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Zero Tillage of Rapeseed and Mustard Cultivation in Thoubal District of Manipur: An Economic Analysis

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Abstract

With the ever changing climatic scenario and its impact on farming community, need is being felt to explore and develop alternative Resource Conservation Technologies (RCT's) which will have positive impact on the environment as well as at the same time will save the critical inputs. Zero tillage is one such important RCT commonly practiced in the study area. Several research works have been reported for impact of zero tillage in wheat, rice but so far no systematic study on economics of rapeseed and mustard cultivation under zero tillage was available in the literature especially in Manipur of North Eastern Hill (NEH) Region. Keeping this in view, the study was undertaken to work out the cost and returns of the rapeseed and mustard growers under zero tillage. Economic analysis of the data presented in the paper showed that zero tillage method for rapeseed and mustard cultivation is the most economical and attractive option for the farming community in the area during *rabi* season.

Key words: Resource Conservation Technologies, zero tillage, rapeseed and mustard, NEH.

Introduction

India is one among the leading oil seed producing countries in the world and this sector occupies an important position in the agricultural economy. Rapeseed and mustard (Brassica) is the second most important edible oilseed crop in India after groundnut and accounts for nearly 30 per cent of the total oilseeds produced in the country. India accounts for 19.92 percent of global production with only 10.14 percent share in the global acreage for rapeseed and mustard. In NEH Region, rapeseed and mustard production accounted for 190.25 thousand

tonnes which was cultivated in an area of 99.80 thousand hectares with the average yield of 762 kg/ha (Ministry of Agriculture, GOI, 2011) which is much lower than to the national average (941 kg/ha).

Zero tillage is one of the most used RCTs (Gupta, 2007) employed for saving precious resources, which gives more economic production (Hobbs, *et al.*, 2002), lower production cost and saving in water and energy (Reifschneider, 2007). Zero tillage not only promotes input-use efficiency but also strengthens natural resource base (Laxmi and Mishra, 2007). It is, in a way, a complete farm management system that should include many agricultural practices including planting, plant residue management, weed and pest control, harvesting and crop rotations (Ekboir, 2002). Conservation agriculture is also a major focus in the Indian agriculture in order to sustain the quality of natural resources and to meet the challenges of ever increasing demands for food, fodder and fuel of the country where it is a concept for resource saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently promoting the environmental balance (FAO, 2007). Moreover, along with conservation agriculture, crop diversification proved to be of paramount importance in mitigating the environmental problems arising on account of monoculture.

Rapeseed and mustard are the predominant crops grown during rabi season after paddy on rainfed farms of the study area and M-27, Ragini and Local variety- Yella are the three popular rapeseed and mustard varieties grown in the area. Various sowing techniques have been practiced in zero tillage cultivation of rapeseed and mustard in Manipur viz. as relay crop, sowing seeds after burning straw; and sowing seeds with straw mulching. In relay crop, if the soil moisture is optimum, as indicated by soil coloration and field test, the seeds are sown in standing paddy field just 4-7 days before harvesting of paddy. After harvesting of paddy, as the seed germinates with 1-2 true leaves, urea is top dressed at the rate of 120-150 kg/ha. The crop is then allowed to complete its life cycle without much after care, but insecticides are applied on need based approach. Under the second method, the farmers harvest paddy crop at the height of 15-20 cm. The threshed out paddy straws are thinly scattered over the entire rice field and then burnt. Mustard seeds are sown in the following days. The method is more advantageous in moist field and also helps in controlling weeds during burning. Under the third method, it is practiced with the presumption that the soil moisture is drying fast and mustard seeds may not be able to germinate. So the straws are scattered thinly over the field after sowing of mustards seeds to serves as mulch for conserving soil moisture. This method is beneficial in increasing soil organic matter in the long run. Hence, with the introduction of zero tillage technology, a vast area of the Manipur (1000 hectares) had lead to the transformation of mono-cropped rice cropping system to double cropped rice- rapeseed and mustard. Since, unless the technology is economically viable and sustainable, a technology cannot be adopted. So, in the present paper, efforts have been made to assess the impact of zero tillage on the overall economics of rapeseed and mustard cultivation in Thoubal district of Manipur.

Methodology

Data

Both primary as well as secondary data were collected for attaining the objectives undertaken. Primary data were collected from the sample households using pre-tested well structured schedule through interview method for the crop year 2012-13. The cost of cultivation data was collected on the entire operations of the zero tillage rapeseed and mustard cultivation, including yield of main product and returns from the crop under zero tillage method. Secondary data were collected from various published and unpublished sources *viz*., various research reports and bulletins of CAU Imphal, State Government publications, Office of the North Eastern Council (NEC), ICAR Research Complex for NEH Region, Department of Agriculture, Directorate of Economics and Statistics, and Directorate of Settlement and Land Revenue, Government of Manipur.

Sampling

The present study was conducted in Thou bal district of Manipur, since the district was having largest area under zero tillage in the state. Out of the two blocks in Thou bal, Kakching Community Development Block was selected for the study on the basis of highest area under zero tillage of rapeseed and mustard cultivation as suggested by the KVK, Imphal East district and KVK, Thoubal district personnel. Out of the 40 villages of Kakching block, three villages viz. Kakching Khullen, Kakching Wairi and Keirak were selected randomly. From the three selected villages a list of both rapeseed and mustard growers under zero tillage was prepared along with their land holding size and total land holding areas were categorized into three categories using cumulative total method viz. small (up to 2 ha), medium (2.1 to 3 ha) and large (3.1 ha and above). A sample of 80 farmers comprising of 44 small, 26 medium and 10 large farmers were selected using proportionate random sampling method.

Analytical tools

The standard cost of cultivation concepts given by Commission for Agricultural Cost and Prices (CACP) viz., Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1 and Cost C_2 were used to work out the cost and returns of the crop. To identify the determinants of crop yield, Cobb-Douglas production function model was used with the following specification:

$$\text{Ln } Y = \text{In } b_0 + b_1 \text{ In } X_1 + b_2 \text{ In } X_2 + b_3 \text{ In } X_3 + b_4 \text{ In } X_4 + b_5 \text{ In } X_5 + + \text{In } u$$

Where,

Y = Gross returns ₹/ha

X1 = Cost on human labour₹/ha

X2 = Cost on seeds ₹/ha

X3 = Cost on fertilizers ₹/ha

X4 = Cost on plant protection chemical ₹/ha

X5 = Cost on plant growth hormones ₹/ha

Results and Discussion

Cost Structure

The cost structure of rapeseed and mustard cultivation under zero tillage on different size of farms is presented in Table 1. The total cost of cultivation of rapeseed and mustard was estimated to be ₹17275.25 per hectare which comprise of variable costs (₹10033.26) and fixed costs (₹7239.57). The variable costs (58.09%) were found to be higher than the fixed costs (41.91%) in production of rapeseed and mustard under zero tillage method. The major contribution in overall variable costs was human labour (38.40%) followed by chemical fertilizers (14.74%), seed (2.22%), interest on working capital (1.81%), plant protection chemicals (0.73%) and plant growth hormones (0.15%) across the categories of the zero tillage rapeseed and mustard growers. Hence, human labour was found to be highest variable cost, which may be due to activities performed manually by the farmers in this method. In case of overall fixed costs, major cost was estimated to be rental value of land (30.56%); followed by rent paid for leased in land (10.38%), depreciation (1.44%), interest on fixed capital assets (0.64%) and land revenue (0.19%). Among the fixed costs, the rental value of land was estimated to be higher and it was only the single item of fixed cost which provides the base for production of rapeseed and mustard.

The category wise analysis further shows that human labour cost was almost similar on all categories of farms *i.e*. 38.58, 37.68 and 39.53 per cent to the total cost for small, medium and large farms, respectively. And the per cent share expenditure on chemical fertilizers was found to be second important item in the variable expenditure. However, the per cent share expenditure for human labour (39.53), chemical fertilizers (16.65), plant protection chemicals (0.82) and plant growth hormones (0.35) were estimated to be highest on large farm which may be due to more use of inputs on the farm. In case of small and medium farm, the cost of chemical fertilizer was accounted to be 14.88 and 13.88 per cent. Among the three groups of farms, the cost of seed was highest in medium farms which accounts for 2.33 percent of the total cost followed by small (2.19) and large (2.00) farms. The total fixed cost was estimated to be highest in case of medium farm (₹7507); followed by small farm (₹7395) and large farm (₹5858) which may be due to increase in farm size. Rental value of land contributes maximum to the total fixed cost *i.e*. 30.56 per cent of which 29.18 per cent for small farm, 31.13 per cent for medium farm and 36.07 per cent for large farm.

Various concepts of cost of cultivation, as given by CACP, were used in this analysis. Cost A_1, A_2, B_1, B_2, C_1 and C_2 of rapeseed and mustard crop are presented in Table 2. Here Cost A_1 is equal to Cost A_2 because no sample farmer had leased in land for the large farm during the study period. The category wise analysis showed that the per hectare costs *i.e.* Cost A_1, Cost A_2, and Cost B_1 were highest in case of small farms; followed by large and medium farms. This was mainly due to higher application of labour inputs by the small farms. The cost B_2 was found to be highest in case of small farm; followed by medium and large farms. The Cost C_1 and Cost C_2 were highest in case of small farms; followed by medium and large farms. The total cost of cultivation (Cost C_2) in case of small, medium and large farms were ₹17673, ₹17272 and ₹15149 respectively per hectare.

Table 1: Category wise cost of cultivation of rapeseed and mustard under zero tillage

(₹/ha)

Particulars	Small	Medium	Large	Overall
Variable costs				
Human labour	6830.74 (38.58)	6520.09 (37.68)	6052.07 (39.74)	6632.45 (38.40)
Seed	388.54 (2.19)	403.99 (2.33)	306.89 (2.00)	383.36 (2.22)
Chemical fertilizers	2633.98 (14.88)	2401.17 (13.88)	2535.65 (16.65)	2546.03 (14.74)
Plant protection chemicals	120.75 (0.68)	132.98 (0.77)	125.19 (0.82)	125.28 (0.73)
Plant growth hormones	17.02 (0.10)	28.91 (0.17)	53.20 (0.35)	26.76 (0.15)
Interest on working capital	318.19 (1.80)	310.55 (1.80)	297.86 (1.96)	313.17 (1.81)
Total variable costs (TVC)	10309.22 (58.23)	9797.69 (56.62)	9370.86 (62.06)	10033.26 (58.09)
Fixed costs				
Rental value of land	5166.42 (29.18)	5387.19 (31.13)	5492.67 (36.07)	5278.95 (30.56)
Rent paid for leased in land	1830.80 (10.34)	1729.06 (10.00)	-	1793.01 (10.38)
Interest on fixed capital assets	105.68 (0.60)	113.65 (0.66)	123.78 (0.81)	110.53 (0.64)
Land revenue	30.73 (0.17)	33.32 (0.19)	35.60 (0.23)	32.18 (0.19)
Depreciation	261.42 (1.48)	244.41 (1.41)	206.46 (1.36)	249.02 (1.44)
Total fixed cost (TFC)	7395.05 (41.77)	7507.63 (43.38)	5858.51 (38.47)	7239.57 (41.91)
Total cost (TVC+TFC)	17704.27 (100)	17305.32 (100)	15229.37 (100)	17275.25 (100)

Note: Figures in parentheses are percentage to total cost

Table 2: Comprehensive Cost of cultivation of Rapeseed-mustard

(₹/ha)

Particulars	Small	Medium	Large	Overall
Cost A_1	9541.60 (53.99)	9154.12 (53.00)	9069.15 (59.55)	9356.61 (54.31)
Cost A_2	11372.40 (64.35)	10883.18 (63.01)	9069.15 (59.55)	10925.50 (63.42)
Cost B_1	9647.28 (54.59)	9267.77 (53.66)	9192.93 (60.36)	9467.15 (54.95)
Cost B_2	16644.50 (94.18)	16350.70 (94.67)	14650.00 (96.20)	16299.70 (94.61)
Cost C_1	10707.05 (60.58)	10189.07 (58.99)	9736.70 (63.93)	10417.41 (60.47)
Cost C_2	17673.54 (100)	17272.00 (100)	15149.37 (100)	17227.52 (100)

Notes: Figures in parentheses are percentage to total cost

Returns and Crop Income Measures

Gross returns, farm business income, family labour income, net income and farm investment income per hectare of rapeseed and mustard cultivation are estimated and presented in Table 3. Considering the prevailing market price of rapeseed and mustard (at producer's level) which was ₹2800/q, on an average farms had gross income of ₹32993.81/ha. Among the various categories of farms, the gross income was highest in case of medium farms (₹33123.67); followed by small (₹32967.62) and large farms (₹32771.43). On the other hand, the farm business income was lowest due to the deductions made towards interest on fixed capital and

Table 3: Economic returns of rapeseed-mustard

(₹/ha)

Particulars	Small	Medium	Large	Overall
Gross income	32967.62	33123.67	32771.43	32993.81
Farm business income	21595.22	22240.49	23542.28	22048.32
Family labour income	16323.12	16772.97	17961.43	16674.11
Net income	15294.08	15851.67	17417.66	15740.74
Farm investment income	20535.45	21319.19	22998.51	21098.05
Output/Input ratio				
(i) Total cost	1.87	1.92	2.16	1.92
(ii) Paid out cost	3.46	3.62	3.61	3.53

Note: Figures in parentheses are percentage to total

imputed value of family labour. However, the net income of rapeseed and mustard growers was calculated to be ₹15740. The output-input ratio for large category was worked out to be 2.16 as against 1.92 and 1.87 for medium and small category when this ratio was calculated over Cost C_2 (cost of cultivation) hence, the favourable benefit cost ratios shows the economic viability of the zero tillage technology of rapeseed and mustard cultivation. Similar findings were reported by Tripathi *et al*. (2006) and Singh *et al*. (2011) in wheat.

Further, it is observed through analysis (Table-4) that the coefficient of elasticity of production (regression coefficient) attached to the variable human labour and chemical fertilizers used turned out to be positively significant at 1 per cent level. The significant and positive co-efficients of human labour and chemical fertilizers indicates that 1 per cent increase in human labour and chemical fertilizer use (value term) would bring about an increase in the gross return by 0.03 per cent and 0.11 per cent respectively. The positive and significant regression co-efficients of zero tillage revealed that this technology has favourable impact on net returns of rapeseed and mustard. Whereas, the regression co-efficients for seed and plant protection chemicals turned out to be negatively significant at 1 per cent level. The significant and negative co-efficient of seed and plant protection chemicals use indicates that there is an excessive use of both the inputs and further increase in seed and plant protection chemicals (value term) will decrease gross return by 0.05 and 0.27 per cent respectively.

The R^2 value was found to be 0.72 indicating 72 per cent of variation in yield was explained by the factors like human labour, seed, fertilizers, plant protection chemicals and plant growth hormones considered in the function. The return to scale was accounted to be 0.19. It indicates 0.19 per cent increase in level of returns by increasing 1 per cent of input level. The seed and plant protection chemicals added negative returns, because of excessive use which decreased the returns two fold *viz.* (cost of inputs and less productivity) which implies the third stage of production function. But remaining inputs are still underutilised which is clear through MVP: MFC ratio.

The resource use efficiency was assessed by estimating marginal value product (MVP) of the inputs used for rapeseed and mustard production under zero tillage. The ratio of MVP and MFC explains economic performance of inputs. The results of the analysis presented in Table 4, revealed that MVP-MFC ratios of the inputs *viz*. human labour, and plant growth hormones show less scope to raise the return by using the inputs. The MVP-MFC ratio for chemical fertilizer highlights possibilities for increasing the profitability through application of more chemical fertilizer in zero tillage cultivation of rapeseed and mustard. The negative ratio of seed and plant protection chemicals indicates there was excessive use of these two inputs in the production of the crops.

Table 4: Estimated Cobb-Douglas production function coefficients and MVP to MFC ratios

Particulars	Parameters	Production elasticities	MVP: MFC
Intercept	a	9.49*** (0.091)	
Human labour	b_1	0.03*** (0.008)	0.14
Seed	b_2	-0.05*** (0.016)	-4.16
Chemical fertilizers	b_3	0.11*** (0.012)	1.70
Plant protection chemicals	b_4	-0.001*** (0.0003)	-0.27
Plant growth hormones	b_5	0.0001 (0.0004)	0.14
Coefficient of determination	R^2	0.72	
Returns to scale	$\sum b_i$	0.19	

Notes: Figures in parentheses are standard errors

*** Indicates significant at 1% level of significance.

Conclusion

It can be concluded that adoption of zero tillage technology had a positive impact on the overall economics of rapeseed and mustard cultivation. This is evident from the higher gross and net income realized on the overall farms through increased productivity under zero tillage cultivation of rapeseed and mustard. Hence, increase in variable costs and returns with the increase in size of farms indicate the principles of economies of scale. The resources (factor of productions) except seed and plant protection chemicals in rapeseed and mustard cultivation have potential to increase its efficiency in enhancement of returns to scale.

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