International Journal of Business and Economic Development
Vol. 2, No. 3; September, 2021. pp 57-69
ISSN 2692-5591 (print), 2692-5583 (online)

Published by International Center for Promoting Knowledge

A Study on the Resource-Use Efficiency in Unirrigated Maize Cultivation

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Abstract

A measure assures regular income to the maize cultivators, regular supply of feed to the poultry industry and other industries which in turn, offers opportunities of employment to the skilled and unskilled workers. There is an urgent need to promote maize on priority basis by implementing maize development programme on "mission mode approach". The respondents of Maize cultivators has selected from Dindigul district of Tamil Nadu (300 samples). Resources are scarce and have alternative uses as well. In order to study resource use efficiency, that is, how resources are used in unirrigated maize cultivation, production function analysis was adopted. The Gross Average Physical Productivity of labour for small farmers was found to be lower than that of the other two categories (large and total) of farmers cultivating maize under unirrigated conditions in the study area. In unirrigated maize cultivation, positive relationship between farm size and productivity was observed in the study area. The Gross Average Value Productivity of labour and the Residual Average Labour Productivity have been found to be higher in the case of total farmers cultivating maize under unirrigated conditions. The analysis shows that the Gross Average Value Productivity of capital and the Residual Average Capital Productivity have been lower for large farmers cultivating maize under unirrigated conditions. An analysis of resource use efficiency in unirrigated maize cultivation in respect of small, large and total farmers distinctively shows excessive use of all the resources by the all the farmers in the study area.

Keywords: Unirrigated Maize, Maize Cultivation, Small Farmers, Large Farmers, Resource Use Efficiency, GAPP, GAVP

1. Introduction

A measure assures regular income to the maize cultivators, regular supply of feed to the poultry industry and other industries which in turn, offers opportunities of employment to the skilled and unskilled workers. Net income earned from crop production activity on tractor farms was higher than that of bullock operated farms in medium and large farms. Tractor farms registered higher marginal value products for resources like human labour, manures and fertilizers irrigation and land (Sharmaet al., 1992) [1]. Farm size, labour (availability and nature), pesticides, herbicides and fertilizer usage are positively related with maize output (Oluwatayo, 2008)[2]. There is an urgent need to promote maize on priority basis by implementing maize development programme on "mission mode approach". Maize is an important cereal crop and It has high value addition potential. Besides, its varied uses have led to increase in demand. Cultivation of maize is carried out in order to get profit. Out of the total land utilization of the Tamil Nadu (13033116 hectares), 43.96 (5729576 hec.) per cent of the area is

[1] Sharma B.M., et al., (1992). "Input Use Efficiency on Tractor and Bullock Operated Farms in Aligarh District of Uttar Pradesh*",* Indian Journal of Agricultural Economics*,* 47(3):p.487.
[2] Oluwatayo, I.B (2008). "Resource Use Efficiency of Maize Farmers in Rural Nigeria : Evidence from Ekiti State", World Journal of Agricultural Science, 4(1): pp.91-99.

occupied by agricultural sector in 2017-18[3]. In 2017-18, primary sector contribution to Tamil Nadu Gross Domestic Product (GDP) is 10 per cent (at constant 2011-12 prices)[4] and provides gainful employment for about 60 per cent of the rural work force. Maize is cultivated in an area of 3.24 lakh hectare with 25.91 lakh tonnes of production during 2017-18 in Tamil Nadu[5].

In recent years, its area, production and productivity have substantially increased[6]. A major chunk of maize produced in the state of Tamil Nadu was procured by the poultry industry. Of the total 20 crore layer birds in the country, poultry farms in the Namakkal zone alone houses around 3.5 to 4 core layer birds. According to research by the Domestic and Export Market Intelligent Cell (DEMIC) of Tamil Nadu Agricultural University, the demand for maize by the poultry industry in Tamil Nadu alone is estimated to be around 8 lakh tonnes a year, but only a fifth of demand was met through local production[7]. Currently Tamil Nadu poultry farms procure a major part of its maize required from Karnataka, Bihar, and Andhra Pradesh at premium price.

Table -1: Area under Maize Cultivation in selected districts of Tamil Nadu during 2017-2018 (in hectares)

Sl. No.	District	Maize Area		
		Irrigated	Unirrigated	Total
1	Dindigul	7230 (6.45)	20054 (7.19)	27284 (6.98)
2	Perambalur	1856 (1.65)	59786 (21.46)	61642 (15.78)
3	Salem	18060 (16.11)	17166 (6.16)	35226 (9.01)
4	Thoothukudi	1068 (0.95)	54407 (19.53)	55475 (14.22)
5	Virudhu Nagar	6256 (5.58)	26676 (9.57)	32932 (8.43)
	State - Tamil Nadu	112065 (100%)	278537 (100%)	390602 (100%)

(Figures in parentheses show the percentages)

Source : Government of Tamil Nadu. Directorate of Economics and Statistics, Season and Crop Report (2017-18), p.124.

Maize is mainly cultivated in Perembalur, Thoothukudi, Salem, Virudhunagar and Dindigul districts which together contribute 54.41 per cent of the total area under the crop in the state. These five districts together contribute 56.8 per cent of the total unirrigated area under maize cultivation[8]. The share of Dindigul district in the total area and unirrigated area of the state under maize cultivation is about 6.45 per cent. Within the district while the total maize area is 27284 hectares, the share of unirrigated maize area is 20054 hectares, which forms 73.50 per cent of the total. The inference is that unirrigated maize cultivation is more in terms of acreage (Table-1).

During the period 2017-18, area under maize, production and productivity have risen by 1.7 times, 2.7 times and 1.6 times respectively in Tamil Nadu compared to base year 2010-11. Dindigul district has rich potential to undergo a breakthrough in maize production. Experiments were conducted on different soil series representing dominant soil types where maize is grown. These include Irugur series in Coimbatore district, sandy clay loam, Typic Haplo Stalf and Pala Viduthi series in Dindigul district[9].

[3] Handbook of Tamil Nadu 2017-18, Department of Economics and Statistics. Chennai-600 006. p.103.
[4] The Finance Minister, Mr Arun Jaitley tabled the Economic Survey 2017-18 on January 29, 2018. Highlights, p.1. https://www.prsindia.org/sites/default/files/parliament_or_policy_pdfs/Eco%20Survey%202017-18%20Summary.pdf
[5] Handbook of Tamil Nadu 2017-18, Op. Cit., p.106.
[6] Salient Achievements of AISCRP Maize (2008), Directorate of Maize Research, New Delhi, p.10.
[7] Government of Tamil Nadu, Directorate of Economics and Statistics, Season and Crop Report (2005), p.20.
[8] Handbook of Tamil Nadu 2017-18, Op. Cit., p.124.
[9] Salient Achievement of AICRP Maize (2008), Op. Cit., p.22.

In addition to the reasons mentioned, the researcher hails from an agricultural family in Dindigul district. So he is conversant with the fauna and flora of Dindigul district and bolts and nuts of the art of maize cultivation. These reasons have added strength to conduct an explorative investigation on "An Economic Study of Unirrigated Maize Cultivation in Dindigul District of Tamil Nadu".

The progressive and promising cultivation of a crop like maize ensures regular income to the farmers living in the fragile regions like Dindigul district depending on monsoon. Moreover, climatic conditions are more suitable for the cultivation of maize. This necessitates undertaking of an urgent study on production conditions of maize in an area where it is extensively grown. It is hoped that the study will bring to light the factors inhibit achieving a better yield in the case of maize production in Dindigul district and offering suggestions for a major break through in maize cultivation.

2.Reasons for the Choice of the Study

Maize, being a miracle crop, finds a dominant place in the cropping pattern of each of the 3 Blocks, namely Palani, Oddanchatram and Thoppampatti in Dindigul district of Tamil Nadu. In the above Blocks, farmers take up maize cultivation under rain fed conditions in view of the fact that there is no organised source of irrigation like canals. The quantum of rainfall recorded in the district is deficient and below normal over the years and with the erratic rainfall which occurs a few days during the cultivation of the crop forces the farmers to have a choice of maize over other crops in the study area. Besides, the cost of cultivation right from the preparatory stage up to the harvesting stage is comparatively low and maize gives an assured net income to farmers. In the marketing of maize, farmers observe that they enjoy a comparative advantage over the other crops. In Palani Block, storage facility for maize has been created by the state where maize can be stored in expectation of a higher price and at the storage point, 80 percent of the value of the produce can be obtained by the farmers if the farmers are in need of cash. Further, the value addition potential and the demand for maize for fodder by the poultry industries of the neighbouring districts create a permanent demand for maize. As a result of these factors, farmers are induced to cultivate maize in the study area.

3. Statement of the Problem

Agricultural production, namely cultivation of crops is unique, for the production conditions in agriculture vary compared to the manufacturing industry. It is applicable to maize also compared to the other crops. Maize is mostly grown under unirrigated conditions. Several studies have been conducted so far on the various technological aspects of maize cultivation. However, the economic aspects have not been sufficiently explored and highlighted. The economic aspects related to maize cultivation need to be exposed to the farmers for its proper dissemination.

Changes in cost of input and the uncertainty in returns make the farmers, distressed. This necessitates the investigation of production conditions of maize especially its cost and return structure. The productivity of maize is comparatively low in India. In a situation where the demand for maize has been increasing steadily and the area available for cultivation is shrinking at a faster pace, the only option is to raise productivity. Hence, the factors that stand as obstacles to achieve higher productivity need to be focused, highlighted and eliminated in order to achieve higher productivity in maize cultivation.

Resources are scarce: these resources available are less than what is required. Their uses have to be optimum. Over utilization and underutilization of resources have to be verified in order to increase the net income in maize cultivation. This situation warrants an empirical verification of the production conditions of maize cultivation in an area where it is extensively grown.

Agricultural development needs to be made sustainable, it would require going beyond the soft option of bringing more area under cultivation; unirrigated farming has to assume an important role. At present, nearly 30 per cent of the total gross cropped area of India is irrigated but there is large regional variation. Further, even after full exploitation of irrigation potential, about 50 per cent of the cultivated land would continue to depend on the erratic rainfall for crop production. Besides, irrigation required a huge investment and considering financial constraints and availability of ground water, it might not be possible to provide irrigation to the entire cultivable land. Also increased irrigation potential and its excessive use have added other dimensions to the problem of soil degradation and ecological balance. The green revolution widened the development gap between irrigated and unirrigated areas. Irrigated agriculture received relatively more attention in the past while unirrigated agriculture remained neglected for a long time.

4. Objective

The basic objective of the study is to examine the resource-use efficiency in unirrigated maize cultivation in Dindugul district.

5. Materials and Methods

This study is mainly based on primary data collected from 300 farmers from selected blocks in Dindugul district through stratified random sampling method. It is a survey cum empirical one based on cross section data for the period 2009-2010, collected by personal interview method. Dindigul district has 14 blocks cultivating maize. Three blocks namely Thoppampatti, Palani and Oddanchatram were selected purposely since these blocks together accounted for 75.48 per cent of the total area under unirrigated maize cultivation in Dindigul district. In unirrigated maize cultivation, out of 300 sample farmers, 246 farmers belonged to the small size (0.1 to 5 acres) and the remaining 54 farmers belonged to the large size (5.1 and above acres) category.

The revenue villages in each of the three blocks were arranged in descending order on the basis of the area under maize cultivation and 10 villages, 11 villages and 12 villages were selected from each blocks respectively. It was decided to have a sample of 300 respondents from the three blocks. As part of the exercise, the 300 respondents were stratified into 246 small and 54 large farmers cultivating maize. Accordingly, 96 farmers, 82 farmers and 122 farmers were selected proportionate to the area under unirrigated maize cultivation in each of the sample villages in each blocks respectively.

6. Limitations

The present study is not free from limitations. The results of the study are based on data provided by the sample farmers from their memory. There may be a possibility for memory bias. As a result, the findings of the study are applicable only to the study area, that is, Dindigul district. The results may not be applicable to maize cultivation which is undertaken in other parts of the state or country, because of variations in agrarian structure and cultivation practices. Therefore, one should be very much cautious in making generalization based on the results of the present study.

7. Resource Use Efficiency

Resources are scarce and have alternative uses as well. The term resource use efficiency in agriculture may be broadly defined to include the concepts of technical efficiency, allocative efficiency and environmental efficiency. An efficient farmer allocates his land, labour, water and other resources in an optimal manner so as to maximise his income at least cost on sustainable basis[10]. The concept of scarcity of resources is of vital importance in economic theory. As a matter of fact, economics is concerned with overcoming the effects of scarcity by improving the efficiency of scarce resources.[11] Examination of efficiency, absolute or relative, has always been one of the important goals of production economics[12].

The inadequacy of capital and other resource inputs combined with their inefficient use is being commonly reported to be the prime cause of low crop productivity under a given set of ecological, social, managerial, and technological conditions at a particular point of time. The inefficiencies in the use of various resources affect productivities of crops and also their cost and returns structure and producer's incentives as well.[13]

To get a realistic picture as to how resources are used in the cultivation of crops, particularly in an important commercial crop like maize, an attempt is made to study resource use efficiency. To what extent the available resources are utilized by the small and large farmers in the study area producing maize under unirrigated conditions is also examined.

[10] Haque T, (2006). Resource Use Efficiency in Indian Agriculture, Indian Journal of Agricultural Economics, Vol. 61(1): p.23.
[11] Dewari D. D and Katar Singh, (1996). Principls of Micro Economics, New Age International, New Delhi, p.4.
[12] Sankhayan P.L, (1988). Introduction to the Economics of Agricultural Production, Prentice Hall of India Pvt. Ltd., p.2.
[13] Pawar Jg. R, D.L. Sale and D.D.Tale, (1992). "Resource Use Efficiency in Crop Production Activity of Farms in Western Maharashtra", Indian Journal of Agricultural Economics, Vol.47(3): July-September, p.486.

7.1. Measures of Productivity of Resources

Measuring productivity of resources is a complex issue. Yet, economists and researchers have attempted to study productivity of resources and resource-use efficiency because such measures provide useful insights into the relationship between inputs and output. There are two measures to calculate the productivity of a resource.

They are:
1) Conventional measure; and
2) Production function approach.

7.1.1. Conventional Measures

In conventional measure, the productivity of a resource is calculated in terms of Gross Average Productivity (GAP) and Residual Average Productivity (RAP).

Gross Average Productivity (GAP)

Gross Average Productivity is computed in order to find out the productivity of labour, capital and land. Kombairaju has computed gross average productivity to find out the productivity of labour and capital.[14] Gross Average productivity is expressed in two forms, they are: (1) Gross Average Physical Productivity (GAPP) and (2) Gross Average Value Productivity (GAVP).

Gross Average Physical Productivity of labour (in quintal per manday) has been calculated by dividing the total output in physical terms (in quintal) by total number of mandays.

$$\text{GAPP of Labour} = \frac{\text{Yield (in quintal)}}{\text{Total labour units (in mandays)}}$$

Gross Average Value Productivity of labour (in rupees per manday) is measured by dividing the total value of output in monetary terms (in rupees) by total number of mandays.

$$\text{GAVP of labour} = \frac{\text{Total value of produce (in Rs.)}}{\text{Total labour units (in mandays)}}$$

Gross Average Physical Productivity of capital (in quintal per manday) has been calculated by dividing the total output in physical terms (in quintal by the total value of non-labour services (in rupees).

$$\text{GAPP of Capital} = \frac{\text{Yield (in quintal)}}{\text{Total value of non labour services (in Rs.)}}$$

The Gross Average Value Productivity of capital (in rupees per mandays) is measured by dividing the total value of output in monetary terms (in rupees) by the total value of non labour services (in rupees).

$$\text{GAVP of Capital} = \frac{\text{Total Value of Produce (in Rs.)}}{\text{Total value of non labour services (in Rs.)}}$$

Residual Average Productivity (RAP)

The residual average productivity is a relatively more accurate measure than the gross average productivity of resources. The residual average productivity is classified into two;
1) Residual Average Labour Productivity (RALP), and
2) Residual Average Capital Productivity (RACP)

The Residual Average Labour Productivity (in rupees per man-day) is computed by deducting the value of non-labour capital services from the total value of the output, and dividing the net value by the Number of Labour Units (NLU) in

RALP = (TVO - VNLCS)/NLU

[14] Kombairaju S, (1982). Studies on Economics of Production and Marketing of Hrysanthemum and Jasmine Flowers in Perianaickanpalayam Block of Coimbatore District, Tamil nadu, Unpublished M.Sc. (Agri) Dissertation, Tamil Nadu Agricultural University, Coimbatore.

The value of Residual Average Capital Productivity (in rupees per manday) is calculated by deducting the value of labour units from the total value of output (in rupees) and dividing the balance by the VNLCS.[15]

RACP = (TVO – VLU)/VNLCS

The Gross Average Physical Productivity of both labour and capital, the gross average value productivity of labour and capital, and the residual average productivity of labour and capital are given in Table-2.

The Table-2 shows the resource use efficiency in unirrigated maize cultivation by the small, large and total farmers.

TABLE – 2: Resource Use Efficiency in Unirrigated Maize Cultivation in Dindigul District

Particulars (in Rs. Per acre)	**Small Farmers**	**Large Farmers**	**Total Farmers**
Yield in (quintal)	17.15	18.30	17.55
Total value of produce	18008.65	19209.96	18432.23
Total cost of production (Cost C)	11698.10	12666.15	12091.78
Variable cost (Cost A)	8460.22	9489.48	8945.50
Total labour units in mandays	18.0	18.45	17.56
Total value of labour units	3157.50	3171.00	3159.93
Total value of non-labour capital services	8540.60	9495.10	8931.85
Capital available per worker	477.47	514.64	508.64
GAPP of labour	0.95	0.99	0.99
GAVP of labour	1000.48	1041.19	1049.67
GAPP of capital	0.002	0.001	0.001
GAVP of capital	2.10	2.02	2.06
RALP	526.002	526.54	541.02
RACP	1.738	1.689	1.709

Source: Computed from Primary data.

From the Table-2 it is observed that the Gross Average Physical Productivity of labour was 0.95, 0.99 and 0.99 for small, large and total farmers respectively cultivating maize under unirrigated conditions. The Gross Average Physical Productivity of labour for small farmers was found to be lower than that of the other two categories of farmers cultivating maize under unirrigated conditions in the study area. The Gross Average Physical Productivity of labour was found to be identical for the large farmers and small farmers in the study area. In unirrigated maize cultivation, positive relationship between farm size and productivity was observed in the study area.

The Gross Average Value Productivity of labour was found to be 1000.48, 1041.19 and 1049.67 for small, large and total farmers respectively cultivating maize under unirrigated conditions in the study area. The Gross Average Value Productivity of labour was observed to be high compared to other two categories of farmers. In unirrigated maize cultivation the gross average value product of labour was found to be lower for the small farmers cultivating maize under unirrigated conditions.

The Gross Average Physical Productivity of capital in unirrigated maize cultivation for all the three categories of farmers namely small, large and total farmers did not exhibit much variations. However, the Gross Average Value Productivity of capital under unirrigated maize cultivations, showed variations of a small magnitude in the study area.

[15] Ibid

The Gross Average Value Productivity of capital was found to be higher in unirrigated maize cultivation in the case of small farmers. The other two categories of farmers namely large farmers and total farmers have obtained a lower productivity of capital compared to the small farmers. However, the Gross Average Value Productivity of capital obtained by the large farmers has been found to be lower in unirrigated maize cultivation in the study area.

The Residual Average Labour Productivity in unirrigated maize cultivation was found to be 526.00, 526.54 and 541.02 for small, large and total farmers respectively in the study area. This implies that productivity of labour for the total farmers has been observed to be higher in unirrigated maize cultivation. The Residual Average Labour Productivity in unirrigated maize cultivation for small and large farmers has emerged more or less identical.

The Residual Average Capital Productivity, under unirrigated maize cultivation has been worked out to be 1.74, 1.69 and 1.71 for the three categories of farmers namely small, large and total respectively. In unirrigated maize cultivation, the Residual Average Capital Productivity has been found to be higher for the small farmers compared to the other two categories of farmers. Which regard to the residual average capital productivity, the large farmers have obtained a lower capital productivity than that of the other two categories of farmers cultivating maize under un irrigated conditions.

The analysis of the efficiency of resource use in the case of unirrigated maize cultivation in terms of conventional measures reveals that the Gross Average Physical Productivity of labour, the gross average value productivity of capital and the residual average capital productivity have been found to be greater for small farmers. However, the Gross Average Value Productivity of labour and the Residual Average Labour Productivity have been found to be higher in the case of total farmers cultivating maize under unirrigated conditions. The analysis shows that the Gross Average Value Productivity of capital and the Residual Average Capital Productivity have been lower for large farmers cultivating maize under unirrigated conditions.

7.1.2. The Production Function Analysis

In order to study resource use efficiency, that is, how resources are used in unirrigated maize cultivation, production function analysis was adopted. A production function is a complex analytical tool which describes the maximum output that can be obtained from a given set of inputs in the existing state of technical knowledge.[16]

By and large, there are five different forms of production function in the existing literature. They are Leontiff type (fixed co-efficient) production function, linear production function, Cobb - Douglas production function, constant elasticity of substitution (CES) production function and variable elasticity of substitution production function. These types production function differ from each other by the numerical value of the elasticity of substitution.

Of the different forms of the production function, Cobb - Douglas production function has been the most popular in empirical research.[17] This algebraic model provides a compromise between

(a) adequate fit of the data,
(b) computational feasibility, and
(c) sufficient degree of freedom unused to allow for statistical testing.[18]

As there were differences in maize yield per acre between small and large farmers under unirrigated conditions, separate production function was fitted for small, large and total farmers in unirrigated maize cultivation.
Cobb-Douglas type of production function was fitted to input-output data to estimate the resource use efficiency. Cobb - Douglas production was preferred for its computational ease. The form of the function used was as follows:

[16] Katz J.M, (1969). Production Function, Foreign Investment and Growth, North Holland Publication Company, Amsterdam, p.18.
[17] Durairaj N, (1981). A Study of Marine Fishing Industry in Thanjavur District, Unpublished Ph.D. Thesis, Madurai Kamaraj University, Madurai, p.95.
[18] Earl O.Heady and John L. Dillon, (1969). Agricultural Production Function, lowa State University Press, Ames, Iowa, p.228.

$$Y = a\, x_1^{b1} x_2^{b2} x_3^{b3} x_4^{b4} x_5^{b5} x_6^{b6} e^u$$

On the logarithmic scale the function takes a linear form

$$\text{Log } y = \log a\ b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 + u \log^{e}$$

Where ,

Y	=	Yield of maize per acre (in Rs.)
X_1	=	Land (in acres)
X_2	=	Value of human labourers (in Rs.)
X_3	=	Value of machine labourers/bullock labourers (in Rs.)
X_4	=	Value of Seeds (in Rs.)
X_5	=	Value of fertilizers (in Rs.)
X_6	=	Pesticides (in Rs.)
a	=	Constant
u	=	Disturbance term
b_1 to b_6	=	Elasticity coefficients of respective inputs.

Efficiency of resource use is taken in its strict theoretical sense that implies equality of marginal value productivity (MVP) to marginal factor cost.[19] The MVP of a particular resource represents "the expected addition factor to the output caused by an addition of one more unit of that resource while other inputs are held constant.

With the help of the regression coefficients, the marginal value productivities (MVPs) of resources were worked out. The most reliable and perhaps the most useful estimate of MVP is obtained by taking the resources (X1) as well as output (Y) at their geometric means.[20]

The marginal value productivities (MVPs) were calculated at the geometric mean level of the variables by using the following formula:

$$\text{MVP of } X_i = b_i \frac{\text{Geometric mean of } Y}{\text{Geometric mean of } X_i}$$

Where

b_i = Elasticity coefficient of the i^{th} variable

Y = Yield of maize in Rs. for the i^{th} variable per acre, and

X_i = Geometric mean of i^{th} independent variable

After having computed the marginal value productivity of a resource input, the resource use efficiency of farmers as users of resources in unirrigated maize cultivation was evaluated. In order to evaluate the economic efficiency of resource use by the maize cultivators, the ratios of marginal value productivities to their factor costs were calculated. A ratio MVP/MFC that is equal to unity indicates the optimum use of that factor. A resource is considered to be used most efficiently if its MVP is just sufficient to offset its cost.[21] A ratio of more than unity indicates that the output can be increased by using that resource and a less than unity ratio indicates the unprofitable level of resource use which should be decreased to minimize the losses.

7.2. Analysis of Results and Discussion

In order to measure the relative contribution of each factor in combination with other factors which are responsible for the changes in the level of output of maize cultivated under unirrigated condition, a multiple linear regression model of the Cobb - Douglas type was fitted separately for the three categories farmers viz., small, large and total. In the following section, the results of the fitted regression models are discussed for the three categories of farmers.

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[19] Randev A.K, S.C. Tewari and R.K. Sharma, (1992). "Rationale of Resource Use in Apple Cultivation – A Case Study of Tribal Area in Himachal Pradesh", Indian Journal of Agricultural Economics, Vol. 47(4): October – December, p.672.

[20] Chandrashekar K.S and M.V. Srinivasa Gowda, (1996). "Resource Use Efficiency in Groundnut Production under Rain-fed Condition – A Study in Challakere Taluk of Karnataka", Agricultural Situation in India, September, p.388.

[21] Invinder Paul Singh, Sunita Verma and A.C. Gangwar, (1992). "Resource Use Efficiency in Haryana Agriculture: A Crop –wise Analysis", Indian Journal of Agricultural Economics, Vol.47 (3): July-September, p.509.

7.2.1. Unirrigated Maize Cultivation

The results of the regression models fitted separately for the three categories of farmers cultivating maize under unirrigated conditions are presented in Table-3.

Table – 3: Estimated Regression Results of Unirrigated Maize Cultivation in Dindigul District

Variable	Parameter Estimate(Production Elasticities)		
	Small Farmers	Large Farmers	Total Farmers
Intercept	3.2586	4.5699	3.6012
$logX_1$	-0.0050 (-0.16)	-0.094** (-3.16)	0.1367** (2.98)
$logX_2$	0.2106** (4.56)	0.3188** (6.19)	0.2526** (5.76)
$logX_3$	0.2981** (7.95)	-0.0374 (-0.40)	0.3677** (7.58)
$logX_4$	0.1895** (3.31)	0.2822** (5.35)	0.2492** (5.26)
$logX_5$	-0.2058** (-4.13)	0.3824** (8.32)	-0.353** (-6.42)
$logX_6$	-0.0090 (-0.45)	-0.0143 (-0.30)	-0.0178 (-0.98)
R^2	0.72	0.83	0.81
F-value	33.212	47.262	42.823
No. of observations	246	54	300

Note: Figures in parentheses are the t-values

*Indicates that the co-efficients are statistically significant at 5 per cent level.

**Indicates that the co-efficients are statistically significant at 1 per cent level.

The results of the fitted regression model presented in Table-3 for all the three categories of farmers namely small, large and total explained 72 percent 83 percent and 81 percent of the variations in the production of unirrigated maize cultivated in the study area respectively. For the small farmers and large farmers the production elasticity co-efficiency have emerged negative. However, the production elasticity co-efficient of the variable land has been found to be positive and has emerged statistically significant at 1 percent level.

The production elasticity co-efficients of the variables human labour (X_2) machine labour bullock labour (X_3) and seed (X_4) have been found to be positive and also statistically significant at 1 percent level for small farmers cultivating maize under unirrigated conditions. In the case of large farmers, the variables human labour(X_2), seed(X_4) and fertilizers(X_5) have been observed to be positive and emerged statistically significant at 1 percent level.

The estimated regression results of unirrigated maize cultivation in the study area also revealed that the variables human labour(X_2), machine labour and bullock labour(X_3) and seeds(X_4) have also emerged positive and statistically significant at 1 percent level for the total farmers. For all the three categories of farmers namely small, large and total farmers, the elasticity co-efficients of the variable pesticides (X_6) have been found negative and statistically insignificant.

7.3. Resource Use Efficiency

7.3.1. Unirrigated Maize Cultivation: Small Farmers

Table-4 shows marginal value products of resource inputs used by small farmers in unirrigated maize cultivation.

Table - 4: Marginal Value Products of Resources of Small Farmers in Unirrigated Maize Cultivation in Dindigul District

Variable	**Units**	**Geometric Mean (GM)**	**Regression Coefficients**	**Marginal Value Products (MVP)**	**Marginal Factor Cost (MFC)**	**Ratio of MVP / MFC**
Yield (Y)	Rupees	1699.42				
Land X_1	Acres	1.01	-0.0050	-8.41	748.92	-0.01
Human Labourers X_2	Rupees	3098.85	0.2106	0.12	1.00	0.12
Machine Labourers / Bullock Labourers X_3	Rupees	1744.62	0.2981	0.29	1.00	0.29
Seeds X_4	Rupees	1472.99	0.1895	0.22	1.00	0.22
Fertilizers X_5	Rupees	1033.71	-0.2058	-0.34	1.00	-0.34
Pesticides X_6	Rupees	497.05	-0.0090	-0.03	1.00	-0.03

Source: Computed from Primary data.

The marginal value products of the variables included in the production function and estimated at the geomentric mean level highlight that the marginal value product of land (X_1) was found to be negative.

The ratio of marginal value product (MVP) to the marginal factor cost (MFC) in respect of land has been found to be 0.01. The respective marginal value products of human labour, (X_2) machine labour/bullock labour (X_3) and seeds(X_4) have been observed to be less than one. These observations indicate that there has been excessive application of each of these resources by the small farmers in unirrigated maize cultivation in the study area. The marginal value products of fertilizers(X_5) and pesticides (X_6) have been found to be less than one and have also emerged negative. This implies that these two resources namely fertilizers(X_5) and pesticide (X_6) have been excessively used. An increase of a unit of each of these two resources will bring about negative returns of 0.34 percent and 0.03 percent respectively for the small farmers in the case of unirrigated maize cultivation.

Thus, the analysis of resource use efficiency in the case of unirrigated maize cultivation reveals that there has been uneconomical use of all the resources employed by the small farmers.

7.3.2. Large Farmers

Table-5 shows marginal value products of resource inputs used by small farmers in unirrigated maize cultivation.

Table-5: Marginal Value Products of Resources of Large Farmers in Unirrigated Maize Cultivation in Dindigul District

Variable	**Units**	**Geometric Mean (GM)**	**Regression Coefficients**	**Marginal Value Products (MVP)**	**Marginal Factor Cost (MFC)**	**Ratio of MVP / MFC**
Yield (Y)	Rupees	1820.95				
Land X_1	Acres	7.12	-0.094	-24.04	892.46	-0.03
Human Labourers X_2	Rupees	3067.52	-0.3188	0.19	1.00	0.19
Machine Labourers / Bullock	Rupees	2098.04	-0.0374	0.03	1.00	0.03

Labourers X_3						
Seeds X_4	Rupees	1605.83	0.2822	0.32	1.00	0.32
Fertilizers X_5	Rupees	1232.25	0.3824	0.57	1.00	0.57
Pesticides X_6	Rupees	549.79	-0.0143	-0.05	1.00	-0.05

Source: Source: Computed from Primary data.

In the case of large farmers the marginal value product of land (X_1) has been found to be negative. The marginal value products of human labour (X2), machine labour/ bullock labour (X_3) seeds (X_4) and fertilizers (X_5) have been found to be 0.19, 0.03, 0.32 and 0.57 respectively. This implies that there has been excessive use of these resources by the large farmer in unirrigated maize cultivation. As the marginal value products of each of these resources namely, land (X_1) and pesticides (X_6) have emerged negative, there is no scope for additional use of these resources by the large farmers in unirrigated maize cultivation in the study area.

In short, the study of resource use efficiency in unirrigated maize cultivation clearly shows that the large farmers have been found to have applied excessive units of all the resources in the study area.

7.3.3. Total Farmers

Table-6 shows marginal value products of resource inputs used by total farmers in unirrigated maize cultivation.

Table – 6: Marginal Value Products of Resources of Total Farmers in Unirrigated Maize Cultivation in Dindigul District

Variable	**Units**	**Geometric Mean (GM)**	**Regression Coefficients**	**Marginal Value Products (MVP)**	**Marginal Factor Cost (MFC)**	**Ratio of MVP / MFC**
Yield (Y)	Rupees	1720.68	-	-	1.00	-
Land X_1	Acres	3.40	0.1367	69.18	820.69	0.08
Human Labourers X_2	Rupees	3093.14	0.2526	0.14	1.00	0.14
Machine Labourers / Bullock Labourers X_3	Rupees	1803.43	0.3677	0.35	1.00	0.35
Seeds X_4	Rupees	1496.23	0.2492	0.29	1.00	0.29
Fertilizers X_5	Rupees	1067.09	-0.353	0.57	1.00	0.57
Pesticides X_6	Rupees	506.14	-0.0178	0.06	1.00	0.06

Source: Computed from Primary data.

The marginal value product of land(X_1) has been found to be positive. However, the MVP to MFC ratio is found to be 0.08, indicating over utilization of resource land (X_1) in unirrigated maize cultivation by the total farmers. The marginal value products of other resources used by the total farmers have been found to be less than one. This implies that the total farmers have been found to have used excessive units of all the factors in unirrigated maize cultivation in the study area. Thus, it is observed that the total farmers have used excessive units of the resources at their disposal.

An analysis of resource use efficiency in unirrigated maize cultivation in respect of small, large and total farmers distinctively shows excessive use of all the resources by the all the farmers in the study area.

An analysis of resource use efficiency is an useful exercise because it reveals how the resources have been used by the farmers more than needed, optimal or less. By using conventional measures and production function analysis, the researcher has focused out that the small and large farmers have used all the resources in excess. This implies that the excess use of resources could have inflated the cost structure and reduced the returns.
The costs are equal but returns are different. This needs elucidation. The higher net return for large farmers may be attributed to the larger farm size and the resultant economies of scale in maize cultivation.

8. Conclusion

The Gross Average Physical Productivity of labour for small farmers was found to be lower than that of the other two categories (large and total) of farmers cultivating maize under unirrigated conditions in the study area. In unirrigated maize cultivation, positive relationship between farm size and productivity was observed in the study area. The Gross Average Value Productivity of labour and the Residual Average Labour Productivity have been found to be higher in the case of total farmers cultivating maize under unirrigated conditions. The analysis shows that the Gross Average Value Productivity of capital and the Residual Average Capital Productivity have been lower for large farmers cultivating maize under unirrigated conditions. An analysis of resource use efficiency in unirrigated maize cultivation in respect of small, large and total farmers distinctively shows excessive use of all the resources by the all the farmers in the study area.

An analysis of resource use efficiency is an useful exercise because it reveals how the resources have been used by the farmers more than needed, optimal or less. By using conventional measures and production function analysis, the researcher has focused out that the small and large farmers have used all the resources in excess. Unirrigated maize cultivation exhibits substantial variations in the cost of production and in the net return. All the resources used by the farmers in unirrigated maize cultivation were excessively utilised. An optimum utilization of the resources available at the disposal of the maize growers together with necessary efforts to address the problems identified in the unirrigated maize cultivation will ensure a higher net return to the maize growers in the study area.

References

Sharma B.M., et al.,(1992). "Input Use Efficiency on Tractor and Bullock Operated Farms in Aligarh District of Uttar Pradesh", Indian Journal of Agricultural Economics,47(3):p.487.

Oluwatayo, I.B (2008). "Resource Use Efficiency of Maize Farmers in Rural Nigeria : Evidence from Ekiti State", World Journal of Agricultural Science,4(1): pp.91-99.

Handbook of Tamil Nadu 2017-18, Department of Economics and Statistics. Chennai-600 006. p.103.

The Finance Minister, Mr Arun Jaitley tabled the Economic Survey 2017-18 on January 29, 2018. Highlights, p.1. https://www.prsindia.org/sites/default/files/parliament_or_policy_pdfs/Eco%20Survey%202017-18%20Summary.pdf

Handbook of Tamil Nadu 2017-18, Op. Cit., p.106.

Salient Achievements of AISCRP Maize (2008), Directorate of Maize Research, New Delhi, p.10.

Government of Tamil Nadu, Directorate of Economics and Statistics, Season and Crop Report (2005), p.20.

Handbook of Tamil Nadu 2017-18, **Op. Cit.,** p.124.

Salient Achievement of AICRP Maize (2008), **Op. Cit.,** p.22.

Haque T, (2006). Resource Use Efficiency in Indian Agriculture, Indian Journal of Agricultural Economics, Vol. 61(1): p.23.

Dewari D. D and Katar Singh, (1996). Principls of Micro Economics, New Age International, New Delhi, p.4.

Sankhayan P.L, (1988). Introduction to the Economics of Agricultural Production, Prentice Hall of India Pvt. Ltd., p.2.

Pawar Jg. R, D.L. Sale and D.D.Tale, (1992). "Resource Use Efficiency in Crop Production Activity of Farms in Western Maharashtra", Indian Journal of Agricultural Economics, Vol.47(3): July-September, p.486.

Kombairaju S, (1982). Studies on Economics of Production and Marketing of Hrysanthemum and Jasmine Flowers in Perianaickanpalayam Block of Coimbatore District, Tamil nadu, Unpublished M.Sc. (Agri) Dissertation, Tamil Nadu Agricultural University, Coimbatore.

Ibid

Katz J.M, (1969). Production Function, Foreign Investment and Growth, North Holland Publication Company, Amsterdam, p.18.

Durairaj N, (1981). A Study of Marine Fishing Industry in Thanjavur District, Unpublished Ph.D. Thesis, Madurai Kamaraj University, Madurai, p.95.

Earl O.Heady and John L. Dillon, (1969). Agricultural Production Function, lowa State University Press, Ames, Iowa, p.228.

Randev A.K, S.C. Tewari and R.K. Sharma, (1992). "Rationale of Resource Use in Apple Cultivation – A Case Study of Tribal Area in Himachal Pradesh", Indian Journal of Agricultural Economics, Vol. 47(4): October – December, p.672.

Chandrashekar K.S and M.V. Srinivasa Gowda, (1996). "Resource Use Efficiency in Groundnut Production under Rain-fed Condition – A Study in Challakere Taluk of Karnataka", Agricultural Situation in India, September, p.388.

Invinder Paul Singh, Sunita Verma and A.C. Gangwar, (1992). "Resource Use Efficiency in Haryana Agriculture: A Crop –wise Analysis", Indian Journal of Agricultural Economics, Vol.47 (3): July-September, p.509.