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Research Article

RESOURCE USE EFFICIENCY OF MUSTARD PRODUCTION IN CHITWAN DISTRICT OF NEPAL

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Abstract

The study was conducted to determine the profitability and resource use efficiency of mustard production in Chitwan. The study used 159 mustard growers from 300 farmers adopting different pollinator friendly practices. Descriptive and statistical tools including Cobb-Douglas production function were used to analyze data which were collected from structured interview schedule. The benefit cost ratio (1.43) indicates that mustard production was profitable with productivity of 0.81 ton per ha. The magnitude of regression coefficients of mustard implied that use of human labor, tractor, nutrient and irrigation and pesticides costs had significant positive effect on gross return with estimated increasing return to scale (1.03). According to estimated allocative efficiency indices, it is suggested to increase use of tractor labor, seed, nutrient and irrigation plus pesticides cost by about 47%, 82%, 84% and 94%, respectively. Extension of modern technologies with adjustment on resource use is to be encouraged for increase in productivity and profit from mustard production which indirectly promotes and ensure forage for pollinators.

Key words: Allocative efficiency; Cobb-Douglas production function; pollinator; profitability; return to scale

Introduction

Mustard (*Brassica campestris* L. Var. *toria*) is one of the important oilseed crop of Nepal which belongs to family Cruciferae and is popularly known as *tori* in Nepal. It occupied 214,835 ha of land area, with the production of 179,145 t and productivity of 0.83 t/ha (MoAD, 2012). Its seed contain 40-50% oil and 20-25% protein (Hasanuzzaman *et al*., 2008). Similarly, 4.8% nitrogen, 2% phosphorus and 1.3% potash can be obtained from mustard oil cake (Prasai and Yadav, 1999).

Mustard is cross pollinated and an entomophilic plant. It requires large number of pollinating agents for better pollination and seed production. Honeybees are natural pollinators of plants throughout their natural range. The main significance of honey bee keeping is pollination with honey and wax as products of secondary value (Verma, 1990). Pudasaini and Thapa (2014) reported pollination deficit on mustard in natural condition, and therefore, management of honeybee is necessary for higher production and productivity in the context of Chitwan.

Pollination is a critical link in the functioning of ecosystems and it is essential for the production of a wide range of crops. Several studies have shown that pollination makes a very significant contribution to the agricultural production of a broad range of crops, in particulars fruits, vegetables, fiber crops and nuts (Gordon and Davis, 2003). Crop pollination services are being hampered by a decline in the number and diversity of pollinator populations throughout the Hindu Kush Himalayan region (Partap *et al*., 2001). Pollinator loss in Chitwan has been attributed to habitat loss resulting from misuse of fertilizers and pesticides, reluctant in beekeeping, deforestation, loss of natural vegetation, increased commercial agriculture, use of high yielding varieties and; many other abiotic and biotic factors (Devkota, 2013). The present mustard production practice under study could be treated as one of the important pollinator friendly practices as it has extended flowering period, mass flowering characteristics and good forage for bees and other natural pollinators.

Farmers might use the resources rationally but not at the economic optimum level, which is mainly due to inadequate knowledge on resource optimization. As the aim of every agribusiness firm is to maximize profit whiles minimizing cost, it is pertinent to determine the efficiency of resource use. Furthermore, future of mustard production in the study area depends very much on the awareness of its profitability and resources use efficiency in the context of growing

competitive crops in winter season, especially with vegetable crops. Keeping this in view the study was undertaken to determine profitability and resource use efficiency of mustard production for the promotion of livelihood of growers and forages for pollinators.

Materials and Methods

Study area and sampling design

The study was conducted at Chitwan district in Nepal where, Global Pollination Project (GPP-FAO) was successfully implemented for five years (2009-2014). Six Village Development Committees (VDCs) namely Padampur and Jutpani from eastern Chitwan; Phulbari and Mangalpur from Central Chitwan; and Meghauli and Sukranagar from Western Chitwan were selected randomly. These VDCs were among the nine VDCs of GPP-FAO conducted in the district. Eastern part of Chitwan is more popular in mustard production. Two farmers' group formed under GPP for the promotion of pollination friendly practices, with size of twenty five members in each group were randomly selected from each VDC. Thus a total of 50 farmers from each VDC and 300 farmers in total were the number of farmers selected for study on different pollinator friendly agricultural practices adopting by farmers. These 300 farmers were studied for ten common pollinator friendly practices among them 159 were mustard growers. Primary data was collected with the use of structured interview schedule using face to face interview technique in April, 2014. After the collection of necessary information it was coded and entered in SPSS data entry sheet and analyzed by using STATA 12.

Cost and Return Analysis

All variable inputs like human labor, tractor labor, seed, inorganic fertilizers, irrigation, pesticides and organic manures were considered and valued at current market prices to calculate cost of production.

$$\text{Total variable cost} = C_{labor} + C_{tractor} + C_{seed} + C_{fert} + C_{irri} + C_{pesti} + C_{manure}$$

Where,

C_{labor} = Cost on human labor used (NRs./ha), $C_{tractor}$ = Cost on tractor labor used (NRs./ha), C_{seed} = Cost on seed (NRs./ha), C_{fert} = Cost on inorganic chemical fertilizers (NRs./ha), C_{irri} =Cost on irrigation (NRs./ha) C_{pesti} = Cost on pesticides (NRs./ha) and C_{manure} = Cost on organic manures (NRs./ha)

Gross return was calculated by multiplying the total volume of output from mustard by the average price at harvesting period (Dillon and Hardaker, 1993). Furthermore, undiscounted benefit cost ratio was estimated as a ratio of gross return and total variable cost. Similarly, gross margin calculation was done to have an estimate of the difference between the gross return and variable costs. Gross margin was calculated by using the method as given by Olukosi *et al*. (2006) using following formula;

Gross Margin (NRs./ha) = Gross return (NRs./ha) - Total variable cost (NRs./ha)

Analysis of Resource Use

Cobb-Douglas type of production function was used to determine the contribution of different inputs on production and to estimate the efficiency of the variable production inputs in mustard production. Cobb-Douglas production function of the following form was fitted to examine the resource productivity, efficiency and return to scale.

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

Where, Y= Gross return (NRs./ha), X_1= Cost on human Labor (NRs./ha), X_2= Cost on tractor labor (NRs./ha), X_3= Cost on seed (NRs./ha), X_4= Cost on sources of plant nutrients (NRs./ha), X_5= Cost on irrigation and pesticides (NRs./ha), e=Base of natural logarithm, u = Random disturbance term, a=Constant, and b1, b2, ..., b5=Coefficients of respective variables.

For the calculation of return to scale on mustard production, coefficients from linearised Cobb-Douglas production function was used and calculated by summing coefficients of all explanatory variables.

The allocative efficiency of a resource used was determined by the ratio of Marginal Value Product (MVP) of variable input and the Marginal Factor Cost (MFC) for the input and tested for its equality to one i.e. (MVP/MFC)=1 . Following Goni *et al*. (2007) the efficiency of resource use was calculated as;

$$r = MVP/MFC$$

Where, r= Efficiency ratio, MVP= Marginal value product of a variable input and MFC= Marginal factor cost. Furthermore, MVP= dy/dx, which is the product of regression coefficient with ratio of geometric mean of gross return to the level of use of respective resource.

Again, the relative percentage change in MVP of each resource required to obtain optimal resource allocation, i.e. r=1 or MVP= MFC was estimated using the following equation below;

$$D = (1 - MFC/MVP) \times 100$$

Or, $D = (1 - 1/r) \times 100$

Where,

D= absolute value of percentage change in MVP of each resource, and

r = efficiency ratio (Mijindadi, 1980)

Results and Discussion

Cost of Production

Human labor was an important and largely used input in the production of mustard. The cost of human labor in mustard production per hectare was estimated at about NRs. 12277. Labor cost accounted about 33% of total variable cost in mustard production. It has shown that mustard production activity in the study area is labor intensive. In the study area, all the farmers used tractor as tillage equipment for their land preparation. Per hectare costs of tractor was about NRs. 8273, which accounted about 22% of total variable cost of mustard production. Per hectare costs of organic manures was about NRs. 8899 which constituted about 24% of the total variable cost (Table 1).

Almost all the farmers used chemical fertilizers, mainly urea, DAP and micronutrients. Per hectare costs of inorganic fertilizer was estimated at about NRs. 3764, which accounted about 10% of total variable cost. Mustard growers use mainly insecticides to control aphids, which was the most severe problem of mustard production in the study area. As regards the production of mustard, the per hectare cost on seed accounted NRs. 1402, which constituted about 4% of total variable cost of production (Table 1).

Table 1: Average cost of mustard production (NRs./ha)

Items of cost	Mean	Percent of total cost
Human labor	12276.63	33.30
Tractor labor	8272.98	22.44
Seed	1402.23	3.80
Organic manures	8898.53	24.13
Inorganic fertilizers	3763.65	10.21
Pesticides	1357.45	3.68
Irrigation	898.97	2.44
Total cost	36870.44	100.00

Source: Field survey 2014

Returns from Mustard Production

Farmers in the study area were growing mustard on an average at 0.30 hectare of land with per hectare physical volume of output as 0.81 ton (Table 2). The average farm gate price of mustard was NRs. 65 per kilogram. Per hectare gross return and total variable cost were estimated at about NRs. 52635 and NRs. 36870, respectively. Per hectare gross margin of mustard production was estimated at about NRs. 15765. Cost and gross margin were also estimated on per kilogram basis and they were estimated at NRs. 45.53 and NRs. 19.47, respectively. It was observed that the overall undiscounted benefit cost ratio considering total variable cost was 1.43. Thus, it was found that mustard production was profitable in the study area.

Table 2: Economic statement of mustard production in the study area

Measuring criteria	Average value
Area (ha.)	0.30
Productivity (t/ha)	0.81
Average revenue (NRs./kg)	65.00
Gross return (NRs./ha)	52635.13
Total variable cost (NRs./ha)	36870.44
Gross margin (NRs./ha)	15764.69
Average cost (NRs./Kg)	45.53
Average gross margin (NRs./kg)	19.47
Benefit cost ratio	1.43

Source: Field survey 2014

Resource Use Efficiency on Mustard Production

Estimated values of the coefficients and related statistics of Cobb-Douglas production function are shown in Table 3. Out of five independent variables included in regression analysis human labor cost, tractor cost, nutrient cost and irrigation cum fertilizer cost were significant at 1% level. The regression coefficient for human labor cost was 0.235, which had depicted that with 100% increase in cost on human labor, gross return could be increased by about 24%. Similarly, with the increase in tractor cost by 100%, gross return from mustard could be increased by about 29% as its coefficient is 0.289, which might be resulted from the higher productivity contributed due to more number of primary tillage. Other inputs used in mustard production namely nutrient cost and irrigation cum fertilizer cost could increase the gross return by about 32% and 5%, respectively with the increase in their use by 100%. Similar to this, Rabbani *et al*. (2013) using revenue type of Cobb- Douglas production function reported human labor, power tiller, fertilizer, irrigation and insecticide costs as significant factors on mustard production in Bangladesh. Results also in consonance with the findings from Wongnaa and Ofori (2012), who have reported significant positive contribution of labor, fertilizer and pesticide on the production of cashew in Ghana.

Table 3: Estimated value of coefficients and related statistics of Cobb-Douglas production function of mustard production

Factors	Coefficient	Std. Error	t-value
Constant	1.732**	0.425	4.07
Human labor cost (NRs./ha)	0.235**	0.082	2.85
Tractor cost (NRs./ha)	0.289**	0.081	3.53
Seed cost (NRs./ha)	0.145	0.088	1.64
Nutrient cost (NRs./ha)	0.323**	0.050	6.45
Irrigation cum pesticide cost (NRs./ha)	0.046**	0.010	4.29
F-value	107.76**		
R square	0.787		
Adjusted R-square	0.774		
Return to scale	1.038		

Note: **Significant at 1% level of confidence

Source: Field survey 2014

Table 4: Estimates of measures of allocative efficiency of inputs used in mustard production

Inputs	Geometric mean	Coefficient	MVP	MFC	MVP/MFC	Efficiency	Percent adjustment required
Human labor cost (NRs./ha)	11547.58	0.235	1.039	1.00	1.039	Under utilized	3.741
Tractor cost (NRs./ha)	7892.00	0.289	1.869	1.00	1.869	Under utilized	46.501
Seed cost (NRs./ha)	1339.74	0.145	5.525	1.00	5.525	Under utilized	81.900
Nutrient cost (NRs./ha)	2663.23	0.323	6.191	1.00	6.191	Under utilized	83.848
Irrigation and pesticide cost (NRs./ha)	151.25	0.046	15.526	1.00	15.526	Under utilized	93.559

Source: Field survey 2014

The sum of the regression coefficients of different inputs stood at 1.038 for mustard production. This indicates that the production function exhibited a increasing return to scale implies that if all the inputs specified in the function are increased by 100%, income will increase by about 104%. Similar to this Wongnaa and Ofori (2012), Saikumar *et al.* (2012) and Goni *et al.* (2007) have found the increasing return to scale on cashew production, tank command farming system and rice, respectively in Ghana, India and Nigeria. The result is contrary to the findings of Obasi (2007), Wosor and Nimoh (2012) and Rabbani *et al*. (2013) who have reported decreasing return to scale on arable crops, chilli and mustard production, respectively.

The estimated MVP of different inputs used in mustard production is presented in Table 4. Given the level of technology and prices of both inputs and output, the study revealed that ratio of MVP to MFC of all the factors of production were positive and greater than one, indicated their under-utilization. It had implied that more profit could be obtained by increasing on their level of use. Study result showed that the efficiency ratio for human labor cost was near to one and had revealed that it is optimally utilized in practical sense. Result agrees with the findings of Ibrahim and Ayinde (2013) for fertilizers and insecticides, and; Gani and Omonana (2009) for seed, labor and fertilizer inputs.

The adjustment in the MVPs for optimal resource use in Table 4 indicated that for optimal allocation of resources, tractor, seed and nutrient cost were required to increase by about 47%, 82% and 84% respectively. The increase in the cost on seed has suggested for more expenditure on seed to purchase improved seed as compared with the own farm produced seed. The irrigation and fertilizer costs were required to increase by approximately 94%. Similar results of underutilization of fertilizer, seed and labor was assessed by Gani and Omonana (2009) on the production of maize in Nigeria. Chapke *et al*. (2011) also reported that for optimum allocation of resources about 88% increase in fertilizer and more than 30% increase in agrochemicals was needed for sorghum production in India but the results disagrees with the findings for adjustment on irrigation and seed inputs in the same study.

Arriving to the concluding remarks, the study showed that mustard production is a reasonably profitable enterprise, although its productivity is still low. Possible reason for underutilization of production inputs. However, optimum economic advantage from per hectare of land can be realized by increasing the level of resources applied to mustard production principally tractor power along with manures, fertilizers, improved seeds and pesticides. As mustard is pollinator dependent crop, judicious use of inorganic pesticides in terms of type, dose, frequency and timing of application is advised. The level of adjustments for use of various resources to earn optimum returns will serve as a bench-mark guideline for the mustard growers in the area, government agencies, and agro-based companies. Thus if proper uses of resources could be ensured, mustard production could be a more viable and attractive commercial enterprise for the promotion of food, income, forage for pollinators and import substitution.

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References

Chapke RR, Mondal B and Mishra JS (2011) Resource use efficiency of sorghum production in rice- fallows in Andhra Pradesh. *Ind. J. Human Ecol.* **34**(2): 87-90.

Devkota K (2012) Economics of pollination and pollination management practices in Chitwan district, Nepal. M.Sc. thesis. Tribhuvan University, IAAS, Chitwan, Nepal.

Dillon JL and Hardaker JB (1993) Farm management research for small farm development. Food and Agriculture Organization of the United Nations, Rome.

Gani BS and Omonona BT (2009) Resource use efficiency among small scale irrigated maize producers in Northern Taraba State of Nigeria. J. *Human Ecol.* **28**(2): 113-119.

Goni M, Mohammed S and Baba BA (2007) Analysis of resource use efficiency in rice production in the Lake Chad area of

Borno State, Nigeria. *J. Sust. Devt. in Agri. and Envt*. **3**(2): 31-37.

Goni M, Umar M and Sman M (2013) Analysis of resource-use efficiency in dry season vegetable production in Jere Borno State, Nigeria. *J. Bio. and Agri. Health* **3**(19): 18-23.

Gordon J and Davis L (2003) Valuing honeybee pollination. Rural Industries Research and Development Corporation. Publication No. 03/077.

Ibrahim U and Ayinde BT (2011) Efficiency of resource use in hybrid and open pollinated maize production in Giwa Lga of Kaduna State, Nigeria. Int. J. *Libyan Agri. Res. C.* **2**(5):215-220.

Majumder MK, Mozumdar L, and Roy PC (2009) Productivity and resource use efficiency of Boro rice production. *J. Ban. Agri. Uni.* **7**(2):247-252.

Mijindadi NB (1980) Production efficiency on farms in northern Nigeria. PhD dissertation. Cornell University, USA.

MoAD (2012) Statistical Information on Nepalese Agriculture (2010/2011). Ministry of Agriculture Development. Agribusiness Promotion and Statistics Division (ABPSD), Kathmandu, Nepal.

Obasi PC (2007) Farm size and productivity relationship among arable crop farmers in Imo state, Nigeria. *Int. J. Agri. and Rural Devt* **9**(91): 91-99. DOI: 10.4314/ijard.v9i1.2673

Olukosi JO, Isitor SU and Ode MO (2006) Introduction to agricultural marketing and prices: principle and application. *American J. Agri. and Forestry* **2**(4): 199-205.

Partap T (2001) Mountain agriculture, marginal land and sustainable livelihoods: Challenges and opportunities. International Symposium on Mountain Agriculture in HKH Region (May 21-24, 2001). International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.

Prasai HK and Yadav HN (1999) Performance evaluation of mustard at Banigama, Morang. Annual report, Regional Agriculture Research Station, Tarahara, Nepal, 141-143.

Pudasaini R and Thapa RB (2014) Effect of pollination on rapeseed (*Brassica Campestris* L. Var. Toria) production in Chitwan, Nepal. *The J. Agri. and Envt.* **15**: 41-45.

Rabbani MG, Sheema AA, Islam MS and Hasan HK (2013) Profitability and resource use efficiency of mustard production: evidence of farmers' practices in Mymensingh District of Bangladesh. *Int. J. App. Research in Business Admin. and Econ.* **2**(3): 37-46.

Saikumar C, Bharamappanavara SM, Mundinamani BK, Naik and Kiresur VR. (2012) Resource use efficiency and constraints in farming in the tank commands: the case of north eastern Karnataka. *J. Rural Devt.* **32**(3): 311-320.

Verma LR (1999) Beekeeping in integrated mountain development: economic and scientific perspectives. ICIMOD senior fellowship series, No. 4. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi, India.

Wongnaa CA and Ofori D (2012) Resource-use efficiency in cashew production in Wenchi Municipality, Ghana. *Agris On-line Papers in Economics and Informatics* **4**: 73-80.

Wosor DK and Nimoh F (2012) Resource use efficiency in chili pepper production in the Keta municipality of Volta Region of Ghana. *J. Elixir Prodn. Mgmt.* **47**: 8595-8598.