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Resource Use Efficiency of Wheat Seed Production: A Case from Chitwan, Nepal

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ABSTRACT

Wheat is staple food for more than thirty percent of the world population and is also a rich source of minerals, proteins, vitamins and dietary fibers. Quality seed is the major reason behind the low productivity of wheat in Nepal. The study was design to investigate the cost, return, and resource use efficiency of wheat seed production in Chitwan district of Nepal. The study used 160 randomly sampled sample of wheat seed producer. Cobb-Douglas production function and benefit cost ratio were used to estimate the resource use efficiency during wheat seed production through data collected using semi-structured interview schedule to meet the objective. The average total cost of wheat seed production with subsidy was NRs. 59440 per hectare and average total cost of wheat seed production without subsidy was NRs. 60731 per hectare. The yield in study area was found 2771.02 kg. The return, profit with subsidy and profit without subsidy from wheat seed production was NRs. 69275.49, NRs. 9835.04 and NRs. 8544.46 in the study area respectively. The benefit cost ratio of wheat seed production in the study area with subsidy was found 1.31 and 1.28 without subsidy. The wheat seed production was found increasing return to scale (RTS = 1.106) in the study area. Seed and Machine were underutilized and other inputs like Farmyard Manure (FYM), chemical fertilizer, labor and other cost were over utilized while producing wheat seed in Chitwan district. The study revealed we can increase profit by optimization of input uses.

INTRODUCTION

Wheat (*Triticum aestivum L.*) is one of the most widely cultivated cereal crop in the world (Este, 2012). Wheat is ranked as 3rd (1st paddy, 2nd Maize) important crop in terms of area cultivated in Nepal. Wheat generally grown as a winter crop in the Hills and the Terai and as summer crop in the Mountains. The area, production and productivity of wheat in Nepal are 753470 ha, 1811889 Mt and 2.40 $Mtha^{-1}$ (MoAD, 2016). It is the major dominant crop of cold temperate region which contributes as source of calories

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to more than 50 precent of world population (Grewal & Goel, 2015). Wheat is main food of the world population and is also rich source of minerals, proteins, vitmins and dietary fibers (Kumar et.al., 2011). The protein content in wheat is higher than other cereals like maize, rice and sorghum (Khan, 1984) which is considered as an important crop that contribute in food security of the world. Many different international organisation has been working on the field of wheat and wheat seed production to combat the food insecurity of world. Majority of the Hill districts are prone to food insecurity, replacing the feeding habit by wheat which can play important role in food security (Kiss, n.d).

The present status of agriculture is at very low developing stage however the adoption of improved technology has been increasing but the rate of adoption is at very slow rate (MoAD, 2015). The government intervention on technology directly affects the farmer perception on adoption of the technology. Nepal has suitable agro-climatic zones for seed production of various crops. Despite the great importance of wheat in food security, the productivity of wheat is very low in Nepal which is 2.5 metric ton per hectare as compared to India and Pakistan which is 3.1 and 3.30 metric ton per hectare respectively (Vijayaraghavan et.al, 2018).

Different research shows that the major constraint to the achievement of national level food security is low productivity (Mc Carthy, et al., 2018; Bekrum, et.al., 2018). Only increased in the land-use does not increases the profit from agricultural production but it can be increased through the efficient use of resource for optimum production and improving the productivities plays important role in food security. Improvement of productivity can be done by either improvement in technology or enhancement in the efficiency of the resources used. Farmers of Nepal have little or no knowledge of rational use of resources at its economical level (Dhakal, Regmi, Thapa, Sah & Khatri- Chetri, 2015). The study by Barmon and Islam (2017) found that farmers had faced decreasing return to scale in wheat production which shows there were further opportunity to increase wheat production using more chemical fertilizers, manure, pesticides and seeds. Optimization of resources use in production of the rice can fulfilled the increasing demand of the rice (Osti, Rizwan, Assefa, Zhou & Bhattrai 2017). Most important driver to increase the output of the products of poor farmers is the resource-use efficiency in developing nations (Goni, Umar, & Usman, 2013).

METHODS

This study was focused in Chitwan district of Nepal because it is one of the major wheat seed producing district of Nepal. The practice of wheat seed production is found good with better recommended practice suggested by District Agriculture Development Office (DADO) and NARC

station situated at Rampur, Chitwan and some private companies (*Unnat bigbridhi krishak samuha* and *New Shree Ram Seed Company)* situated at the district.

The list of 655 farmers growing wheat for seed purpose was identified with the help of DADO of Chitwan and cooperative seed company *Unnat bigbridhi krishak samuha* and *New Shree Ram Seed Company* of western Chitwan. Due to time and budget constraints, it was impossible to collect the information from whole population. So, scientific sampling procedure was adopted to collect the sample size. The appropriate sampling method help to reduce the errors and also minimize the cost of the study and gives acceptable results. Simple random sampling method was used to collect sample from sampling frame to reduce the sampling errors during study. The total farmers involved in wheat seed production were 655, out of these the total of 160 samples were selected for the study which represents the 24.42 percent of the total population size. Random sampling without replacement technique was used to avoid the bias in selection of sample.

The primary data was collected by face-to-face interview with the respondent using pretested questionnaire. FGD checklist was used to conduct focus group discussions to validate the responses. Secondary data and other relevant information for this study was collected from bulletins, books, journals, publication from district office of respective site, reports from the Ministry of Agricultural Development (MoAD), Central Bureau of Statistics (CBS), DADO, Community Based Organizations (CBOs), private companies and cooperatives etc.

Analysis of cost and benefit of wheat seed production

The variable costs incurred in the production of wheat seed was used to calculate the cost of production. The variable costs such as farm expenditure on seed, farmyard manure (FYM), chemical fertilizers, human labor, bullock labor or tractor, cost on pesticides and postharvest handling, etc. The total cost of production was calculated by adding all expenditure on variable inputs as below.

$$\text{Total variable costs} = C_{seed} + C_{labor} + C_{FYM} + C\text{-----}_{cf} + C_{pesticides} + C_{machine} + C_{irrigation} + C_{other}$$

Where C_{seed} = Cost of seed per hectare (NRs.); C_{labor} = Cost of labor per hectare (NRs.); C_{FYM} = Cost of FYM per hectare (NRs.); $C\text{-----}_{cf}$ = Cost of chemical fertilizer per hectare (NRs.); $C_{pesticides}$ = Cost of pesticides per hectare (NRs.); $C_{machine}$ = Cost of machine (tillage +harvest) per hectare (NRs.); $C_{irrigation}$ = Cost of irrigation per hectare (NRs.); and C_{other} = other cost of cultivation (grading, packaging, transportation, etc.) per hectare (NRs.).

Gross margin analysis

It is the simple and quickest method for analysis of farm business.

It is the difference between the gross return and the total variable cost incurred.

Gross margin = Gross revenue – total variable cost

Where gross revenue = revenue from seed and grain + revenue from straw = (Total volume of outputs of wheat seed * Price of wheat seed at harvesting period) + Total volume of non-seed wheat * Price of non-seed at harvesting period) + (Total volume of outputs of wheat straw * Price of wheat straw at harvesting period).

Benefit-Cost ratio (B/C ratio)

The purpose of cost and benefit analysis is to find the investment made on the resources that will yield a reasonable return to the resources engaged (Adhikari, 2011). Benefit cost ratio is assumed as a quick and one of the easiest methods in evaluating the economic performance of any farm. B/C ratio compares the benefit per unit of cost. Thus, B/C ratio was calculated out by using the following formula:

$$B/C\ ratio = \frac{Gross\ \text{revenue}(NRs.)}{Total\ variable\ cost\ (NRs.)}$$

Determination of efficiency ratios (Cobb-Douglas production function)

The efficiency of resources (various inputs) used in wheat seed production was estimated by using Cobb-Douglas production function. Marginal Value Product (MVP) of each input was calculated based on the regression coefficient of each input. The efficiency ratio is estimated as the ratio of MVP to the Marginal Factor Cost (MFC). The method to estimate over utilized and under-utilized of resources were based on marginal value following Ali et al. (2017).

The Cobb-Douglas production function is:

$$Y = aX_i^{b_i}$$

Where, X is input, Y is output and a is intercept.

By taking natural logarithm on both side, we get:

$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + \ldots\ldots + b_7 \ln X_7$

Where, Y= Total income from wheat seed production (NRs.); X_1= Total seed cost (NRs.); X_2= Total FYM (NRs.); X_3= Total chemical fertilizer cost (NRs.); X_4=Total cost of tillage (NRs.); X_5=Total cost of Harvest (NRs.); X_6= Total cost of management (NRs.); X_7=other cost of cultivation (transportation, irrigation, chemical pesticides, grading, packaging).

The efficiency ratio was calculated by using formula:

$$r = \frac{MVP}{MFC}$$

r = efficiency ratio

$MVP_i = b_i * Y/X_i$

Where b_i = Estimated regression coefficients; Y = Geometric mean of total income form wheat seed production; X_i= Geometric mean of i^{th} inputs; MFC = Marginal factor cost.

The decision about the under-utilization, over utilization and efficient utilization of a particular input resource is taken by using following rule. If r = 1 or MVP=MFC, it indicates efficient utilization. If r <1 or MVP<MFC, it indicates over utilization. If r > 1 or MVP>MFC, it indicates under-utilization.

RESULTS AND DISCUSSION

The major inputs applied for wheat seed production were categorized and described below in Table 1. The average seed used in the field was 128.68 kg in the study area. Similarly, the average FYM, chemical fertilizer, tillage by a tractor, harvest by combine harvester, labor used for management was found 13,485.66 kg, 152.02 kg, 5.74 hours, 1.5 hours and 22.11 days respectively in the study area (Table 1).

None of the inputs were significantly different in both type of seed except man days used for management of the filed or labor used which was higher in certified seed producer (23.36 days) than foundation seed producer (17.64 days) (Table 1). The reason for higher labor used in certified seed producer may be due to seed purity which is lower than foundation seed so extra days used in field inspection, roughing etc.

The various cost involved in the wheat seed production was collected and they were categorized into seven categories: seed cost, FYM cost, Chemical fertilizer cost, tillage cost, harvest cost, management cost and other cost as shown in Table 2.

The result revealed that the average total cost of wheat seed production with subsidy was NRs. 59,400 per hectare and average total cost of wheat seed production without subsidy was NRs. 60,731 per hectare (Table 2). The average total cost of certified seed grower (NRs. 60,081) was higher than the

Table 1. Inputs in wheat seed production by seed class per hectare

Variable	Overall	Seed Class		Mean difference	t-value	p-value
		Foundation	Certified			
Seed (Kg)	128.68 (24.06)	126.87 (23.16)	129.19 (24.36)	-2.32	-0.50	0.614
FYM (Kg)	13,485.66 (868.23)	13,383.49 (1589.53)	13,514.26 (1021.401)	-130.77	-0.06	0.950
Chemical Fertilizer (Kg)	152.02 (6.08)	142.04 (14.04)	154.80 (6.72)	-12.76	-0.87	0.387
Tillage tractor (hour)	5.74 (0.17)	5.21 (0.34)	5.88 (0.20)	-0.69	-1.60	0.110
Harvest (Hour)	1.50 (0.04)	1.37 (0.08)	1.52 (0.05)	-0.15	-1.63	0.105
Management (MD)	22.11 (0.99)	17.64 (1.67)	23.36 (1.16)	-5.72	-2.42**	0.016

Source: (Survey, 2017)

Note: Figures in parentheses indicates standard deviation. *, ** and *** indicates the significant at 10%, 5%, and 1% respectively.

Table 2. Cost of wheat seed production by class of wheat seed (per hectare

Variable	Overall	Seed Class		Mean Difference	t-value	p-value
		Foundation	Certified			
Seed cost with subsidy	73,56.3 (13,89.66)	7,329.50 (1,413.73)	7,363.8 (1,388.51)	-34.2675	-0.129	0.898
Seed cost without subsidy	8,646.9 (1,633.46)	8,615.4 (1,661.76)	8,655.7 (1,632.11)	-40.2794	-0.129	0.898
FYM	20,199 (15,200)	20,290 (12,703.94)	20,174 (15,874.44)	116.3491	0.04	0.968
Chemical fertilizer	5,290.8 (2,631.64	4,916 (2,909.57)	5,395.7 (2,551.15)	-479.695	-0.953	0.342
Tillage	8,250.2 (2,722.67)	7,894.7 (2,495.84)	8,349.8 (2,784.18)	-455.039	-0.873	0.384
Harvest	8,305.6 (2,914.70)	7,351.4 (3,009.35)	8,572.8 (2,842.76)	-1221.38	-2.218**	0.028
Management	5,031.9 (2,491.56)	4,532.7 (2,486.84)	5,171.6 (2,484.83)	-638.905	-1.344	0.181
Other	5,006.3 (3,868.89)	4,838 (3,166.52)	5,053.4 (4,053.85)	-215.373	-0.29	0.772
Total with subsidy	59,440 (21,193.09)	57,153 (18,921.81)	60,081 (21,814.23)	-2928.32	-0.721	0.472
Total without subsidy	60,731 (21,233.92)	58,439 (19,033.80)	61,373 (21,838.24)	-2934.33	-0.722	0.472

Source: (Survey, 2017)

foundation seed grower (NRs. 57,153) with subsidy per hectare. Similarly, the average total cost of wheat seed production without subsidy was also higher in certified seed grower (NRs. 61,373) than foundation seed grower (NRs. 58,439)per hectare. The seed company provides NRs. 15 subsidy per kg of seed.

From the result of analysis, it was found that average cost of seed with subsidy from Seed Company was found NRs. 7,356.3 per hectare. Similarly, the average cost of seed per hectare without subsidy was found NRs. 8,646.9. The average cost of FYM, Chemical fertilizer, cost of tillage, cost of harvest, cost of management and other cost were NRs. 201,099, 5,290.8, 8,250.2, 8,305.6, 5,031.9, and 5,006.3 per hectare respectively (Table 2).

Both seed cost, i.e with subsidy and without subsidy, was found higher in certified seed grower (NRs. 7,363.8, 8,655.7) than foundation seed grower (NRs. 7,329.5, 8,615.4) per hectare respectively. Similarly, the FYM cost was found higher in foundation seed grower (NRs. 20,290) than certified seed grower (NRs. 20,174) per hectare. Also, the chemical fertilizer cost was higher in certified seed grower (NRs. 5,395.7) than foundation seed grower (NRs. 4,916) per hectare. The average cost of harvest using combine harvester was found higher in certified seed

grower (NRs. 8,572.8) than foundation seed grower (NRs. 7,351.4) per hectare. The average management cost per hectare was also found higher in certified seed grower (NRs. 5,171.6) than foundation seed grower (NRs. 4,532.7). Similarly, the average other cost of cultivation of wheat for seed was also higher in certified seed grower (NRs. 5,053.4) than foundation seed grower (NRs. 4,838) per hectare. The difference of all cost except the cost of harvest using combine harvester were not significantly differ between foundation seed grower and certified seed grower. However, the cost of harvest using combine harvester was found statistically differ at 5 percent level of significant between foundation seed grower and certified seed grower. The result is similar to the study conducted in Kavre, Nepal which found the average cost of wheat cultivation per ha was NRs. 59,268.00 (Dhital, 2017). The average cost of cultivation of wheat in India was Re 45,784.31 which was higher than cost of cultivation of wheat in Nepal (Sureshkumar et al., 2014). The cost of cultivation of wheat per hectare of cost was Rs. 37,235.99 (Agam et al., 2017). According to MoAD (2017), the average cost of cultivation of wheat in Chitwan was Rs. 70,212.50 and average cost of cultivation of wheat in Nepal was Rs. 62,136.79.

The total production of wheat seed comprises the amount of quality seed and amount of grain (not suitable for selling as a seed). From Table 3, it is revealed that average production of wheat seed was found 1281.87 kg per household of the study area. The average production of foundation seed (1,905.71 kg) was higher than the certified seed (1,107.28 kg). The difference between foundation seed production and certified seed production was statistically significant at 1 percent level of significant.

Similarly, the yield (kg seed per hectare) was found 2,771.02 kg. The yield of foundation seed (3,101.92 kg) was also higher than certified seed (2,678.36 kg) and the difference was also significant at 1 percent level of significant. Seed quality may be the reason for higher production and yield of foundation seed. Similar result was found in the

Table 3. Production and yield of wheat seed (kg) by seed class

Variable	Seed class			Mean Difference	t-value	p-value
	Overall	Foundation	Certified			
Production (kg)	1,281.87 (1,384.16)	1,905.71 (1,467.68)	1,107.28 (874.89)	798.51	3.099***	0.002
Yield(kg/ha)	2,771.02 (615.93)	3,101.92 (620.58)	2,678.36 (584.21)	423.55	3.739***	0.000

Source: (Survey, 2017)

Note: Figures in parentheses indicates standard deviation. *, ** and *** indicates the significant at 10 %, 5 %, and 1 % respectively.

study conducted by Khan et al. (2015) in Bangladesh. Year of experience in wheat seed production, training on wheat seed production was higher in founder seed producer which may be the reason for higher yield and production. The result is similar to the national average profit of wheat cultivation of wheat in Nepal which is NRs. 26,985.34 (MoAD, 2017). The study conducted by Mehmood et al. (2014) found gross return from the wheat grain per acre was Rs. 45,315.39, which was similar to this study.

Profit loss analysis

The revenue of wheat from quality seed and seed for household consumption and feed purpose was estimated. The profitability from wheat seed production was determined by subtracting the grand total cost from total revenue. The revenue and profitability with and without subsidy from wheat seed production was NRs. 69,275.49, NRs. 9,835.04 and 85,44.46 per ha in the study area, subsidy from wheat seed production was NRs. 69,275.49, NRs. 9,835.04 and 85,44.46 per ha in the study area, respectively. The revenue from the wheat seed found higher in foundation seed grower (NRs. 77,548.01) than the certified seed grower (NRs. 66,959.18). The difference was found significant at 1 percent level of significance. Similarly, the profit with subsidy was also found higher in foundation seed grower (NRs. 20,395.31) then certified seed grower (NRs. 6,878.16). Also, the difference was significant at 1 percent level of significance. Likewise the profit without subsidy was also found higher in foundation seed grower (NRs. 19,109.43) then certified seed grower (NRs. 5,586.27). Also, the difference was significant at 1 percent level of significance.

The benefit cost ratio was computed as the ratio of gross return to the total variable cost involved in wheat seed production. The benefit

Table 4. Returns and profit of wheat seed production by seed class per hectare

Particulars	Overall	Seed Class		Mean Differ-	t-value	p-value
		Foundation	Certified			
Return	69,275.49 (15,398.3)	77,548.01 (15,514.55)	66,959.18 (14,605)	10,588.83	3.739***	0.000
Profit With Subsidy	9,835.04 (27,346.28)	20,395.31 (25,399.87)	6,878.16 (27,234.3)	13,517.14	2.632***	0.009
Profit without Subsidy	8,544.46 (4,268.38)	19,109.43 (25,511.45)	5,586.27 (760.87)	13,523.16	2.629***	0.009

Source: (Survey, 2017)

Note: Figures in parentheses indicates standard deviation. *, ** and *** indicates the significant at 10 %, 5 %, and 1 % respectively.

cost ratio was computed in two cases: with subsidy and with subsidy on wheat seed cost. The overall benefit cost ratio of wheat seed production with subsidy was found 1.31. Similarly, the benefit cost ratio of wheat seed production without subsidy was found 1.28 in the study area.

Case I: With subsidy on seed

The benefit cost ratio of foundation seed grower (1.50) was higher than the certified seed grower (1.26) and the difference was significant at 5 percent level of significance. This indicate that foundation seed growers gain 0.5 paisa on each rupee investment and certified seed grower gain only 0.26 paisa on each rupee investment.

Case II: Without subsidy on seed

The result of benefit cost ratio revealed that the average benefit cost ratio of foundation seed grower was 1.46 which is higher than the certified seed grower (1.23) and the difference was significant at 5 percent level of significance. On each rupee investment by foundation seed grower and certified seed grower, they will gain 0.46 paisa and 0.23 paisa, respectively.

The B:C ratio of the study area was found lower than the national average which is 1.39 (MoAD, 2017). To estimate the effect of cost of various inputs on the total income from wheat seed production, the Cobb-Douglas production function was used. Transformation of the Cobb-Douglas function into linear form by using the natural logarithm for both dependent and independent variables. The Cobb-Douglas production function was estimated using Ordinary Least Square (OLS) method after transformation. The estimated coefficients represent the elasticity of individual inputs. The elasticity's associated with all inputs were more than one for some inputs and less than one for some inputs. So, for inputs with less than one elasticity, a unit increase input would result less than a unit increase in wheat income whereas for inputs with more than one elasticity result in increased more than one. The F-value was 154.54 and it was statistically significant at 1 percent level of

Table 5. Benefit cost analysis of wheat seed production in study area

B:C ratio	Overall	Seed Class Foundation	Certified	Mean Difference	t-value	p-value
With subsidy	1.31 (0.54)	1.50 (0.52)	1.26 (0.53)	0.23	2.307**	0.021
Without subsidy	1.28 (0.51)	1.46 (0.50)	1.23 (0.51)	0.23	2.368**	0.019

Source: (Survey, 2017)

Note: Figures in parentheses indicates standard deviation. *, ** and *** indicates the significant at 10 %, 5 %, and 1 % respectively.

Table 6. Estimates of measures of allocative efficiency of inputs used in wheat seed production

Variable	Coefficient	Standard error	t-value	MVP	MFC	r
Log Seed Cost	0.576	0.075	7.70***	5.38	1	5.38
Log FYM Cost	-0.003	0.005	-0.47	-0.11	1	-0.11
Log fertilizer cost	0.012	0.008	1.40	0.25	1	0.25
Log Machine cost	0.438	0.084	5.24***	1.85	1	1.85
Log mgmt./other cost	0.083	0.059	1.39	0.65	1	0.65
Constant	1.037	0.432	2.39**			

Number of observation	= 160
F(5, 125)	= 154.54***
Prob > F	= 0.0000
R-squared	= 0.8338
adjusted R squared	= 0.8284
Root MSE	= .26699
Return to scale	= 1.160

significance. This indicates that the explanatory variable included in the model were important for the explanation of variation in the wheat income. The R square value was 0.83 which implies that about 83 percent of variation on wheat income was explained by the explanatory variable. The multi-collinearity was checked by using VIF and heteroskedasticity test was done by Breusch Pagon Test found there was no problem.

It was found that 1 percent increase in seed cost would increase the income from wheat by 0.57 percent, keeping other factor constant, and it was found highly significant at 1 percent level of significant. The result was similar to the study conducted by Gautam et al. (2017) and Barmon & Islam (2017) who found that the coefficient of seed cost has positive and significant effect on wheat yield. Similarly, 1 percent increase in cost of machine (tractor for tillage and combine harvester for harvesting) would increase the return from wheat by 0.43 percent, other factors remaining constant, and is statistically highly significant at 1 percent level of significant and the result consistent to the result of Gautam et al. (2017) and Agam et al. (2017).

The cost of FYM has negative effect on wheat seed production whereas the chemical fertilizers have positive effects. Effect of both FYM and chemical fertilizer was found to be statistically insignificant. The return to scale was calculated by adding up the elasticity of individual inputs which was estimated using Cobb-Douglas production function and found 1.160 which implies that there was increasing Return to scale from wheat seed production.

CONCLUSION AND SUGGESTION

The study revealed that wheat seed production is a profitable enterprise with B/C ratio more than one. Foundation seed production was

more profitable than the certified seed production due to higher productivity and return. The profitability of wheat seed production in Chitwan district can be increase by the optimization of resources used during production. The analysis of resource use efficiency reveled all resources were inefficiently utilized. Inputs like seed and machine were underutilized and other inputs like FYM, chemical fertilizers and management and other cost were over utilized. Thus, to obtain economic advantages, farmers are recommended to increase/reduce the inputs used during the production of wheat seed. So, if proper uses of resources could be ensured, wheat seed production could be more profitable and attractive commercial enterprise for promotion of food security, income generation. With the NRs. 15 per kg subsidy on wheat seed can increase the profit from wheat seed production. So, efficient use of factor of production and some sort of subsidies on mechanization would make the wheat seed production more profitable business and also can solve the problem of quality seed in Nepal.

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