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Empirical study on Input Use, Yield Dynamics, and Disposal Pattern of Litchi Cultivation

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Abstract

Input use pattern in Litchi *(Litchi chinensis) orchard growing* and estimation of functional co-efficient between selected inputs (X's) as independent variable and with yield (Y) as dependent variable was found imperative. Average number of trees per hectare orchard on sample farms was found 119, which was 20 per cent more than recommended no of trees in a hectare. The average age of orchard among sample growers were found 19.66 years. The use of human labour was found decreasing from small to large group. A definite logical pattern was observed in the use of inputs (Bullock power, machine power, irrigation and other input uses) influenced by scale of operation, management concern, social and economic status of the grower.

On fitting cob-doulas production function to the input uses by identifying 6 independent variables (X'i) with yield (Y) (dependent variable) 77.33 per cent of variation in the output was jointly explained by the identified 6 independent variables. Three variables (age of orchard, no. of trees in orchard and human labour use per hectare found highly significant contributor with 1 per cent level of significance), whereas expenses on other working capita laws found significant at 10 per cent level of significance. The expenses on fertilizer and manure and plant protection were found insignificant at overall level but significant at medium orchard grower level.

Three channels were found to be used by grower to dispose their produce. Channel-I, distant market channel was found most preferred channel in terms of number of grower and amount of produced disposed. 80.83 per cent farms were used the channel I, 15.00 per cent farms used the channel II and 4.16 per cent of farms used the channel III to dispose off their litchi. In terms of quantity also similar preference prevailed and in quantity terms 91.49 per cent of per farm litchi production was marketed through channel I, 7.29 per cent

marketed through channel II and 1.21 per cent marketed from channel III.

Key words: Input use, Cobb-douglas production function, Independent variable, dependant variable Functional co-efficient, marketing channel,

1. Introduction

Litchi *(Litchi chinensis*) is an important sub-tropical evergreen fruit crop, belongs to family *Sapindaceae.* Being a perennial fruit crop its input use requirement varies with the time of planting to fruit bearing age and also when it starts bearing fruits to economic maturity. Being one of the oldest fruit crop it has significant Impact on the economy especially of India, whose about 60 Percent population depends on agriculture and allied activities for their survival. In spite of being so old crop there are very few studies have been conducted so far on the various economic aspects of this crop. The economic studies on litchi was mostly informative in nature and focused on estimating the cost of production, marketing pattern and price spread in marketing of litchi through different channels. No study was conducted on the input use pattern and their relationship with yield through functional analysis. This present study identifies input use pattern and establishes a functional relationship between selected inputs (X's) as independent variable and with yield (Y) as dependent variable. The study also identifies lacunae and how to mitigate by varying input use pattern.

The other aspect of present study is to identify the produce disposal preferences and pattern of the identified group of litchi growers.

2. Study area:

Bihar is selected purposively for the present study being the highest acreage under litchi production in India. The current acreage under litchi cultivation in Bihar is 31280 ha.[1] Muzaffarpur district and its blocks Mushhari, Minapur, Bochahan, and kanti selected for survey as the district was having highest area under litchi cultivation in the state and more than 50 per cent of the district's litchi area was under these four blocks**[2].**

3. Methodology

Eight villages from each block selected randomly for drawing the sample population. From each village farmers are categorized into, viz., small (0.01 ha – 0.8 ha) medium (0.81 ha – 1.60 ha) and large (>=1.61 ha) based on the area under litchi orchard. Fifteen growers, five each from the three categories specified were selected by simple randomization as sample. The primary data related to litchi orchard growing viz; input used at various stages, the aspects of establishment, costs incurred on various items, problem in production and marketing of litchi were collected by survey method for the year 2010-11 with the help of specially designed pre-tested schedule by personal interview of litchi orchard owners.

The data were therefore subjected to functional analysis by using the following form of Cobb-Douglas type of production function.

$$Y= aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} \ldots\ldots\ldots\ldots X_n^{bn} u$$

where, 'Y' is dependent variable, 'X_i's are independent variables, 'a' is the constant representing intercept of the production function and 'b_i's is regression coefficient of the respective resource variable. The sum of regression coefficients i.e. $\sum$ 'b_i' indicate returns to scale.

3.1 Sélection of input variables

To fit the production function for litchi orchard cultivation six Independent variables were identified. The équation fitted was as follows ;

$$Y= aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} x_6^{b6} u$$

Where,

Y	=	Yield in MT/ha
X_1	=	Age of orchard (yrs)
X_2	=	No of trees in orchard/ha
X_3	=	Human labour in man equivalent (days/ha)
X_4	=	Expenses on manure and fertilizers (Rs/ha)
X_5	=	Expenses on plant protection (Rs/ha)
X_6	=	Expenses on other working capital (Rs/ha)
a	=	Constant
b_i's	=	Regression coefficients
U	=	Error term

The coefficients of independent variables were tested by Students' 't' test for their significance and coefficient of determination R^2 was estimated for judging the suitability of variable selected and their explanatory power.

4. Result and discussion

4.1 Input use pattern

The average number of trees per hectare was found 119 on overall basis which was found 20 per cent more than recommended no of trees in a hectare. On group wise it was found decreasing from 138 trees per hectare in small, 111 trees per hectare in medium and 108 trees per hectare in large group. Thus small farms orchards were denser followed by medium than large. The average age of orchard among sample growers were found 19.66 years.

The information about per hectare resource use i.e. human labour, bullock power, machine power, FYM, fertilizer, plant protection and irrigation are given in table 1

The table revealed that at overall level, the per hectare human labour use was

30.16 man days of which male labour use was 28.34 man days and female labour use was 1.84 man days. On group wise use of human labour were found decreasing from small to large group. The both male and female labour use was found increasing from large (17.15 and 1.22 man days) to small group (45.17 and 3.55 man days). The same trend was observed in the use of hired and family labour used. The male family labour used was most in case of small group (9.12 man days) and least in large group (0.38 man days). In case of medium and large groups the use of female family labour was not observed. The reasons identified were far location of orchard from home and social status of the group. The use of bullocks power were found highest in case of small(2.24 pair days) group followed by medium(0.50 pair days) then large(0.40 pair days). The use of machine power was found increasing from small (6.78 hrs) group followed by medium (7.56 hrs) then large (8.16 hrs). On overall 7.50 hrs of machine power was found to be used in per hectare cultivation.

The use of FYM was 21.73 qtls per hectare at overall level. Its use was found increasing with size of holding. It was 9.64 qtls for small group 26.98 qtls for medium group and 28.55 qtls for large group.

The per hectare use of fertilizers at overall level was 99.17Kg N, 31.98 Kg P and 54.42 Kg K. The use of fertilizer was more in case of small group due to more number of trees per hectare. The use of Potassic fertilizer was found more as it helps in good fruit setting and fruit development. A lack of clear knowhow was observed about recommended dose of fertilizer and application of micronutrient among growers.

The per hectare cost of plant protection was Rs 655.30 at the overall level. It was the lowest (Rs. 619.02) in the large size group of holdings and highest in case of medium (Rs. 705.35).

In the case of irrigation, per hectare expenditure was around Rs. 1098.32 at the overall level. It was more in case of small (Rs. 1728.00) as small size of orchard led better management and able to apply more number of irrigation than large sized orchards.

4.2 Yield dynamics

In order to estimate the factors responsible for production and thereby to establish relationship between the yield of litchi and independent variables, Cobb Douglas type of production function was fitted to the data and the results are given in Table 2.

It was observed from the table that, 77.33 per cent of variation in the output was jointly explained by the independent variables. The regression coefficient of age of orchard (X_1) was positive and significant at 10 per cent level of significance for small size group, while it was significant at 1 per cent level of significance for medium and overall basis. The regression coefficients were 0.20, 0.45 for small and medium respectively. The value of coefficient at overall level was 0.28, it means that small and medium groups orchard were in increasing yield age, and yield will further increase by 0.20 and 0.45 per cent with 1 per cent advancement of orchard age. The production elasticity of variable age (X_1) was positive but non-significant for large group. It means age of orchard for large group was not a determining factor for yield. The orchards of large group has already attained the age of maturity.

The regression coefficient of the variable, number of trees per hectare (X_2) for all three size groups and overall level was positive and significant at 1 per cent. Thus it was found the production elasticities of number of trees per hectare for small, medium and large groups were 0.79, 0.76 and 1.01 respectively. At overall level, the regression coefficient was 0.84, which means, for one per cent increase in number of tree per hectare, the value of output would increase by 0.84 per cent.

The use of human labour per hectare (X_3) was found positive and significant at 1 per cent level of significance. The production elasticity of human labour use per hectare at over all level was 0.07. It means by using additional 1 per cent human labour per hectare production would increase by 0.07 per cent. The regression coefficients for human labour per hectare in case of small and large group were 0.10 and 0.08 respectively. The coefficients were also significant at 10 per cent level of significance. It means by increasing 1 per cent use level of human labour per hectare the production of small and large group would increase by 0.10 and 0.08 per cent respectively. The value of coefficient was negative and non significant for medium group, which means their use of human labour per hectare is incurring extra cost. So they can reduce some of their cost by reducing human labour per hectare.

The expense on manures and fertilizer per hectare (X_4) was found positive and significant at 10 per cent and expenses (X_5) was found significant at 10 per cent level for medium group. But the same were insignificant for other groups and overall level. This shows that these factors are not contributing in the yield realized by small and large group.

The expenses on the other working capital per hectare (X_6), which includes bullock power use, machine power use and irrigation expenses was positive and significant at 5 per cent for small group and at 10 per cent at overall level. The production elasticities were 0.14 and 0.06, it means by increase in 1 per cent expense on other working capital yield for small group would increase by 0.14 per cent and at overall level by 0.06 per cent.

In nutshell, it can be said that the contributing factors for realized yield were number of trees in orchard, age of orchard, human labour use and expenses on other working capital. The other important factors are not contributing in yield it means they are not properly utilized at overall level. It can also be justified by yield potential of mature bearing orchard which is 80-150 kg/ tree.[3]

4.3 Disposal of litchi

Disposal pattern and preference decide the actual realization from produce. Disposal of produce is found a complex behavior in the case of litchi. Produce disposal preferences found varying with the growers group (small, medium and large). The table 3 presents the quantity of litchi produced and its disposal pattern by sample growers.

The table 3 shows the average per farm production of litchi among different group and its disposal pattern. It can be observed that per farm yield of litchi was 117.14 quintal on overall basis. While it was 32.10, 80.95 and 238.37 quintals per farm for small, medium and large group respectively. The quantity marketed peer farm was 99.41 per cent of total per farm production, 0.18 per cent for home

consumption and given on gratis to friends and relatives, and 0.26 per cent was spoiled due to fruit cracking, sunburn and other pest disease problem. The spoilage were accounted by only small group as few of them marketed the litchi in local market by own, while other two groups had sold their orchard to either pre-harvest contractors or directly to local retailers for marketing in distant and district and nearby markets respectively.

The prime reasons observed for behind the disposal pattern were high perishability of produce and its availability in the market. Litchi fruits availability in market opens for a short window of maximum two months, (Second week of April-3rd week of June)[4]. *(**www.agriexchange.apeda.gov.in***) This short availability is not only in India but also in most of the litchi producing countries (China, Taiwan, Vietnam, Thailand, Bangladesh, Maurititus etc.) of the world.[5] The short availability not only distinguishes litchi from other fruit crops but also poses various problems which ultimately leads the disposal and marketing pattern. The survey revealed that the large producers were sold their orchards well in advance during flowering to pre harvest contractor by personal negotiation. The preharvest contractor was most important functionary in litchi produce disposal and led us to identify following channels for disposal of produce.

Channel I
Producer – Pre-harvest contractor – wholesaler (Muzaffarpur) – wholesaler/commission agent (Distant market) – retailer – consumer **(distant market)**

Channel II
Producer – retailer – consumer **(district and nearby market)**

Channel III
Producer – consumer **(local sale).**

The preference of channel for disposal of produce is presented under heads of quantity of litchi disposed and number of growers used a particular channel in Table 4 and figure 1.

It can be seen from the table 4 and figure 1 that 80.83 per cent farms were used the channel I, 15.00 per cent farms used the channel II and 4.16 per cent of farms used the channel III to dispose off their litchi. Thus channel I which contain pre-harvest contractor was major channel in the study area. The result is similar to the study made by Anonymous (2010). In quantity terms 91.49 per cent of per farm litchi production was marketed through channel I, 7.29 per cent marketed through channel II and 1.21 per cent marketed from channel III.

The third channel is only used by small group while no third channel was used by medium group, because of handling difficulties and short shelf life of litchi and large group because huge volume of produce from large sized orchard.

5. Summary and conclusion

The overall level, per hectare use of human labour was 30.18 mandays, comprising 28.34 male labour and 1.84 female labour. The use of human labour decreased with the increase in the size of holdings. At the overall level, the use of bullock was 1.05 pair days per hectare and was relatively more on small sized farms. At the overall level, the use of F.Y.M. was found to be 21.73 qtls. The use of fertilizers was found to be more with the small group followed by large and medium group. The per hectare cost of plant protection was Rs. 655.30 at the overall level. It was the lowest in the large size group of holdings.

77.33 per cent variation in the output was jointly explained by the independent variables at the overall level. The production elasticities of age of orchard (X_1) was significant for small, medium and overall level only non significant for large group. The production elasticities of no of trees for small, medium and large sized holdings were 0.79, 0.76 and 1.01 respectively.

The human labour use per hectare (X_3) was significant for small, large and overall level but non-significant for medium group growers.

The factor Expenses on manures and fertilizer per hectare (X_4), expenses on plant protection per hectare (X_5) and expenses on other working capital (X_6) were found significant for medium group only, while the factor expenses on other working capital (X_6) was significant on overall level also.

Disposal pattern and preference opted by the sample grower depended on high perishability of produce and its availability in the market which led litchi a risky enterprise. Most preferred channel for large group of farmers were found channel –I, which inspite of being a lengthy channel in terms of intermediaries involved and remove the risk of marketing losses. It led to the outcome where 80.83 per cent farms were used the channel I. In terms of quantity also similar preference prevailed and in quantity terms 91.49 per cent of per farm litchi production was marketed through channel I, 7.29 per cent marketed through channel II and 1.21 per cent marketed from channel III.

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Table 1 Inputs use pattern for litchi cultivation

(Per ha)

Sr. No.	Particulars		Size group of holding			Overall
			Small	**Medium**	**Large**	
1.	Average no. of trees		138	111	108	119
2.	Average age of orchard orchard orchard		17	17	21	19.66
3.	Total human labour (man days)		48.73	23.44	18.37	30.16
	a. Male	Hired	36.05	21.49	16.77	24.77
		Owned	9.12	1.20	0.38	3.56
		Total	**45.17**	**22.69**	**17.15**	**28.33**
	b. Female	Hired	3.42	0.75	1.22	1.79
		Owned	0.13	0.00	0.00	0.04
		Total	**3.55**	**0.75**	**1.22**	**1.83**
4.	Bullock power (pair days)		2.24	0.50	0.40	1.05
5.	Machine power (hours)		6.78	7.56	8.16	7.50
6.	Manures (Qtls)		9.64	26.98	28.55	21.73
7.	Fertilizers (Kg)					
	Nitrogen (N)		106.76	93.87	96.89	99.17
	Phosphorous (P)		40.77	29.86	25.32	31.98
	Potassium (K)		56.64	51.68	54.93	54.42
8.	Plant protection (Rs.)		641.54	705.35	619.02	655.30
9.	Irrigation (Rs.)		1728	1087	479.48	1098.32

Table 2. Results of estimated Cobb-Douglas type of production function

Sr. No.	Particulars	Size group of holding			Overall (N=120)
		Small (N=40)	**Medium (N=40)**	**Large (N=40)**	
1.	R^2	84.23	74.66	63.91	77.33
2.	Constant (a)	-2.02	-1.87	-1.47	-1.68
3.	Age of orchard (X_1)	0.20* (0.111)	0.45*** (0.069)	0.17^{NS} (0.070)	0.28*** (0.042)
4.	No of trees in orchard/ha (X_2)	0.79*** (0.088)	0.76*** (0.187)	1.01*** (0.186)	0.84*** (0.055)
5.	Human labour (mandays/ha) (X_3)	0.10* (0.058)	-0.06^{NS} (0.09)	0.088* (0.054)	0.07*** (0.027)
6.	Expenses on manure and fertilizers (X_4) (Rs/ha)	0.09^{NS} (0.0760)	0.13* (0.073)	0.009 (0.055)	0.03^{NS} (0.035)
7.	Expenses on plant protection(X_5) (Rs/ha)	-0.001^{NS} (0.019)	0.029* (0.016)	0.005^{NS} (0.017)	0.009^{NS} (0.009)
8.	Expenses on other working capital (X_6) (Rs/ha)	0.14** (0.066)	0.03^{NS} (0.070)	0.025^{NS} (0.053)	0.06* (0.033)

(Figures in parentheses are the standard error of respective coefficients)

Note: '','**'and'***'indicate significance at 10, 5 and 1 per cent level of significance*

Table 3. Quantity of Litchi produced and its disposal

(Qtls/farm)

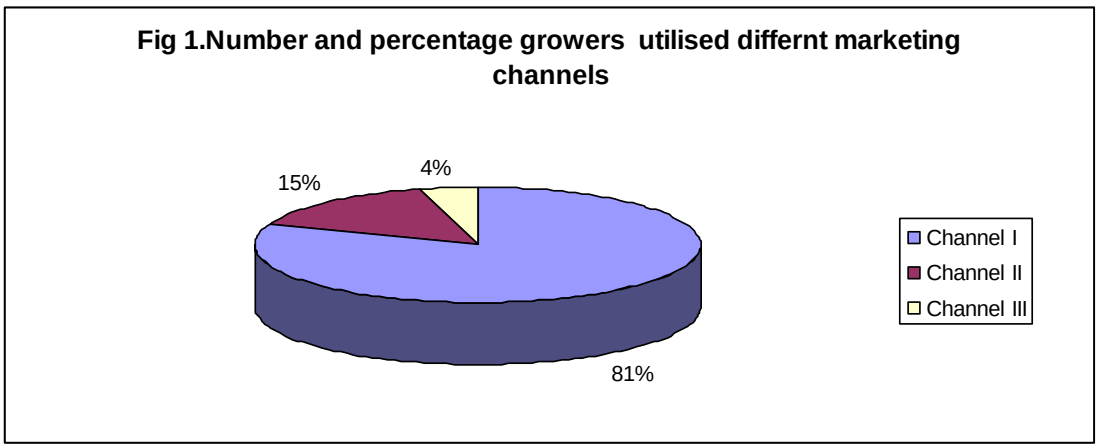
Sr No	Particulars	Size Group			Overall
		Small	Medium	Large	
1.	Total produced quantity	32.10 (100.00)	80.95 (100.00)	238.37 (100.00)	117.14 (100.00)
2.	Used for home consumption and given gratis	0.17 (0.52)	0.23 (0.28)	0.29 (0.12)	0.22 (0.18)
3.	Spoilage due to fruit cracking, sunburn etc	0.26 (0.80)	-	-	0.08 (0.26)
4.	Total marketed quantity	31.67 (98.67)	80.72 (99.71)	238.08 (99.87)	116.82 (99.41)
a.	Grade - I	11.08	33.90	76.27	40.41
b.	Grade - II	17.41	40.36	143.02	66.93
c.	Ungraded	3.18	6.46	19.08	9.57

(Figures in parentheses are the percentage to total produced quantity)

Table 4 Disposal of litchi through different channels

Sr No	Marketing channel	No of farms			Total	Quantity(qtl)			Total
		Small	Medium	Large		Small	Medium	Large	
1	I	25 (62.50)	32 (80.00)	40 (100.00)	97 (80.83)	17.53 (55.35)	65.04 (80.57)	238.08 (100.00)	320.63 (91.49)
2	II	10 (25.00)	8 (20.00)	-	18 (15.00)	9.87 (31.16)	15.68 (19.43)	-	25.55 (7.29)
3	III	5 (12.50)	-	-	5 (4.16)	4.27 (13.48)	-	-	4.27 (1.21)
4	Total	40 (100.00)	40 (100.00)	40 (100.00)	120 (100.00)	31.67 (100.00)	80.72 (100.00)	238.08 (100.00)	350.45 (100.00)

(Figures in parentheses are the percentage to the total number of litchi growers)



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