500 g	1000 g
A	**Cost incurred by producer**				
1	Production cost	54.27	108.54	54.27	108.54
2	Labour charges	1.40	1.00	1.40	1.00
3	Transportation charges	1.20	0.90	1.20	0.90
4	Miscellaneous charges	2.15	1.60	2.15	1.60
5	GST (18 %)	9.77	19.54	9.77	19.54
	Sub total	68.79	131.58	68.79	131.58
6	Margin of Producer	51.21	78.42	51.21	78.42
7	Selling price	120.00	210.00	120.00	210.00
B	**Cost incurred by Wholesaler**				
1	Purchase price	120.00	210.00		
2	Labour charges	1.30	1.00		
3	Transportation charges	0.75	0.50		
4	Miscellaneous charges	1.50	2.00		
	Sub total	123.55	213.50		
5	Margin of wholesaler	11.45	26.50		
6	Selling price	135.00	240.00		
C	**Cost incurred by retailer**				
1	Purchase price	135.00	240.00	120.00	210.00
2	Labour charges	1.30	1.00	1.30	1.00
3	Transportation charges	1.50	1.30	1.50	1.00
4	Miscellaneous charges	1.20	1.50	1.20	1.50
	Sub total	139.00	243.80	124.00	213.50
5	Margin of retailer	16.00	36.20	16.00	36.50
6	Consumer price	155.00	280.00	140.00	250.00
7	**Price spread**	**35.00**	**70.00**	**20.00**	**40.00**

CONCLUSIONS

The financial overview, profitability, and growth indicators of Kohinoor Turmeric Mill underscore its robust economic performance and sustainable growth prospects. The unit's efficient allocation of investment in building and machinery has resulted in a competitive production cost for turmeric powder. Strong profitability metrics, including a high B:C ratio, favorable IRR, and reasonable payback period, indicate sound financial management and market demand. The emphasis on strategic marketing through Channel-II further enhances the unit's overall efficiency and profitability. Overall, Kohinoor Turmeric Mill exemplifies the importance of effective resource allocation, strategic marketing, and operational efficiency in ensuring the economic viability and growth of agro-processing units.

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Best Management Practices Followed By Agri-Incubatees of Angrau Agribusiness Incubator, Tirupati

P. Hanumanth Reddy* , A. Lalitha , P. Bala Hussain Reddy and K.S. Purnima

Institute of Agribusiness Management,Sri Venkateswara Agricultural College,
Acharya N. G. Ranga Agricultural University,Tirupati -517502
*Correspondence: phreddy@gmail.com

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ABSTRACT

The ANGRAU Agribusiness Incubator was purposively selected for the study conducted in the year 2023 because it has a specific focus on nurturing agri-startups that are working towards improving the farming communities in the state of Andhra Pradesh. Ten successful incubatees trained at ANGRAU agribusiness incubator was purposively selected for the study, based on category, product, service, R&D and achievements.The findings demonstrated that best management practices such aspractices such as 'offering innovative products/services', 'leveraging technology and automation', 'staying adaptable to changing market trends', 'prioritizing customer satisfaction', 'maintaining transparency and ethical practices' and 'implementing effective waste management and recycling' received the highest mean score of 3, ranking I. Following closely with a mean score of 2.9 and ranking II were strategies including 'vision and mission prepared', 'actively managing risks and developing contingency plans', 'consistently evaluate and improve product quality' and 'ensuring compliance with government laws and regulations. Practices like monitoring and evaluating financial performance', 'integrating sustainable practices in the supply chain', 'conducting feasibility surveys/market research', 'setting clear and measurable goals', 'giving employment to at least three persons', 'actively building a network of stakeholders and forming strategic partnerships', 'implementing effective marketing strategies', 'focusing on brand identity and positive image' and 'regularly optimizing operational costs' scored between 2.8 to 2.4, placing them in ranks between III & VII. However, practices concerning leveraging digital marketing strategies, having a detailed project report and income flow statement, developing a comprehensive business plan, seeking partnerships and collaborations for innovation, establishing relationships with financial institutions for funding and creating assets for the agribusiness with profits ranked lower, indicating disagreement among agri-incubatees, with scores 2.3 to 1.9 placing them in ranks between VIII and IX.

Perception of the incubatees towards best management practices inferred that nearly one-third (30.00%) of the agri-incubatees rated their best management practices as "low", while half of the incubatees(50.00%) considered them "moderate", and only one-fifth (20.00 %) of the agri-incubatees rated their practices as "high".

Keywords: *ANGRAU Agribusiness Incubator,Agri-startups, Management practices, Success in agribusiness*

INTRODUCTION

In the recent years, a surge in educated youth's interest in India's agricultural sector has been fueled by innovative ideas and a desire to modernize traditional practices with cutting-edge technologies and business models. Start-ups have emerged as crucial catalysts, bridging gaps in the agricultural value chain and delivering efficient products, technologies and services to both farmers and consumers. Agri-business incubators play a vital role in supporting these agri-tech start-ups by providing funding channels, enterprise development support and enhanced business opportunities. By fostering market connections, reducing wastage, establishing sustainable logistics systems and assisting agri-tech start-ups, incubators shape innovative ideas into viable business models, contributing significantly to rural economic development and ensuring food security. In India, the government, through initiatives such as the National Science and Technology Entrepreneurship Development Board (NSTEDB), actively promotes start-up growth, with a focus on recognizing the potential of innovations to bring about societal changes.

There is a great need to infuse strong startup culture across 759 universities promoting pre-incubation support to students. The success of both the University and the Business Incubator can be facilitated by policies of Governments.

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A University is supposed to spark innovation and to help develop new technologies through freedom to work and through mentorship. A University is able to do so if it is able to create an entrepreneurial culture and has built an effective connectivity with industries. Incubators, either as a part of the University or as an entity outside the university, help build the products in close proximity of inventors whose inputs are essential for further development. They also play a crucial role in reducing overall cost of technology and ventures development(Akiwatkar,2016). The Agri-Innovations and Entrepreneurship Development (AIED) Cell, operating since 2019 at the Regional Agricultural Research Station (RARS), ANGRAU, Tirupati, is a project supported by the Rashtriya Krishi Vikas Yojana(RKVY). ANGRAU Agribusiness Incubator aimed to encourage innovation, entrepreneurship and business creation in agriculture through schemes such as SANKALP and SAMRIDDHI, creating a robust agri-startup ecosystem in Andhra Pradesh and neighbouring states such as Telangana, Tamilnadu, etc. These programs provide opportunities for individuals in agri and allied sectors to work on innovative ideas, from development to commercialization, with support from industry experts, mentors, and funding institutions under one roof at the ANGRAU Agribusiness Incubator.

METHODOLOY

The study was conducted in the year 2023. The study employed a descriptive research design to achieve its objectives. The ANGRAU Agribusiness incubator was purposively selected for the research study because it has a specific focus on nurturing agri-startups that are working towards improving the nutritional outcomes of farming communities in the state of Andhra Pradesh since 2019. Ten successful incubatees trained at ANGRAU - agribusiness incubator were purposively selected for the study, based on category, product, service, R&D and achievements.

Best Management Practices followed by agri-incubatees of ANGRAU-Agribusiness incubator (ABI) was analyzed using through a three-point rating scale. 'Agree' statement was rated with a three score (3); 'Can't say' statement was rated with two score (2); and 'Disagree' statement was rated with one score (1), respectively. An interview schedule was developed consisting of twenty- seven statements. Each statement was rated on three-point continuum *i.e.* agree, can't say and disagree with scores of 3, 2 and 1, respectively. The maximum and minimum score of each agri-incubatees were 81 and 0, respectively. The scores obtained for each identified parameter were summated and the respective means were estimated and are arranged in descending order as per the mean values obtained and ranked.Primary data was gathered throughthe structured interview schedule from the incubatees, ensuring cooperation and response accuracy. Descriptive statistics were then computed for the primary data and the results were analysed.

RESULTS AND DISCUSSION

Best Management Practices followed by agri-incubatees of ANGRAU Agribusiness incubator

From the Table 1, The practices with the highest mean score and ranking of I included 'offering innovative products/services', 'leveraging technology and automation', 'staying adaptable to changing market trends', 'prioritizing customer satisfaction', 'maintaining transparency and ethical practices' and 'implementing effective waste management and recycling'. These practices received agreement from the participants, indicating their recognition of the importance of these strategies in best management practices.

The practices with a mean score and ranking of II were 'vision and mission prepared', 'actively managing risks and developing contingency plans', 'consistently evaluate and improve product quality' and 'ensuring compliance with government laws and regulations. While these practices were also generally agreed upon, they received slightly lower scores when compared to the top-ranked practices.

Following closely with ranking between III &VII observed best practices were 'monitoring and evaluating financial performance', 'integrating sustainable practices in the supply chain', 'conducting feasibility surveys/market research', 'setting clear and measurable goals', 'giving employment to at least three persons', 'actively building a network of stakeholders and forming strategic partnerships', 'implementing effective marketing strategies', 'focusing on brand identity and positive image' and 'regularly optimizing operational costs'. These practices were still positively regarded by the participants but had a neutral perception.

The remaining practices, rankings of VIII and IX, received relatively disagreement from the agri-incubatees. These practices included leveraging digital marketing strategies, having a detailed project reportand income flow statement, developing a comprehensive business plan, seeking partnerships and collaborations for innovation, establishing relationships with financial institutions for funding and creating assets for the agribusiness with profits.

Overall, these results suggested that agri-incubatees have generally embraced and implemented a range of best management practices, particularly in areas related to innovation, technology adoption, customer satisfaction, and sustainability. However, there are still opportunities

for improvement in areas such as linkages, digital marketing, detailed project planning, and partnerships with financial institutions. By focusing on enhancing these practices, agribusinesses can further optimize their operations and position themselves for continued growth and success in the industry.

ANGRAU agri-incubator initially mentored these start-ups to have a business plan for three years and break even (if not profits) in the first year. The start-ups already have launched themselves in the agri markets and it is high time to prepare a comprehensive business plan for their start-ups for the next three years. Also, digital marketing is cost effective and a free of cost social media page on Facebook or Instagram can help them to reach wider consumers across India and give visibility to their business. All the start-ups can link a cell phone number to WhatsApp business account and can increase their consumer base. A WhatsApp business account can be made free of cost and an automated greeting message can be inserted to acquire new consumers. Furthermore, partnerships with financial institutions can help them to upscale their business and obtain loans with low interest. The start-ups were suggested these strategies during personal interview by the researcher and they agreed that they will focus on the weaknesses and plan to expand their business, including above strategies.

Overall perception of the agri-incubatees on best management practices

The data presented in Table 2 shows Perception of the incubatees towards best management practices concluded that nearly one-third (30.00%) of the agri-incubatees rated their best management practices as "low" while 50.00 percent considered them "moderate", and only 20.00 percent of the respondents regarded their practices as "high".Babu*et al*. (2015) reported that three technological innovations and eight institutional innovations can be the factors for speeding up agricultural transformation and lead to agribusiness in a transformed agricultural sector.

To provide additional information about the dataset, the mean is calculated ($\bar{x}$ = 73.40) and the standard deviation is (σ = 5.08). The mean plus one standard deviation is 78.48, while the mean minus one standard deviation is 68.32. These values indicated the range within which most of the data points fall and the majority of the respondents (70.00%) fell under 'moderate and high' perception.

As for the best management practices, the majority of the agri-incubatees rated them as moderate, with smaller proportions considering them low or high. It is interesting to note that 100 percent of the agri-incubatees employed at least three persons to initiate and stabilize their start-up. Eventhough, only nearly one-third of the respondents created assets, broke even or obtained minimum profit could also be viewed as a best management practice. A total of 70.00 percent of the respondents had marketing strategies and were trying to include free digital marketing strategies, such as "Youtube", "Facebook page" and "Instagram page" in the near future. Every new business should have a vision and mission and 90.00 percent of the respondents had a written vision and mission. None of the agri-incubatees said that they are not adaptable to changing marketing trends which is a positive attitude for their business growth.The ZTM-ABI Centre operational at ICAR-CIFT managed technologies/ innovations, assisted the entrepreneurs in seizing new business opportunities, and thus became key player in the growth of industries in fisheries and food processing sector (Razia Mohamed *et al.,* 2020).

CONCLUSIONS

The study underscored the pivotal role of best management practices in the success of agri incubatees. Overall, these results suggested that agri-incubatees have generally embraced and implemented a range of best management practices, particularly in areas related to innovation, technology adoption, customer satisfaction, and sustainability. However, there are still opportunities for improvement in areas such as linkages, digital marketing, detailed project planning, and partnerships with financial institutions. By focusing on enhancing these practices, agribusinesses can further optimize their operations and position themselves for continued growth and success in the industry. Overall,perception of the agri-incubatees on best management practices nearly one-third (30.00%) of the agri-incubatees rated their best management practices as "low", while 50.00 percent considered them "moderate", and only 20.00 percent of the respondents regarded their practices as "high". As for the best management practices, the majority of the agri-incubatees rated them as moderate, with smaller proportions considering them low or high**.**

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Table 1.Best Management Practices followed by Agri-Incubatees of ANGRAU Agribusiness Incubator in Tirupati (n=10)

S. No.	Best management Practices	Agree		Can't Say		Disagree		Total score	Mean	Rank
		f	S	f	S	f	S			
1	I offer innovative product/ service to the customers and constantly have a look on the USPs of my product/ service	10	30	0	0	0	0	30	3	I
2	I leverage technology and automation to enhance efficiency in my agribusiness	10	30	0	0	0	0	30	3	I
3	I stay adaptable to changing market trends and evolving consumer preferences.	10	30	0	0	0	0	30	3	I
4	I prioritize consumer satisfaction by consistently delivering high-quality products or services	10	30	0	0	0	0	30	3	I
5	I maintain transparency and ethical practices in all aspects of my agribusiness	10	30	0	0	0	0	30	3	I
6	I implement effective waste management and recycling practices in my agribusiness	10	30	0	0	0	0	30	3	I
7	I have a vision and mission prepared for my start-up	9	27	1	2	0	0	29	2.9	II
8	I actively manage risks and develop contingency plans to mitigate potential challenges	9	27	1	2	0	0	29	2.9	II
9	I consistently evaluate and improve the quality of my products or services	9	27	1	2	0	0	29	2.9	II
10	I ensure compliance with Govt. laws and regulations in my agribusiness operations	9	27	1	2	0	0	29	2.9	II
11	I monitor and evaluate my financial performance to ensure profitability and sustainability	8	24	2	4	0	0	28	2.8	III
12	I integrate sustainable practices throughout my agribusiness supply chain	8	24	2	4	0	0	28	2.8	III
13	I have done feasibility survey/market research before planning my agribusiness	8	24	1	2	1	1	27	2.7	IV
14	I set clear and measurable goals to drive growth and success of my agribusiness.	7	21	3	6	0	0	27	2.7	IV
15	I gave employment for at least three persons	8	24	1	2	1	1	27	2.7	IV
16	I actively build a network of relevant stakeholders and form strategic partnerships.	7	21	3	6	0	0	27	2.7	IV

Contd..

17	I implement effective marketing strategies to promote my agribusiness.	7	21	3	6	0	0	27	2.7	IV
18	I focus on building a strong brand identity and positive brand image.	7	21	3	6	0	0	27	2.7	IV
19	I regularly assess and optimize operational costs to maximize profitability.	8	24	1	2	1	1	27	2.7	IV
20	I have well established forward linkages such as collection centres at farm gate/ processing centres/ refrigerated transport/ retail stores, etc to buy my product.	6	18	4	8	0	0	26	2.6	V
21	I have well established backward linkages such as direct raw material procurement, availability of chemicals, technology backstopping, etc	5	15	5	10	0	0	25	2.5	VI
22	I will try to leverage digital marketing strategies to build a strong online presence.	7	21	1	2	2	2	25	2.5	VI
23	I have detailed project report (DPR) of my agri business along with the income flow statement for next 3 years	5	15	4	8	1	1	24	2.4	VII
24	I have developed a comprehensive business plan / model outlines my strategies for first 3 years	5	15	4	8	1	1	24	2.4	VII
25	I actively seek partnerships and collaborations to foster innovation in my agribusiness.	4	12	4	8	2	2	22	2.2	VIII
26	I am trying to establish network with financial institutions to access funding options.	5	15	2	4	3	3	22	2.2	VIII
27	I created assets for my agri-business with the profit	3	9	3	6	4	4	19	1.9	IX

n=No.of respondents; f= frequency; S = Score

Table 2. Perceptionoftheagri-incubateesonbest management practices (n=10)

S.No.	Parameter	Frequency	Percentage
1	Low (< 68.32)	3	30.00
2	Moderate (68.33 to 78.47)	5	50.00
3	High (> 78.48)	2	20.00
Total		**10**	**100.00**
Mean = 73.40		**Standard Deviation = 5.08**	