Plant Archives Volume 20 No. 2, 2020 pp. 9113-9119 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

RESOURCE-USE-EFFICIENCY ANALYSIS FOR THE SELECTED MAJOR HORTICULTURAL CROPS IN THE STATE OF NAGALAND AND MANIPUR, INDIA

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Abstract

In India, agriculture is important occupation of which 52.00 percent of the people depend for their livelihood. Although agriculture dominates the primary sector however it has not reached its potential level, since most of the farmers use traditional technology, slow adoption of modern and proven technologies which impaired productivity and results in lower standard living of the framers in the region. In flip side the intensification of agriculture in recent decades made the agricultural sector unsustainable due to overexploitation of groundwater and land degradation because of non-judicious of fertilizers. To meet the objectives of the proposed study, both primary as well as secondary have been collected. The primary data and other relevant information of the proposed study has been collected by adopting personal interview method from the selected farm households in the study area for agricultural year 2016 to 2018.

Key words: *Resource-use-efficiency, economic, horticultural, function, regression.*

Introduction

The world's population is projected to reach 8.5 billion by 2030, 9.7 billion by 2050 and exceed 11 billion in 2100, with India expected to surpass China as the most populous around seven years from now and Nigeria overtaking the United States to become the world's third largest country around 35 years from now, according to a new United Nations report released today (*UNO, 2015*). According to the report of "Future of Food and Agriculture, Trends and Challenges; 22 February, 2017- FAO-United nation" major transformation in agricultural systems, rural economics and natural resource management will be needed if we are to meet the multiple challenges before us and realize the full potential of food and agriculture to ensure a secure and healthy future for all people and the entire planet. High-input, resource-intensive farming system, which has caused massive deforestation, water scarcities, soil depletion and high levels of green-house emission cannot deliver sustainable food and agricultural production, adds the report.

The North-Eastern states of India are inhibited by several Indigenous people having various cultural, political, social and economic values. The region has a rich flora and fauna and is considered as biodiversity Hotspot of many crops. North-Eastern region has a huge potential for growth and development in agriculture and allied sectors as the region is endowed with various Indigenous socio-economic aspect of farming. The Apatani; Bun; Zabo; Zero Tillage and Fruit-Based system of Farming can be mentioned. The region is considered or assumes as low uses of synthetic inputs and even some states are declared as Organic states and many more are on the pipeline of organic states. In fact, majority of the agricultural land areas are declared as "Organic by Default" and even some states are also considered as less or minimum inorganic user states (Chishi and Sharma, 2019).

Manipur and Nagaland are the two adjoining states out of the seven states of North-Eastern States of India. These states are inhabitated by many Indigenous people having special or peculiar system of social and economic life. *Zhuming; Zabo; Zero-Tillage and Fruit-Based Farming system* are some of the exemplified ones and many system are still left untouched in many pockets or areas from extensive study. Bringing the agricultural

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scenario of these two states on the sustainability forum; assessing the various form and system of existing agricultural practices and their recommended practices that have been existing and adopted/adopting is the need of the hour so as to come up with the concrete findings and recommendations for future course of action and a handy manual for the Planners and Policy makers is the real core of the study. Thus, a thorough study and understanding of various Indigenous Agricultural Practices of these two agriculturally important states has been taken up. (Imlibenla and Sharma, 2019).

Materials and Methods

The present study has been carried out in Manipur and Nagaland both state in consultation with the organizations and the line-departments working in the field of Organic farming at the first and secondly the feasibility of the researcher. A multi-stage-random sampling technique has been used for the selection of sample units. Both purposive and cluster sampling method have been used for the selection districts, blocks and surveyed of the sample sizes.

In the first stage of sampling, Dimapur and Kohima both districts from Nagaland and Senapati and Thoubal districts from Manipur were selected purposively due to popularity and production of major horticultural crops. In the second stage block having highest acreage and production of major horticultural crops under the selected district has been selected with the help of District Agriculture Department and other reputed institutes. Kohima and Medziphema from Nagaland and Thoubal & Mao-Maram blocks from Manipur were purposively. In the third stage, a list of villages under the selected block was prepared with the help of Block Development Officer/District Agriculture Department and ICAR institutes. Accordingly, Medziphema and Jakhama from Nagaland and Phikomai; Kalinamei and Waithou Chiru were selected for the study. In the fourth stage of sampling plan, with the help of the selected villages, authority (Headman) and KVKs institutes, the farmers who cultivate pineapple and potato were analysed and from these villages, 300 farmers (150 respondent farmers from Manipur and 150 respondent farmers from Nagaland) were selected for each crop (i. e; 75 farmers/crop) for the data collection of the above crops. From the prepared farmers list, by adopting stratified random sampling, proportional allocation and cluster sampling techniques, the respondent farmers were drawn for collection of information using pre-tested schedule.

The categorizations of household farmers into marginal, small and medium group were done on the basis of their operational land holdings as follows:

Marginal	:	Less than ha
Small	:	1.01 to 2 ha
Medium	:	2.01 & above.

Result and Discussion

Production function

The functional relationship between inputs use and output produced has been fitted using Cobb-Douglas type of production function. The parameters of the function have been estimated using ordinary least square method. The production function is as follows:

$$Y = aX_i^{bi} \quad ......(1)$$

By taking natural logarithm of both side the functional relationship will be transformed into log-linear form as:

$$\log Y = \text{Log } a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 + b_7 \log x_7 + u \log e \text{ .....(2)}$$

Whereas:

Y = Gross returns (Rs)

X_1 = Value of seed (Rs)

X_2 = Value of manures and fertilizers (Rs)

X_3 = Value of plant protection chemicals (Rs)

X_4 = Human labour charge (Rs)

X_5 = Bullock labour charge (Rs)

X_6 = Machine labour (Rs)

a = Constant/intercept term

b_i = Production elasticities (i = 1, 2, …..6)

The Cobb-Douglas production function facilitates to examine the resource use efficiency by comparing marginal value product (MVP) to its factor cost. The marginal value product of an input is computed as: MVP $x_1 = d_y/d_x = b_1 . y/x_1$, where b_1 is the elasticity co-efficient of x_1, x_1 and y are the geometric means of input and output respectively.

Resource use efficiency

Cobb-Douglas Production Functions have been used in the present study for the assessment of the resource use efficiency of different horticultural crops *viz*; pineapple, potato and cabbage crops on different farm size groups in the selected area. The production function of different enterprises were fitted as regressing gross return (y), x_1, x_2, x_3, x_4, x_5 and x_6 in terms of rupees as independent variables on marginal, small and medium farm size groups as well as overall farm size group.

A. Resource production of horticultural

production enterprise

The ordinary least square (OLS) estimates of parameters of Cobb-Douglas type of production with respect to different farm size groups and overall farm size samples are presented in table 1.

It is clear from the table that the value of co-efficient of multiple determinations (R^2) ranged from 99.56 percent as maximum in marginal size group of Manipur state farm to 87.08 percent as minimum of the selected sample in small farm size group of Nagaland state farm, which will be explaining the variation in the dependent variables by the selected independent variable chosen in the equation in different farm size groups and in overall farms too. Even in the Nagaland state the overall horticultural crop for farm size group was also explained 99.76 percent of the sample farms, which shows as good fit of the selected model and found to be statistically significant at 1 percent. The remaining variation of dependent variable might be due to other variables, which have been used in excess or not properly used. Study carried out in the same line by the Das and Sharma (2018).

Table 1: Elasticity Co-efficient of horticultural crops farm size groups in Nagaland state.

SN	No's of obs.	Vari-ables	Reg. Co-efficient	t-Stat-istics	R^2
(i).	Marginal farm size group:				
1.		a	-16384^{NS}(5.09E+10)	-3.2E-07^{NS}	0.995627*** (312.048)
2.		x_1	0.025571^{NS}(0.038727)	0.660283^{NS}	
3.		x_2	33.91158*(24.25238)	1.398279*	
4.		x_3	3.17E+16^{NS}(2.96E+16)	1.072674^{NS}	
5.		x_4	-42.0953^{NS}(27.14217)	-1.55092^{NS}	
6.		x_5	44.36427***(30.91366)	1.435103***	
7.		x_6	244.4481***(131.2289)	1.862762***	
(ii).	Small farm size group:				
1.		a	2723.806***(3.912539)	1.886113***	0.870789*** (1527.016)
2.		x_1	0.19939*(0.088797)	2.245466*	
3.		x_2	4.847295*(3.912539)	1.238913*	
4.		x_3	53.15255*(259.3595)	0.204938*	
5.		x_4	-11.1585^{NS}(67.17767)	-0.1661^{NS}	
6.		x_5	-1.0825^{NS}(1.791139)	-0.60436^{NS}	
7.		x_6	6.654108*(17.58313)	0.378437*	
(iii).	Medium farm size group:				
1.		a	-5750.69^{NS}(5319.275)	-1.0811^{NS}	0.99505*** (849.6419)
2.		x_1	0.095459^{NS}(0.204114)	0.467673^{NS}	
3.		x_2	7.061947*(6.164715)	1.145543*	
4.		x_3	25.75573***(15.20491)	1.693909***	
5.		x_4	16.18642***(2.428331)	6.665657***	
6.		x_5	45.66887***(37.39815)	1.221153***	
7.		x_6	4.768853*(3.139343)	1.519061*	
(iv).	Overall farm size group				
1.	150	a	716.0078***(947.6455)	3.246245***	0.947637*** (1787.897)
2.		x_1	0.245545*(0.07564)	0.755565*	
3.		x_2	1.398507*(1.995703)	0.700759*	
4.		x_3	9.466241***(4.491117)	2.10777***	
5.		x_4	2.708045*(1.695795)	1.596917*	
6.		x_5	10.34837**(15.08908)	0.685819**	
7.		x_6	-0.38046^{NS}(1.41825)	-0.26826^{NS}	

(*** Significant at 1 per cent, ** significant at 5 per cent and * significant at 10 per cent level) (Figures in parenthesis indicates the Standard Error of regression Co-efficient).

The regression co-efficient of constant (a), along with inputs x_3 & x_5 all were found to be positively significant at 1 percent level, which indicate that the model is good fit, while the inputs x_1, x_2 & x_4 were also found to be positively significant at 10 percent level, which indicate that overall model is good fit on the overall farm size group, respectively. Even the negative inputs returns and non-significant values, indicate that constant have very little role towards the gross return, besides the contribution of the constant is having the importance if all the selected inputs variables were kept as constant. Study carried out in the same line by the Yadav and Sharma (2019).

The regression co-efficient of x_5 & x_6 both were found to be highly significant at 1 percent level of significance, x_2 is also found to be significant on the marginal farm size group, while other inputs on the farms has contributes less role on gross income, which was found to be statistically non-significant indicate that their role is very less to the return, even the investment of some inputs were found to be negative impact, so it is better to re-allocate the input variables for further investment and have the meaningful contribution with regard to the input investment by re-investment to the potential areas on marginal farm size group, respectively. Similar study was carried out by Jamir and Sharma (2014).

The regression co-efficient of input a (constant) was found to be positive with significant at 1 percent level on small farm size group, which indicate that overall model is good fit, also the regression co-efficient of x_1, x_2, x_3 & x_6 all were found to be significant at 10 percent level of significance on the small farm size group, even the negative inputs returns and non-significant values, indicate that constant have very little role towards the gross return, besides the contribution of the constant is having the importance if all the selected inputs variables were kept as constant. Similar study was carried out by Sharma (2013).

Even the regression co-efficient of inputs x_3,

x_4 & x_5 were found to be positive highly significant at 1 percent level, which indicate that overall model is good fit, also the regression co-efficient of x_2 & x_6 both were found to be significant at 10 percent level of significance on the marginal farm size group, respectively, even the negative inputs returns and non-significant values, indicate that constant have very little role towards the gross return, besides the contribution of the constant is having the importance if all the selected inputs variables were kept as constant. Similar study was carried out in the same line by Imlibenla and Sharma (2019).

It is clear from the table 2 that the value of co-efficient of multiple determinations (R^2) ranged from 99.99 percent as maximum in marginal size group of Manipur state farm to 94.55 percent as minimum of the selected sample in medoum farm size group of Manipur state farms, which will be explaining the variation in the dependent variables by the selected independent variable chosen in the equation in different farm size groups and in overall farms too. Even in the Manipur state the overall horticultural crop for farm size group was also explained 99.97 percent of the sample farms, which shows as good fit of the selected model and found to be statistically significant at 1 percent. The remaining variation of dependent variable might be due to other variables, which have been used in excess or not properly used. By aggregating the cross-sectional data of all the farms in various farm size groups, production has been estimated for all the selected sample farms. Study carried out in the same line by Kent and Sharma (2014).

Table 2: Elasticity Co-efficient of different farm size groups in Manipur state.

SN	No's of obs.	Variables	Reg. Co-efficient	t-Statistics	R^2
(i).	Marginal farm size group:				
1.		a	722.6128***(241.2675)	2.995069***	0.999967***
2.		x_1	0.942542*(0.023498)	40.11149*	(16.71651)
3.		x_2	1.156315**(0.122511)	9.438457**	
4.		x_3	-0.6849NS(0.770485)	-0.88892NS	
5.		x_4	-7.75261NS(2.923082)	-2.6522NS	
6.		x_5	-9.39066NS(4.15061)	-2.26248NS	
7.		x_6	12.74165***(3.522442)	3.617278***	
(ii).	Small farm size group:				
1.		a	261.4756***(98.52987)	2.65377***	0.998825***
2.		x_1	0.96716**(0.016182)	59.76906**	(66.51042)
3.		x_2	1.102792*(0.198469)	5.55649*	
4.		x_3	-0.57408NS(0.696591)	-0.82413NS	
5.		x_4	0.653858NS(0.376943)	1.734635NS	
6.		x_5	1.1719*(0.250646)	4.675523*	
7.		x_6	0.51656NS(0.217086)	2.379517NS	
(iii).	Medium farm size group:				
1.		a	-2863.69NS(1538.522)	-1.86133NS	0.945508***
2.		x_1	0.203841NS(0.06347)	3.211612*	(713.0072)
3.		x_2	3.841157**(1.680644)	2.285527**	
4.		x_3	4.266043*(4.18209)	1.020074*	
5.		x_4	-41.692NS(33.66562)	-1.23842NS	
6.		x_5	-3.62684NS(3.485446)	-1.04057NS	
7.		x_6	8.827077***(1.386537)	6.366275***	
(iv).	Overall farm size group:				
1.	150	a	16.16413*(42.62756)	0.379194*	0.999662***
2.		x_1	0.993629NS(0.0084)	118.2938NS	(69.96485)
3.		x_2	1.066331*(0.086997)	12.2571*	
4.		x_3	1.036308*(0.166168)	6.236491*	
5.		x_4	0.952754NS(0.267153)	3.566325*	
6.		x_5	1.27755*(0.247783)	5.155922*	
7.		x_6	0.21086NS(0.207801)	1.014721NS	

(*** Significant at 1 per cent, **Significant at 5 per cent and * significant at 10 percent level) (Figures in parenthesis indicates the Standard Error of regression Co-efficient).

The regression co-efficient of constant (a) and inputs viz; x_2, x_3 and x_5 on overall farm size group were found to be statistically significant at 10 percent level, the inputs were found statistically non-significant, shows less role of the input towards the gross return. The negative values indicate an alarm and also shows that either those inputs were utilized in excess amount or not used in the properly manner, so it is better to invest more to those prospect areas to get the better returns. Similar study carried out by Sharma (2006).

Even the regression co-efficient of constant (a) and input x_6 both were found to be positive highly significant at 1 percent level, which indicate that overall model is good fit and the regression co-efficient of x_2 is found to be significant at 5 percent level of significance, even the regression co-efficient of x_1 is also found to be significant at 10 percent level of significance on the marginal farm size group, respectively, even the negative inputs returns and non-significant values, indicate that constant have very little role towards the gross return, besides the contribution of the constant is having the importance if all the selected inputs variables were kept as constant. Similar study carried out in the same line by the Sharma (2014).

While the regression co-efficient of constant (a) was found to be positive highly significant at 1 percent level, which indicate that overall model is good fit and the regression co-efficient of x_1, also found to be significant at 5 percent level of significance and the regression co-efficient of x_2

and x_5 both were also found to be significant at 10 percent level of significance on the small farm size group, respectively, even the negative inputs returns and non-significant values, indicate that constant have very little role towards the gross return, besides the contribution of the constant is having the importance if all the selected inputs variables were kept as constant. Study carried out in the same line by the Sharma (2005).

Whereas the regression co-efficient of input x_6 is found to be positive highly significant at 1 percent level, which indicate the model is good fit and the regression co-efficient of x_2 is found to be significant at 5 percent level of significance and the regression co-efficient of x_3 is also found to be significant at 10 percent level of significance on the small farm size group, respectively, even the negative inputs returns and non-significant values, indicate that constant have very little role towards the gross return, besides the contribution of the constant is having the importance if all the selected inputs variables were kept as constant. Similar study was carried out by Sharma *et al.,* (2016).

B. Resource use efficiency

To evaluate how efficiently the farmers in Nagaland state of the study area have been utilizing their resources, the marginal value product (MVP) of an input was compared with its respective factor cost. An optimal use of that factor was indicated as the ratio approach unity. The value of ratio greater than unity meant that returns could be increased by using more of that resource and for value of ratio will be less than unity indicates improper

Table 3: Result of MVP analysis of different farm size groups in Nagaland.

SN	Vari-ables	Geometric Mean	MVP	MFC	Effici-ency
(i).	Marginal farm:				
1.	x_1	7712.69	4.21915	98	0.04305
2.	x_2	239.363	932.569	23	40.5465
3.	x_3	49.4956	-420.76	22	-19.126
4.	x_4	118.756	7E+17	17	4.1E+16
5.	x_5	406.416	-11576	200	-57.881
6.	x_6	260.841	244.003	4	61.0008
7.	y	6635.75	-450560	24	-18773
(ii).	Small farm:				
1.	x_1	10404.1	44.8628	98	0.45778
2.	x_2	1146.43	181.774	23	7.9032
3.	x_3	48.933	-182.76	22	-8.3072
4.	x_4	305.331	1594.58	17	93.7986
5.	x_5	1188.44	-4184.5	200	-20.922
6.	x_6	929.477	-8.1187	4	-2.0297
7.	y	16865.6	102143	24	4255.95
(iii).	Medium farm:				
1.	x_1	14158.1	16.1802	98	0.1651
2.	x_2	1956.09	199.5	23	8.67391
3.	x_3	57.1146	727.599	22	33.0727
4.	x_4	516.804	-2339.4	17	-137.61
5.	x_5	1953.82	-3004.2	200	-15.021
6.	x_6	1713.19	91.4533	4	22.8633
7.	y	28374.6	-162457	24	-6769
(iv).	Overall farm:				
1.	x_1	10419.3	45.7941	98	0.46729
2.	x_2	965.251	43.4703	10	4.34703
3.	x_3	50.306	-58.865	22	-2.6757
4.	x_4	284.781	-735.4	17	-43.259
5.	x_5	1079.68	2942.42	200	14.7121
6.	x_6	832.766	16.835	4	4.20875
7.	y	15744.8	22255.9	24	927.33

Table 4: Result of MVP analysis of different farm size groups in Manipur.

SN	Vari-ables	Geometric Mean	MVP	MFC	Effici-ency
(i).	Marginal farm				
1.	x_1	2757.18	155.519	98	1.58693
2.	x_2	330.073	31.7986	23	1.38255
3.	x_3	36.312	-18.835	22	-0.8561
4.	x_4	98.3419	-170.56	17	-10.033
5.	x_5	369.376	-2582.4	200	-12.912
6.	x_6	283.641	70.0791	4	17.5198
7.	y	4652.31	19871.9	24	827.994
(ii).	Small farm				
1.	x_1	4976.64	217.611	98	2.22052
2.	x_2	583.298	41.3547	23	1.79803
3.	x_3	36.2255	-21.528	22	-0.9786
4.	x_4	95.5636	19.6157	17	1.15387
5.	x_5	762.246	439.463	200	2.19731
6.	x_6	550.167	3.8742	4	0.96855
7.	y	8418.94	9805.34	24	408.556
(iii).	Medium farm				
1.	x_1	7772.05	34.5511	98	0.35256
2.	x_2	919.278	108.513	23	4.71794
3.	x_3	78.0913	120.516	22	5.47799
4.	x_4	88.9051	-942.24	17	-55.426
5.	x_5	1284.39	-1024.6	200	-5.1229
6.	x_6	963.289	49.873	4	12.4682
7.	y	13452.2	-80899	24	-3370.8
(iv).	Overall farm				
1.	x_1	5336.71	185.312	100	1.85312
2.	x_2	629.176	33.1451	23	1.44109
3.	x_3	46.8111	32.2119	22	1.46418
4.	x_4	93.6476	23.6918	17	1.39364
5.	x_5	823.528	397.105	200	1.98553
6.	x_6	607.041	1.24531	4	0.31133
7.	y	9094.06	497.411	24	20.7255

use of the resources. The marginal value products of a particular resource indicate the expected addition of that resource to the gross return caused by an addition of one unit of that resource, while other inputs are held constant. The marginal value products of these factors were computed by multiplying the regression coefficient of that resource with the geometric mean of gross return to the geometric mean of each resource. The computed MVP of different strategic variables is shown in table 3. Similar study carried out by Sharma *et al.,* (2018).

The value of MVP for x_2, x_5, x_6 and y all were found to be positive statistically significant in the Nagaland state towards the horticultural crops on different farm size groups, further data indicate that by adding of one unit to this input would be providing an adding income ranging from 4.20 to 147.00 in rupees towards the gross return on the overall farm size group, respectively, so it may be continue in future. Similar study carried out by Sharma and Nizammudin (2014).

While the value of MVP for x_2, x_5 and x_6 all were found to be positively and statistically significant in the Nagaland state for horticultural crops on different farm size groups, further data indicate that by adding of one unit to this input would be providing an adding income ranging from 40.00 to 61.00 in rupees towards the gross return on the marginal farm size group, respectively, so it may be continue in future. (Sharma *et al.,* 2000).

Whereas the value of MVP for x_2, x_4 and y all were found to be positively and statistically significant in the Nagaland state for horticultural crops on different farm size groups, further data indicate that by adding of one unit to this input would be providing an adding income ranging from 7.90 to 93.00 in rupees towards the gross return on the small farm size group, respectively, so it may be continue in future.

Even the value of MVP for x_2, x_3 and x_6 all were found to be positively and statistically significant in the Nagaland state for horticultural crops on different farm size groups, further data indicate that by adding of one unit to this input would be providing an adding income ranging from 22.86 to 86.00 in rupees towards the gross return on the medium farm size group, respectively, so it may be continue in future.

Also, similarly to evaluate how efficiently the farmers in Manipur state of the study area of have been utilizing their resources, the marginal value product (MVP) of an input was compared with its respective factor cost. An optimal use of that factor was indicated as the ratio approach unity. The value of ratio greater than unity meant that returns could be increased by using more of that resource and for value of ratio will be less than unity indicates improper use of the resources. The marginal value products of a particular resource indicate the expected addition of that resource to the gross return caused by an addition of one unit of that resource, while other inputs are held constant. The marginal value products of these factors were computed by multiplying the regression coefficient of that resource with the geometric mean of gross return to the geometric mean of each resource. The computed MVP of different strategic variables is shown in table 4. Similar study carried out by Sharma (2014).

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