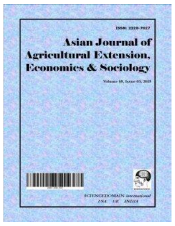

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Economic Analysis of Maize Production and Marketing in Khammam District, Telangana

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Authors' contributions

This work was carried out in collaboration between all authors. Author BS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors HHK and RNJ managed the analyses of the study. Author NG managed the literature searches and edited total manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Maize is the most important cereal and it is mostly used as grain, feed, fodder, starch and industrial products. In the present study, an attempt was made to calculate the cost of cultivation, find out resource use efficiency, price spread and market efficiency of maize in different marketing channels and to find out constraints in production and marketing of hybrid maize in the study area. The study area selected was Chinthakani mandal of Khammam (dist.). A multi-stage sampling method involving a combination of purposive and random sampling procedures was employed in drawing up the sample block, villages and farmers for collecting primary data. Sixty farmers (23 marginal, 20 small and 17 large) were selected at random by proportional probability sampling technique. In the study Maximum likelihood Estimation (MLE) technique was used in stochastic frontier production for

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finding out the technical efficiency. The coefficients of stochastic regression model were used to calculate the Marginal Value Product of Variable Inputs (MVP) and its ratio R with Marginal Factor Cost (MFC) used to determine resource use efficiency (RUE). The price spread was applied to measure the degree of pricing efficiency, marketing costs; market margins to calculate Index of the marketing efficiency (MEI). Total fixed cost for marginal, small and medium farmer are Rs.7337.43, Rs.7281.84 and Rs.7261.11 respectively .The benefit cost ratio is Maximum in case of medium farmers with at 2.7:1, followed by small farm (2.5:1) and marginal farmers (1.5:1). The gross returns from a hectare land are highest in case of medium farm with Rs 89364.63, followed by small (75396.54) and marginal (64845.89). A significant difference indicates sub-optimal allocation of resource. Labour, fertilizer and machine are under-utilized in the study area. The study suggested that a well-built strong infrastructure provision with efficient use of inputs and without marketing malpractices would show the way to an economically well-built maize economy.

Keywords: Maize (Zea mays L.); production and marketing of maize; Maximum Likelihood Estimation (MLE); Marginal Value Product of Variable Inputs (MVP); Marginal Factor Cost (MFC); Resource Use Efficiency (RUE); Index of the Marketing Efficiency (MEI).

1. INTRODUCTION

1.1 Maize History and Climate

Maize (*Zea mays* L.) was one of the first plants cultivated by farmers between 7000 and 10,000 years ago, with evidence of maize as food coming from some archaeological sites in Mexico where some small corn cobs, estimated to be more than 5000 years old, were found in caves. Other theories describe maize as originating in the region of in the high lands of Bolivia, Ecuador, and Peru as evidenced by the presence of popcorn in South America [1]. The spread of maize from its center of origin in Mexico to various parts of the world has been remarkable and rapid with respect to its evolution as a cultivated plant and as a variety of food products. It can be grown successfully in variety of soils ranging from loamy sand to clay loam. However, soils with good organic matter content having high water holding capacity with neutral pH are considered good for higher productivity [2]. Fertile well-drained alluvial or red loams free from coarse materials and rich in nitrogen are the best soils for its successful growth.

The cultivation of maize in India is characterized by inter-cropping i.e. along with and in pulses, vegetables and oil seeds. It can be grown under varied climatic conditions. Maize is mainly a rainfed kharif crop, it requires 50-100 cm of rainfall and it cannot be grown in areas of more than 100 cm rainfall. In areas of lesser rainfall, the crop is irrigated. This crop usually grows well under temperatures varying from 21°C to 27°C, although it can tolerate temperatures as high as 35°C.Maize is an inferior grain which is used both as food and fodder. Because of its worldwide distribution and relatively lower price maize has wider range of uses. (Source: Meteorology department of PJTSAU) [3].

1.2 Economic Potential of Maize

Maize is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. It is an important cereal crop in world after wheat and rice. The importance of the crop lies in its wide industrial applications besides serving as human food and animal feed. As the demand for the crop is growing globally due to its multiple uses for food, feed and industrial sectors new production technologies offer great promise for increasing productivity to meet the growing demands of consumers.

1.3 Overview of Maize Potentials in Telangana

The role of agriculture sector in the state economy is very significant. It produces 30 percent of the income and 78 percent of the working population is dependent directly and indirectly on agriculture and mostly dependent on rainfall. Monsoon and seasonal conditions play a major role in the agricultural production. The contribution of agriculture and livestock under primary sector to the state Telangana is the twelfth largest state in India in terms of area. Gross Domestic Product for the year 2012-13 is 13.67 per cent (BES of Andhra Pradesh, 2012-13). Telangana is one of the large maize producing states in India. In Telangana, maize is cultivated in all the districts (except Hyderabad) in both the Kharif and Rabi seasons. The total maize production doubled in the state within the past ten years (DES, 2014). The maize production in the state has been largely influenced by increasing demand from the feed industries and various industrial uses [4]. Major maize growing districts in Telangana are Karimnagar, Warangal, Nizamabad, Mahaboobnagar, Khammam and Medak. Area and production of maize have increased manifolds in the state during the previous decade. In Medak district, the maize yield has declined over the years with very high instability [4]. Since maize demand is increasing consistently, it has become important to understand the existing maize situation in the newly formed Telangana state and plan the future of maize in the state based on the past and present situation.

2. MATERIALS AND METHODS

2.1 Study Area

Telangana state is geographically located in a semi-arid area and has a predominantly hot and dry climate. Summers start in March, and peak in May with average high temperatures in the 42 °C (108 °F) range. The monsoons enter in the state in June and lasts until September with about 715 mm of precipitation. A dry, mild winter starts in late November and lasts until early February with little humidity and average temperatures in the 22–23 °C (72–73 °F) range. The average annual rainfall in the state is about 906.6 mm and 80% of annual rainfall is received from the south-west monsoons (June-September) recorded a highest rainfall during 2013-14 with 1212.2 mm., production of total food grains was recorded at 107.49 lakh tonnes. Of the total food grains production, production of cereals and millets was 102.78 lakh tonnes, production of maize was 35,24,907 tonnes. The average productivity of Maize is 1716 Kgs. in Telangana. Maize is cultivated in all the districts (except Hyderabad) in both the Kharif and Rabi seasons. The total maize production doubled in the state within the past ten years. The maize production in the state has been largely influenced by increasing demand from the feed industries and various industrial uses. Whereas Khammam district lies between 16° 45' and 18°35' of the north latitude and 79°47' to 81°47' of the east longitudes. The district is drained by Godavari and Krishna river systems. The district forms part of Godavari river basin. The main crops of the district are maize, rice, jowar, bajra, cotton and chillies. The total cropped area in the district is 4,39,050 ha which forms about 30 percent of the total geographical area.

The study was confined to Khammam district of Telangana. The selected villages represent fairly well the agro-climatic, Socio-economic situation of the Khammam district.

2.2 Sampling Technique

A multi-stage sampling method involving a combination of purposive and random sampling procedures was employed in drawing up the sample. The first stage was purposefully selecting the district and secondly purposefully selecting the EAPs. The purpose for selecting area was based on highest productivity of maize per hectare and climatically suitable area and it was help for economic researcher for reference in future research. The selected sites were Chinthakani mandal of khammam district EPAs. Thirdly, the sampling units (households) were sampled randomly from the selected EPAs where equal number of households was drawn from each EPA. For the purpose of selecting desired number of sampling units from each village, the farm households of these villages were listed separately.

The households listed were again stratified in to 3 size groups.

Households having less than one hectare of operational land holding
(<1ha, marginal).
Households having one to two hectare of operational land holding
(1-2 ha, small).
Households having two to four hectare of operational land holding
(2-4ha, medium).

23 marginal farmers, 20 small farmers and 17 large farmers were selected at randomly. Thus a total 60 respondents were selected at random for the purpose of this research study.

2.2.1 Prevailing marketing channels

Channel-I (Producer→ Consumer)
Channel-II (Producer→primary wholesaler→→retailer Consumer)
Channel-III (Producer→primary→wholesaler→seconadary wholesaler→reatailer →Consumer)
Channel-IV (Producer→retailer→Consumer)

2.2.2 Analytical technique

In the study, a number of analytical approaches were used. They include; Descriptive Statistics, stochastic frontier analysis (SFA), marketing margins, marketing costs, marketing efficiency index (MEI) and price spread.

2.3 Descriptive Statistics

Descriptive Statistics such as mean, standard deviation and percentages were calculated on all variables including; maize area (ha), yield (kg/ha), seed (kg/ha), labour used (man-day /ha), chemical fertilizer (kg/ha), manure (tonnes/ ha), cost of pesticides and insecticides (rupee/ha), credit access (per cent), extension services (per cent), age of head (years), education (years), experiences (years), total agricultural areas (ha).

2.4 Farm Business Analysis

The following cost concepts were used to find out the costs structure in the production of Maize.

Variable costs (seeds, Manure, Fertilizer, Human labour etc.).

Fixed costs (Rental value of land, Interest in fixed capital Depreciation).

Total costs = Total variable cost (TVC) + Total Fixed Cost (TFC)

For examining the cost of cultivation of Maize with its market price, the following concepts were worked out;

Table No: Cost concepts

Cost groups	Items of the costs included
Cost A1	Seed, Manure, Fertilizer, Human labour, Hired labour, pesticides etc
Cost A2	Cost A1 + rent paid for leased in land
Cost B1	CostA1 + interest on fixed capital
Cost B2	Cost B1+ rent paid on leased in land+ rental value of owned land
Cost C1	Cost B1+imputed value of family labour
Cost C2	Cost B2+ imputed value of family labour

2.4.1 Estimation of measures of farm income employed the following measures

Gross Farm Income: (GI) was estimated at prevailing market prices of main product and bi-product at the time of harvest.

Net Farm Income (NI): NI was calculated by deducting total cast (TC) from Gross Farm Income (GI).NI=GI – TC

Farm business Income (FBI): its disposable income but of the enterprise and defined as retunes to family labour, owned land, owned fixed capital and management. It is expressed as FBI = Gross Income – Cost A2.

Family labour Income: it is the return to family labour (including management). It is defined as; FLI = Gross Income – Cost B2.

Return on Kwacha: it was estimate by dividing Gross Income (GI) by Total Cost (Cost C2), B: C ratio = GI/ TC.

2.5 Stochastic Frontier Analysis (SFA)

Stochastic frontier Analysis (SFA) was employed to analyse the data collection. The frontier production differs from production function in the sense that its disturbance term has two components, one to account for technical inefficiency and the other to permit the random event due to measurement errors [5-6].

The empirical Stochastic Frontier Production Model used for the study of the analysis of technical efficiency is expressed as follows:

$$Ln\ Yi = \beta0+\beta1\ In\ X1 + \beta2\ In\ X2 + \beta3\ In\ X3 + \beta4\ In\ X4 + \beta5\ In\ X5 + \beta6\ In\ X6 + vi - ui \quad (1)$$

Where
- Ln Yi = Output (Kg of Maize of the farmer)
- Xi = Farm size (in hectares)
- X2= seed (Kg/ha)
- X3= Hired labour used (in man days)
- X4= Fertilizer used (in Kg)
- X5= family labour used (in man days)
- X6= Herbicides used (in litters)
- Vi= Random noise
- Ui= Inefficiency effect which are non-negative, half normal distribution

The technical efficiency (T.E) of an individual farm is defined in terms of the ratio of the observed output (Yi) to the corresponding frontier output (Yi*), given the available technology, conditional on the level of input used by the farm. Hence the technical efficiency of farm is expressed as follows:

$$T.E. = Yi/Yi^* = f\ (Xi,\beta)\ exp\ (Vi - Ui)/\ f\ (Xi,\beta)\ exp\ (Vi) = exp\ (-Ui). \quad (2)$$

The technical efficiency of the i- th farm is given by TEi= exp (- ui) and has value between 0 and 1, with 1 defining a technically efficient farm. Since only the difference between both random terms wi= vi – uican be observed, uiis predicted by its conditional expectation given the estimate value of wi: E [ui/wi] . The conditional distribution of ui/wiis that of a truncated N (μi*σ*2), where μi*= (wiσu2 - μiσv2) / (σu2+σv2) and σ*2= σu2σv2/ (σu2+ σ v2) [7-12].

The socio- economic factors affecting level of technical efficiency model was defined by:

T.E. = б0 + б1Z1+ б2Z2 + б3Z3 + б4Z4 + б5Z5 + б6Z6 (3)

Where,

T.E = Technical Efficiency
Z1 =Farming experience (in years)
Z1 = Gender of the respondent
Z3 = Age of the respondent (in years)
Z4 = Literacy level (in years)
Z5 = Family size (number of persons in farmer's household)
Z6 = Number of contact by extension agent (in number)
бo – б6 = Are parameters to be estimated.

The Maximum Likelihood Estimation (MLE) for all parameters of the Stochastic Frontier Production function and the inefficiency model defined above and the technical efficiency were obtained using R project software.

2.6 Resource Use Efficiency

The estimation coefficients from the stochastic regression model above were used to calculate the MVP and its ratio R with MFC used to determine the economics efficiency of resource used. The model was estimated as follows;

R = MVP/ MFC (4)

Where,

R = efficiency ratio
MVP = Marginal Value Product of Variable Inputs
MFC = Marginal Factor Cost (price per unit inputs)

Based on economics theory, a farm maximizes profits with regards to resource use when the ratio of the marginal return to opportunity cost is one. The values are interpreted as follows;

If r is <1; resource is excessively used or over utilize hence decreasing the quantity use of that resource increases profits.
If r is > 1; resource is under use or is being underutilized hence increase in the rate of use will increase profit level. If r is = 1; it show that the resource is efficiently used, that is optimum to utilization of resource hence the point of profit maximization [9].

2.7 Estimation of Technical Efficiency (Stochastic Frontier Production)

In this study we were interested to find out the individual and the overall technical efficiency of different size group of maize farmer. For the estimation of the technical efficiency we have used stochastic frontier production function. While it was also possible to use the technique with a single input and output. This technique was also capable of taking panel data as well as single time cross section data for calculation of inefficiency of the individual farm.

Farrell-1957 introduced the idea of an empirical approach to efficiency by the firm specific quotient of observed production Yi to optimal production Yi*. Stochastic production frontiers indicate the maximum expected output for a given set of inputs [13]. Explicit representation of this relationship as a production frontier allows a detailed characterization of input and output relationships. So when assuming cross sectional data for n units indexed by i (i = 1,…, n) using K (k = 1, ...,K) different inputs contained in the input efficiency .

TEi = Yi/ 〖Yi〗^* =Yi/ (g(xi:β)) ∈ |0,1|
TEi = Technical efficiency
Yi = Represents the output for the i-th firm
Yi* = Represent optimal production of ith firm
g(X i :β)= a deterministic production function.
xi = input vector xi to produce a single output Yi

The main idea of the stochastic frontier production function was what the contribution of the technology different individual farms were employing in the production process. So we can write the output including stochastic terms

Yi = g (xt; β) · evt · e−ut

Transforming into log is

$$\log (Y_i) = \log(g(x_i; \beta)) + v_i - u_i$$

Where,

v_i= were assumed to be independent and identically distributed random error which have normal distribution with mean zero and unknown

Variance $\sigma 2v$. $v_i \sim N(\mu v ; \sigma 2v)$

u_i = were non-negative unobservable random variables associated with the technical inefficiency of production, such that, for the given technology and levels of inputs, the observed output falls short of its potential output.
u_i can be defined as:

$$u_i = \{\exp [-\eta (t - T)]\} u_h, \quad (2)$$

Where

η = is an unknown parameter to be estimated.

In the following we assume a simple Cobb-Douglas production function

$$g (X_i; \beta)= e^{\beta 0} X_i \beta k$$

Transforming into Log

$$\text{Log} (X_i; \beta) =\beta 0 +\sum_{(k=1)}^{K} \beta k \text{Log} X_{ik}$$

The output model was given by

$$\text{Log} (X_i; \beta) =\beta 0 +\sum_{(k=1)}^{K} \beta k \text{Log} X_{ik} + v_i + u_i$$

This gives us firm specific technical efficiency point in Cobb-Douglas case.

$$TE=(g (x_i; \beta) \cdot e^{vi} \cdot e^{-ui})/(g (x_i; \beta) \cdot e^{vi})= e^{-ui}$$

2.7.1 Maximum likelihood Estimation (MLE)

Maximum likelihood Estimation (MLE) technique has been used in stochastic frontier production for finding out the technical efficiency.

In this study SPF was used to find out the individual technical efficiency of onion farmer as well as the overall efficiency of onion farmer under study. As we assume that our sample represents the whole population we can get an idea how efficient our onion farmer in Odisha or in other words how inefficient they are.

$$\sigma s2 = \sigma 2+\sigma v2 \text{ and } \gamma=\sigma 2/(\sigma 2+ \sigma_v^2)$$

In this study, the stochastic frontier production function of Cobb-Douglas form was specified as follows

2.7.1.1 Model Specification for the particular study

$$\text{Ln} (Y_i) = \beta 0 + \beta 1 \text{Ln} (A_i) + \beta 2 \text{Ln} (S_i) + \beta 3 \text{Ln} (L_i) + \beta 4 \text{Ln} (F_i) + \beta 5 \text{Ln} (IR_i) + \beta 6 \text{Ln} (O_i) + V_i - U_i$$

Where:

- i = It refers to ith farm (i = 1,2,3,…..N) , (N=121)
- Ln = represents the natural logarithm (ie. to base e)
- Y = represents the quantity of Onion produced (in Qtl))
- A = Area under onion (in Ha)
- S = Seeds used (in Rs)
- L = Human Labour used (in Man-days)
- F = Fertilizer used (in Rs)
- IR = Irrigation Expenditure (in Rs)
- O = Expenditure on Other activities (in Rs)

V_i & U_i were the random variables defined above.

The technical efficiency of the i-th farmer can be calculated as:

$$TE_i =\exp (-u_i)$$

2.8 Marketing Costs, Margins and Marketing Efficiency Indices

2.8.1 Producer's share in consumer's kwacha

It is the price received by the farmer, to the retail price, expressed as a percentage. If Pr is the retail price and Pf is the price received by the farmer, than the producer's share in the consumer's rupee Ps may be expressed as follows;

$$Ps = (Pf /Pr) \times 100 \quad (5)$$

2.8.2 Total cost of marketing

The total cost incurred on the marketing either in cash or in kind by the producer-seller and other various intermediaries involved in the sale and the purchase of the commodity till the commodity reaches the ultimate consumers, may be computed as follows;

$$MC = MCf + MCm1 + MCm2 + \text{---} + MCmn, \quad (6)$$

Where,

MC= Total cost of marketing of paddy
MCf= Total cost paid by the producer from the time of the produce leaves the farm till he sells it.
MCm1= Cost incurred by the ith middle man in the process of buying and selling the products [14].

2.8.3 Marketing margin of the middlemen

Marketing margin was calculated by determining price various at different segment and compare them with the final price paid by the consumer. The formula for total marketing margin was as follows;

$$MM = (RP - FP)/ RP * 100 \quad (7)$$

Where,
MM= Marketing Margin
RP= Retail Price
FP= Farm gate Price

2.8.4 Marketing efficiency

Marketing efficiency is the ratio of the market output to market input. An increase in this ratio represents improved efficiency and decrease denotes reduced efficiency. It is the effectiveness or competence with which a market structure performs its designed function.

Marketing efficiency is represented as follows.

$$MEI = V/ I - 1 \text{ (Shepherd's formula)} \quad (8)$$

Where,
MEI= Index of the marketing efficiency
V= Value goods sold/ retail price
I= Total marketing cost

According to Acharya and Agarwal [15] MIE is the ratio of net price received by the farmer to the total marketing cost plus total margins follows;

$$MEI = FP/ (MC + MM) \quad (9)$$

Where,
MEI= Marketing efficiency Index
FP = Farmer Price
MC= Marketing cost
MM = Marketing margin

2.9 Constraint Analysis

The sample farmers and traders were asked to mention constraints and challenges they face in the production and marketing of maize. The questionnaire had pre- identified constraints from which farmers and traders were asked to indicate if they faced such constraints. Farmers were also asked to indicate any other constraints that did not appear on the list of pre-identified constraints. The frequency table and percentage were computed.

3. RESULTS AND DISCUSSION

3.1 Cost Structure and Return on Maize Cultivation in the Sample Farms

For decision making process in any farm business analysis, cost structure composition is crucial. The cost structure include variable cost, fixed cost, cost ratios etc. The analysis of cost and return indicates profitability of the farm business. The concept of cost and return used in the present discussion are the same as generally adopted in the farm management studies conducted in the country. This section provides the cost structure prevailing in the study area. The costs were determined keeping into account the inputs that the farmers in the study area use in the maize cultivation. The total variable cost of marginal farmers were higher than small and medium farmers (Table 2).

3.2 Variable Cost of Maize Cultivation in the Sample Farms

The variable cost is such cost which varies with the level of production. These costs include the cost of inputs responsible for production such as labour (human and machinery), seed, machine, manure, fertilizer, pesticides and interest on working capital. It is observed from the Table 1 that, the average variable cost per hectare is Rs. 16296.66 in all sample farms for one hectare of maize cultivation. It is found from the study that, the per hectare variable cost is high in marginal farms i.e.Rs.17858.90, followed by medium and small farms Rs.16376.57 and Rs.14131.83 respectively. Seed accounted highest percentage of total variable cost i.e. 31.01% in all farm size.

Plant protection chemical accounts the next highest of total variable cost i.e. 19.14%.The per hectare expenditure on Manure is Rs. 2317.20 which accounted for 14.22% of the TVC that is third highest of all the input cost. On an average, the per hectare expenditure on interest on working capital was 6.54% of TVC that is the least among all input. The per hectare expenditure on fertilizer and labour was Rs.2234.81 (13.71%) and Rs. 1386.94 (8.51%) respectively (Table 1).

3.3 Fixed Cost of Maize Cultivation in the Sample Farms

Fixed cost is also important part of total cost calculation which decide whether the farmer to stay in farm business or not. It is observed from Table 2 that on an average about Rs.7297.31 was spent on fixed inputs on one hectare of maize cultivation. Total fixed cost for marginal, small and medium farmer is Rs.7337.43, Rs.7281.84 and Rs.7261.11 respectively, that the trend was highest cost for marginal farm followed by small and medium farm subsequently. Out of all the components of TFC, rental value of owned land for Rs.6666.66 (91.35%) which is highest cost among all the fixed input and Rs. 41.66 (0.57%) is on land revenue which was least among all the fixed cost. Rental value of own land and land revenue is same for medium, small and marginal farms i.e. Rs.41.66. Depreciation was more for marginal and small farmers as compared to medium farmers because they use their own machinery like thresher and sprayer for operational farm business. On an average about, depreciation accounts 111(1.52%) of the total cost was spent on total fixed cost.

3.4 Total cost Farm Size Gross Income and of Maize Cultivation in the Sample Farms

It was observed from the Table 3, that TC is about Rs.23589.97 on an average for one hectare of maize cultivation. Total cost is higher for marginal farms followed by medium followed by small farm. On an average, Rs 25196.33, Rs.23637.68 and Rs.21413.67 are spent by marginal, medium and small farmers in the study area. The TC has been partitioned into variable and fixed cost. TVC constituted 60.06% of TC and TFC constituted 30.93% of TC on an average. The amount of variable and fixed cost is Rs.16292.66 and Rs. 77297.31 respectively for all farms on an average. The amount of fixed cost is high in marginal farm followed by small and medium farms and variable cost shown high in marginal farms followed by medium and small farms. The table reveals that per hectare return of maize was Rs. 89364.63 highest in case of medium farms followed by small farms Rs. 75396.54 and marginal farms Rs.64845.89. on an average, total revenue for all farm is Rs 75346.46 in one hectare of maize cultivation. The cost of production per quintal of maize is highest for marginal farms i.e. Rs.25196.33 followed by medium farms Rs.23637.68 and small farms Rs 21413.67 and on average, total cost of production for all farm is Rs 23589.97 in one hectare of maize cultivation. On an average about Rs.51756.49 net profit gained in maize cultivation in the study area overall. Out of which, highest net return is in case of medium farmer Rs.65726.95, followed by small farmers Rs. 53982.87 followed by marginal farmers Rs. 39649.56 is seen in the study area. From Table 3 the average benefit cost ratio is 2.1:1 in the study area. Hence, it is concluded that maize cultivation is profitable for all farms in the study area.

3.5 Farm Efficiency Measures in Different Farm Sizes

These ratio measures like gross ratio, fixed ratio and operating ratio were calculated to find farm efficiency measures. Farm efficiency is the ratio of total expenses to gross income. It is a combined measure of profit making ability of the farm which expresses the percentage of the gross income consumed by the expenses and is therefore, indicative of absolute size of business. It represents profit margin for business as a whole. Table 4 indicated that gross ratio was highest for marginal farms (0.38) followed by small farms and medium farms (0.28) and (0.26) respectively. Fixed cost ratio was highest for marginal farms (0.11) followed by small farms and medium farms i.e. (0.09) and (0.08) respectively. But in case of operating ratio it is highest in case of marginal farm followed small farm and medium farm i.e. (0.27), (0.21) and (0.18) respectively. Table 4 shows that, an average of all farms of the gross ratio was 0.31, fixed ratio was 0.09 and operating ratio was 0.21 in the study area.

Table 1. Composition of variable cost of maize production (rupees per hectare) in different categories of farm holdings

Particulars	Marginal farmers	Small farmer	Medium farmer	All farms
Seed	4806.00 (26.91%)	4860.00 (34.39%)	8724.70 (53.27%)	5053.20 (31.01%)
Fertilizer	2638.51 (14.77%)	2228.78 (15.77%)	1695.73 (10.35%)	2234.81 (13.71%)
Labour	1656.94 (9.27%)	1356.02 (9.59%)	1058.02 (6.46%)	1386.94 (8.51%)
Plant protection chemical	4143.95 (23.20%)	2704.96 (19.14%)	2121.87 (12.95%)	3118.62 (19.14%)
Machine	1491.82 (8.35%)	971.40 (6.87%)	777.73 (4.74%)	1116.02 (6.84%)
Manure	1953.35 (10.93%)	1086.16 (7.68%)	927.16 (5.66%)	2317.20 (14.22%)
Interest on working capital	1168.33 (6.54%)	924.51 (6.54%)	964.54 (5.88%)	1065.87 (6.54%)
Total variable costs	17858.90 (100.00)	14131.83 (100.00)	16376.57 (100.00)	16292.66 (100.00)

(Figures in parenthesis are percentage of total cost)

Table 2. Composition of fixed cost of maize production (rupees per hectare) in different categories of farm holdings

Particulars	Marginal farmers	Small farmers	Medium farmers	All farms
Rental value of land	6666.66 (90.85%)	6666.66 (91.55%)	6666.66 (91.81%)	6666.66 (91.35%)
Land revenue	41.66 (0.57%)	41.66 (0.57%)	41.66 (0.57%)	41.66 (0.57%)
Depreciation	149.10 (0.48%)	97.14 (0.44%)	77.77 (1.07%)	111.60 (1.52%)
Interest on fixed capital	480.01 (6.54%)	476.38 (6.54%)	475.02 (6.54%)	477.39 (6.54%)
Total fixed cost	7337.43 (100%)	7281.84 (100%)	7261.11 (100%)	7297.31 (100%)

Table 3. Total cost of maize farm size gross income and cost of production (rupees per hectare) in different categories of farm holdings

Particulars	Marginal farmers	Small farmers	Medium farmers	All farms
Total variable cost (TVC)	17858.90 (70.87%)	14131.83 (65.99%)	16376.54 (69.28%)	16292.66 (69.06%)
Total fixed cost (TFC)	7337.43 (29.13%)	7281.84 (34.11%)	7261.11 (30.71%)	7297.31 (30.93%)
Total costs (TVC+TFC)	25196.33 (100.00)	21413.67 (100.00)	2361.11 (100.00)	23589.97 (100.00)
Cost of production (TC)	25196.33	21413.67	23637.68	23589.97
Gross return (TR)	64845.89	75396.54	89364.63	75346.46
Net return (TR-TC)	39649.56	53982.87	65726.95	51756.49
Benefit cost ratio (B:C Ratio)	1.5:1	2.5:1	2.7:1	2.1:1

Table 4. Farm efficiency measures in different farm sizes

Categories of farmers	Gross ratio	Fixed ratio	Operating ratio
marginal farmers	0.38	0.113	0.27
small farmers	0.28	0.096	0.21
medium farmers	0.26	0.008	0.18
All farmers	0.31	0.009	0.21

Table 5. Estimation of technical efficiency from a Stochastic Frontier Analysis Model

	Estimate	Std. error	z value	Pr(>|z|)
(Intercept)	5.118538	0.956145	11.3533	8.636e-08 ***
Log seed	0.046418	0.052970	0.8763	0.380864
log manure	0.586356	0.085193	9.0136	0.610753**
log pesticide	0.013805	0.034768	2.3971	0.691323
log fertilizer	0.687901	0.075174	12.1693	0.442282
log credit	0.127557	0.116835	1.0918	0.274937
log labour	0.149610	0.134352	3.1136	0.465463***
log machine	0.662397	0.057897	11.4409	< 2.2e-16 ***
Sigma Sq	0.058519	0.018277	3.2019	0.001365 **
Gamma	0.977845	0.125197	7.8105	5.697e-15 ***

*Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 and log likelihood value: 63.29569*

3.6 Technical Efficiency of Maize Production in the Study Area

More or less technical efficiency tells about how the resources used in production process used impact on output or not. Whether, the inputs have significant impact on output or not, that is clarified. Here from Table 5, it is found that there are number of variables like seed, manure, fertilizer, credit, labour, machine etc. but it was found that, labour, fertilizer and machine have significant impact on maize production in the study area as per the 'z' value by frontier analysis model.

3.7 Resource Use Efficiency in Different Categories of Farms

The resource use efficiency of variable input (X_i) was examined by $MVPx_i/Px_i$ ratio. The acquition cost of resource was taken as rupee one. The $MVPx_i/Px_i$ ratio indicates optimum use of resource. In order to find out optimum use of resource the difference of MVP and price ratio from unity was tested. A significant difference indicates sub-optimal allocation of resource. It was observed from the Table 6, we concluded that labour, fertilizer and machinery are under utilized in the study area. The MVP is higher than the unit price of inputs. Very weak picture of efficient use of input is seen in the study area. Oguniyi. 2008 [16] reported that there was underutilization of resources like farm size, labour, fertilizer, chemical and seed for maize in Oyo state of Nigeria [17].

3.8 Prevailing Marketing Channels

There are numbers of market intermediaries working in the study area. About six marketing channels identified in the study area. Those channels were given as follows:

Channel-I (Producer→Retailer→Consumer)
Channel-II (Producer→Government Agency→Consumer)
Channel-III (Producer→Trader→Consumer)
Channel-IV (Producer→ Broker→ Retailer→Consumer)
Channel-V (Producer→Commission Agent →Retailer→Consumer)

3.9 Total Production, Consumption and Marketed Surplus of Maize

Total maize surplus was disposed through broker, trader, commission agent, government agency and retailer. A perusal of Table 7 indicated that the marketed surplus of maize was disposed off by the producers according to preference and importance they gave to each outlet. Here we found that, the farmers in the study are marketed all the maize that is produced as they are not consuming for family purpose i.e.

growing the crop as a cash crop. Hence, the total marketed is 100% of total production. Out of average 65.05 quintal maize production, medium farmers produce highest i.e 75.89 quintals per hectare as compared to small (64.20) and marginal farmer (55.18 quintal) per hectare, hence the same amount is total marketed surplus.

3.10 Marketing Cost, Margin and Producer's Share in Consumer's Rupee through Different Marketing Channel

Marketing cost and margin of maize at producer level was varied according to selected market, method of sale, quantity of marketed surplus, distance from production point to market and type of storage materials. From Table 8, it was observed that marketing cost was highest in Channel IV i.e Rs. 10.2 and margin was also more as compare with other four channels i.e Rs. 17.71 per quintal of maize. But in case of producer's share in consumer's rupee was Rs. 91.33 which was higher in channel II than Channel I, III, IV and V. In case of marketing efficiency was 2.30 was highest in channel II.

3.11 Constraints in Production and Marketing of Maize Farmers

Production problems in the study area were presented in Table 9. All problems perceived by farmers were analyzed by Garrett ranking technique. Almost 41.6 score was gone for bird damage to maize cod as they eat and

Table 6. Resource use efficiency different inputs used

Variable	Coefficient or Elasticity P	App (Y/p)	Mpp (E_p*App)	Output price	Vmp (Mpp*Py)	Input price	Allocation (Mpp/Input Price)
Ln labour (Man Day)	5.54	11.56	64.04	1197	76655.88	250	306.62
Ln machine (Hour)	1.11	57.70	64.04	1197	76655.88	1000	76.65
Ln manure (Tractor)	2.31	27.72	64.03	1197	76643.91	1000	76.64

Table 7. Total production, consumption and marketed surplus of maize of different categories of maize producers (quintal per season per hectare)

Farm category	Total production (q)	Total consumption (q)	Total marketed surplus (q)
Marginal farmers	55.18 (100.00)	0(0.00)	55.18 (100.00)
Small farmers	64.20 (100.00)	0(0.00)	64.20 (100.00)
Medium farmers	75.89 (100.00)	0(0.00)	75.89
All farmers	64.05 (100.00)	0(0.00)	64.05

(Figure in parentheses indicate the percentage of marketed surplus

Table 8. Marketing cost, margin and producer's share in consumer's rupees of different marketing channels

S. No.	Particulars	Channel I	Channe III	Channel III	Channel IV	Channel V
1	Producer's share in Consumer's price	85.5	91.33	84.45	72.11	79.21
2	Marketing cost	7.8	5.4	8.0	10.2	8.9
3	Marketing margin	6.7	3.27	8.55	17.71	11.69
4	Consumer price	100.00	100.00	100.00	100.00	100.00
5	Marketing efficiency	1.60	2.30	1.16	1.22	1.40

Table 9. Ranking of various constraints in production faced by maize farmers

S. No.	Constraints in production	Score	Rank	Constraints in marketing	Score	Rank
1	Lack of knowledge	4.9	VII	Lack of Market Information	7.4	IV
2	Lack of quality seed	7.8	IV	Lack of transportation Facility	19.6	III
3	Lack of training	6.3	VI	Lack of Storage Facility	6.0	V
4	Bird damage	41.6	I	Low Price	35.6	I
5	Seed infertility	7.5	V	Irregular Payment	31.4	II
6	Lack of capital	21.3	II			
7	Lack of technical input	8.4	III			

destroy it, which fetched less production to the farmer in the study area. About 21.3 score was given to lack of capital like not easy availability of fund; the government is not giving any incentive or subsidy to the farmer on the credit burrowed. Lack of technical input is the third most important problem (score 8.4) in the study area. In case of constraints in marketing, almost 35.6 score was gone for low market price of maize which fetched less profit to the farmer in the marketing. Irregular payment for maize by purchaser accounted about 31.4 of the score which got second next problem of marketing faced by maize producer. About 19.6 scoring complained was lack of transportation facility. Other problems are lack of market information, lack of storage facility which scores about 7.4 and 6.0 [7-12].

4. CONCLUSIONS

Total variable cost of marginal farmers was higher than small and medium farmers. And the trend for fixed cost was highest for marginal farms followed by small and medium farm. The total cost and gross retuns was higher for marginal farms. And In case of net return and B:C ratio was higher in medium farms. And Farm efficiency in marginal farms was highest (0.38) followed by small (0.28) and medium (0.26). Labour, fertilizers and machine have significant impact on maize production. Total marketed surplus was higher in medium farmer's i.e 75.89 and Producers share in consumer rupee was more in Channel II. And Bird damage was major constraints in production of maize and low price was major constraints in marketing of maize.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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