Production Economics of Rice in Different Development Regions of Nepal

Niraj Prakash JOSHI
Graduate Student
Graduate School for International Development and Cooperation
Hiroshima University
1-5-1 Kagamiyama, Higashi-Hiroshima, 739-8529 Japan
E-mail: niraj_2008@yahoo.com

Keshav Lall MAHARJAN
Professor
Graduate School for International Development and Cooperation
Hiroshima University
1-5-1 Kagamiyama, Higashi-Hiroshima, 739-8529 Japan
E-mail: mkeshav@hiroshima-u.ac.jp

Luni PIYA
Graduate Student
Graduate School for International Development and Cooperation
Hiroshima University
1-5-1 Kagamiyama, Higashi-Hiroshima, 739-8529 Japan
E-mail: loonypiya@yahoo.com

Abstract

Rice is the most important staple food crop grown in Nepal. This study tries to analyze the production situation and production efficiency of rice in different development regions of Nepal. In this study 480 farmers were selected randomly from 12 districts representing entire five development regions and surveyed using semi-structured questionnaire. This information was supplemented by the information obtained from group discussions, observations and other secondary sources. With average landholding of 1.6 ha/household, 64.6% of the respondents were growing rice under 1 ha of land on an average. Western Development Region dominated all other development regions in terms of average production, marketed amount and yield. The benefit-cost ratio of rice production was the highest in Central Development Region indicating the most efficient production practice in the country. This is mainly due to easy availability and judicious use of production inputs. The overall net profit was Rs 16,147 per ha. The most prominent production problems as perceived by the farmers are lack of technical know-how, lack of irrigation, lack of organized credit facilities, and lack of quality inputs at the time of need. These problems need to be addressed to improve the production situation and efficiency of rice production in the country.

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1. Introduction

Rice, maize, and wheat are three major food crops in Nepal. Among them rice is increasingly becoming the most important staple food crop and is grown in wide range of agro ecological zones under varying climates, altitudes and topography ranging from 60 meters in Tarai to 3050 meters above sea level in Chumchure, Jumla (Bhujel, 2004 and Bista, 2004). It occupies 58% of the country's total cultivated land and 55% of the total food grain production, contributing to 25% of the country's gross domestic product (MOAC, 2005). Thus it dominates the agricultural sector in Nepal.

Many plans and programs were formulated and many operational modalities were experimented for the development of agriculture system including rice production in Nepal. However, the achievements are yet below the satisfactory level resulting into shifting of the country from a net exporter of food grain including rice to a net importer in recent years (Joshi et al., 2010; Maharjan & K. C., 2005; and Agricultural Projects Services Center & John Mellor Associates, 1995). This was mainly due to low rate of increase in agriculture production compared to population growth (Maharjan, 2003). The main factors responsible for this are inadequate supply of various essential inputs like quality fertilizer, improved seed and pesticides, coupled with lack of adequate irrigation facility and knowledge on improved techniques of cultivation. In addition, the poor farming techniques, insufficient incentive to augment production under the traditional system of land tenure (*Mohiyani*[1], share cropping), and lack of agricultural credit and marketing facilities are the factors responsible for this slow growth (Pro public, 2002). Particularly in the case of rice cultivation; irrigation, credit supply, input supply, soil problem, pests and diseases are recognized as the major production problems in Nepal (Television Trust for Environment, 2004).

Considering the importance of rice production in the national economy and the problems faced by farmers, this study aims to assess situation, economics, potentials and constraints of rice production.

2. Methodology

Stratified random sampling technique was used for the selection of 12 districts representing each of the five development regions and three agro-ecological zones (Mountains, Hills and Tarai) based on their potentiality for rice production and accessibility (Figure 1). The Village Development Committees (VDCs) adjoining to the headquarters of the districts were purposively selected for the study. Thus, 40 farmers from the selected VDCs of each of the sampled district were randomly identified with the help of District Agriculture Development Office together with the agriculture service centers and sub centers of the respective districts and VDCs. In total 480 farmers were surveyed in the year 2003 using pre-tested semi-structured questionnaires. These primary data were supplemented by the data and information obtained through observations and informal group discussions and secondary sources, as well.

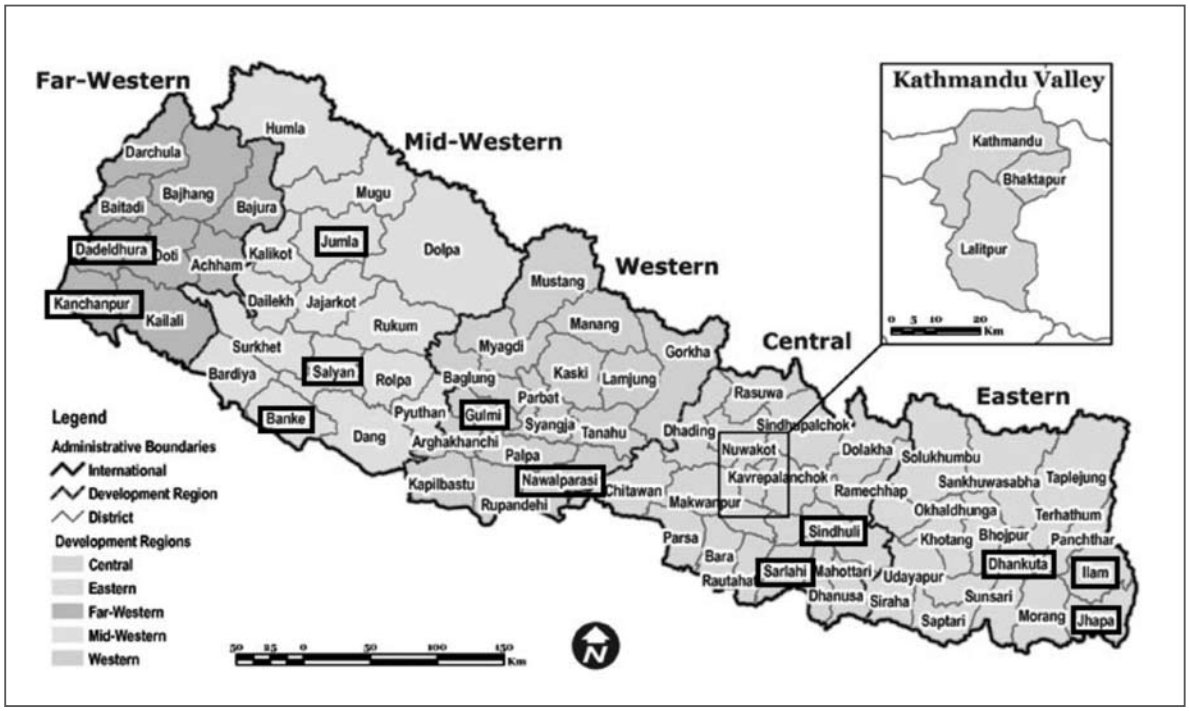

Figure 1: Map of Nepal showing sample districts
Source: http://www.un.org.np/maps/maps.php

Results were summarized using descriptive statistics together with Chi-Square test wherever applicable. Benefit Cost Ratio, and net profit were calculated to assess the production efficiency. The Cobb-Douglas production function (equation 1) was used to estimate the contribution of different independent variables like area, labor, farm yard manure (FYM), tractor use, chemical fertilizer use, irrigation and ecological zone on production (Y_1). In order to get better separation of each component, logs were taken on both sides of Cobb Douglas production function (2).

$$Yi = \beta_0 X_{1i}^{\beta 1} X_{2i}^{\beta 2} \ldots X_{ki}^{\beta k} e^{\mu i} \quad (1)$$

$$\ln Y_1 = \beta_0 + \beta_1 \ln area + \beta_2 \ln lab + \beta_3 \ln FYM + \beta_4 dumtra + \beta_5 dumchf + \beta_6 dumirri + \beta_7 dummount \quad (2)$$

Here, Y_1 represents production of rice (in ton); area = area under rice production (in ha); lab = labor in man-days; FYM = farm yard manure (in *doko*[2]); dumtra = dummy for tractor use (1 for tractor use and 0 for otherwise), dumchf = dummy for chemical fertilizer use (1 for chemical fertilizer use and 0 for otherwise), dumirri = dummy for irrigation (1 for irrigation and 0 for otherwise) and dummount = dummy for mountain region (1 for mountain region and 0 for otherwise), and β_0 is constant, β_1, β_2, … β_7 are coefficient of respective variables.

3. Results and discussion

3.1. Land holding and utilization

The average land holding is 1.5 ha/household (hh), which is higher compared to the national average (0.8 ha).

This is mainly due to the nature of survey concentrated on farmers having more land in order to perceive the problems and potentials of rice production more effectively. Irrigation is crucial for rice production. The average holding of the irrigated land is 0.8 ha, i.e. 52% of land is under irrigation, which in the case of the country is 54% (Central Bureau of Statistics, 2004).

Table 1. Distribution of sample households by rice cultivation

Development region	Sample size	Rice cultivating households	Chi-Square value	P-value
Eastern	120	55 (45.8%)	0.8	0.36
Central	80	54 (67.5%)	9.8	0.02*
Western	80	53 (66.2%)	8.5	0.04*
Mid-Western	120	88 (73.3%)	20.0	0.00**
Far-Western	80	60 (75.0%)	26.1	0.00**
Overall	480	310 (64.6%)	40.8	0.00**

Source: Field Survey 2003.
Note: * and ** indicate significance level at 5% and 1%, respectively.

Majority of (64.6%) the respondents were found to be cultivating rice, which is slightly low compared to the national scenario of 75.4% (Central Bureau of Statistics, 2003). This is mainly due to the expansion of cash crop in the sample areas. The proportion of the farmers growing rice is significant in all development regions except Eastern Development Region (Table 1). Increasing interest of farmers on cash crops like tea, cardamom, broom grass, and ginger resulted into less interest of farmers towards rice cultivation in Eastern Development Region to a greater extent.

3.2. Potentiality of rice production

Rice is an integral part of Nepalese agriculture system. Factors like geography, market, and technology are regarded as important factors in its production. Therefore, potentiality of rice cultivation was measured through the perception of the farmers towards the geographic suitability, market availability and technical service availability. Central Development Region shows the highest potentiality in all aspects of rice cultivation (Table 2).

Table 2: Perception towards potentiality of rice cultivation by development region

Development region	Potentiality	Suitable
Eastern ($n^1 = 55$)	Geographical	37 (67.3%)
	Market	39 (70.9%)
	Technical	14 (25.5%)
Central ($n^3 = 54$)	Geographical	54 (100%)
	Market	53 (98.2%)
	Technical	53 (98.2%)
Western ($n^3 = 53$)	Geographical	53 (100%)
	Market	49 (92.5%)
	Technical	40 (75.5%)
Mid-Western ($n^3 = 88$)	Geographical	76 (86.4%)
	Market	62 (70.5%)
	Technical	65 (73.9%)
Far-Western ($n^3 = 60$)	Geographical	48 (80.0%)
	Market	48 (80.0%)
	Technical	59 (98.3%)

Source: Field Survey 2003.

From the perspective of geographical suitability, Central Development Region and Western Development Region were perceived as the most potential development regions. This is mainly due to the easy access to market in these development regions. Technically, Far-Western Development Region and Central Development Region have high potential for rice production. Timely availability of production inputs and frequent contact with extension workers, who help the farmers to make judicious use of those inputs, are the main reasons to perceive these development regions to have the technical potential.

3.3. Knowledge and use of improved rice production technology

Due to lack of knowledge about the improved technology, most respondents are using inputs of improved technology in injudicious ways. This led to the inefficient use of those inputs. Only 5.2% of the respondents were found to have proper knowledge on improved technology though 41.6% are using it (Table 3). Therefore there is a potentiality to increase rice production by regulating the use of existing inputs by providing proper knowledge on their rational use to the farmers. Knowledge and usage of these inputs is the highest in the Central Development Region.

Table 3: Knowledge and use of local and improved rice production technology

Development region	Attributes	Improved
Eastern	Knowledge	2 (3.6%)
	Usages	11 (20.0%)
Central	Knowledge	4 (7.4%)
	Usages	31 (57.4%)
Western	Knowledge	2 (3.8%)
	Usages	20 (37.7%)
Mid-Western	Knowledge	6 (6.8%)
	Usages	46 (52.2%)
Far Western	Knowledge	2 (3.3%)
	Usages	21 (35.0%)
Overall	Knowledge	16 (5.2%)
	Usages	129 (41.6%)

Source: Field Survey 2003.

3.4. Input use situation

Seed, labor, draft power, tractor, FYM, chemical fertilizer, irrigation, pesticide and farm equipments like sickle, plough, spade, etc. are the major inputs used for cultivation of rice besides land. Labor is the most important input for rice production right from the preparation of seedbed to harvesting and threshing. All together 86.9 labor man-days are involved in production of rice in 1 ha, of which 36.5 are male and 50.4 are female. This signifies that rice cultivation is employing higher proportion of female labors, especially in seedbed preparation, transplanting, weeding, fertilizer application, harvesting and threshing. Draft powers are used to plough, plank and level the field, and for *dain*[4] . The use of draft power was found negatively associated with tractor use that replaces the draft power used for land preparation and *dain*. With the highest proportion of household using tractor, the draft power use is the lowest in Western Development Region

The average seed rate for rice was found to be 66.5 kg/ha, quite high compared to the national average of 55 kg, which is again quite high compared to standard recommendation dose of 15-25 kg/ha in transplanted condition (FAO, 2000; Dat, 2001). The seed rate was found to be the lowest in Central Development Region, which reflects the efficient use of seed in the region. FYM is basically the local resource produced and consumed within the household from their livestock. It is used as supplements to the chemical fertilizer by 66.5% of the households whereas for 33.5% of the

households it is the sole source of soil nutrient supplements. With only 44.3% of the households applying chemical fertilizer, Mid-Western Development Region has the highest level of FYM application (Table 4). Pesticide use for controlling insect pests and diseases is the highest Western Development Region where 50.9% of the households use it. The proportion is the lowest in Central Development Region. This is mainly due to the farmers' consciousness towards the negative impact of these chemicals, which led them to application of integrated pest management techniques that gives emphasis on the use of cost effective and environment friendly local resources like cow dung, cow urine, Neem extract (*Azadirachta indica)* etc. Although 52% of the land area is under irrigation, only 46.7% of the households has access to irrigation and the rest are totally dependent on rainfall.

Table 4: Development region wise input use

Cost items	Development region					Overall
	Eastern	Central	Western	Mid-Western	Far-Western	
Labor (Man-days/ha ± SE)	77.8 ± 2.1	73.5 ± 1.4	94.7 ± 4.7	103.8 ± 4.2	75.5 ± 3.4	86.9 ± 1.8
Draft Power (Days/ha ± SE)	20.3 ± 0.9	13.6 ± 0.9	8.9 ± 0.92	18.5 ± 1.1	12.9 ± 1.5	15.2 ± 0.5
Seed use (Kg/ha ± SE)	64.7 ± 2.5	56.9 ± 0.8	63.1 ± 2.42	70.54 ± 2.6	74 ± 2.14	66.5 ± 1.1
FYM (Doko[1]/ha ± SE)	138.7 ± 18.3	167.7 ± 26.9	318.6 ± 22.6	337.6 ± 29.7	268.8 ± 26.6	256.2 ± 12.8
Tractor (HHs)	9 (16.4%)	20 (37.0%)	33 (62.3%)	21 (23.9%)	27 (45.0%)	110 (35.5%)
Chemical fertilizer (HHs)	45 (81.8%)	49 (90.7%)	40 (75.5%)	39 (44.3%)	33 (55%)	206 (66.5%)
Pesticides (HHs)	24 (43.6%)	12 (22.2%)	27 (50.9%)	22 (25%)	16 (26.6%)	101 (32.6%)
Irrigation (HHs)	34 (61.8%)	30 (55.5%)	30 (56.6%)	23 (26.1%)	28 (46.6%)	145 (46.7%)

Source: Field Survey 2003.

3.5. Production situation

The average land area under rice cultivation (1.0 ha) (table 5) is higher compared to the national average of 0.62 ha (Central Bureau of Statistics, 2003). This is mainly due to the selection of study area having high rice production potentials. In contrast to the few proportion of the respondents involved in rice production, area under rice production is found to be higher in Eastern Development Region (1.5 ha/hh) followed by Western Development Region (1.3 ha/hh). Average area under rice production is the lowest in Mid-Western Development Region (0.7 ha/hh).

Yield of rice in overall is 2.9 ton/ha, almost the same as national average (Ministry of Agriculture and Co-operatives, 2004). Yield is the highest in Western Development Region (3.3 ton/ha) followed by Central Development Region (3.2 ton/ha), whereas Far-Western Development Region with 2.7 ton/ha of yield lags far behind. Average yield under irrigated condition is 3.4 ton/ha, and that under unirrigated condition is 2.5 ton/ha. Analysis of Variance (ANOVA) shows this difference to be significant, i.e., rice yield is significantly high in irrigated condition. [ANOVA analysis of yield: $F(1, 308) = 87.91$, $P = 0.00$** (** significant at 1%)]

With the largest area under rice cultivation and the highest yield, Western Development Region and Eastern Development Region also have the highest average production of 5.0 and 4.4 ton/hh, respectively. The overall average production and marketed amount of paddy-rice-rice is 3.2 and 1.4 ton/hh, respectively. Marketed amount of paddy-rice is also found to be the highest in Western Development Region and Eastern Development Region. Though Mid-Western Development Region has the lowest average production due to low area under rice cultivation and poor yield, farmers are still selling paddy-rice. Farmers are selling their product regardless of their household demand in order to meet other basic needs and to repay the credit taken at the time of cultivation. This clearly signifies that though government in policy level does not perceive rice as cash a crop, it is deriving significant amount of instant cash to meet the basic household needs.

Cobb-Douglas production function is used to estimate the factors affecting rice production in the study area. Table 5 presents the descriptive statistics of the variables considered for the production function. We reported the huge

range in all the continuous variables considered for the analysis. For instance, the production of rice varies from 0.1 ton per household to 25.0 tons per household. In case of dummy variables, values less than 0.5 means imply that low proportion of households are applying tractor and irrigation. On the other hand mean value more than 0.5 means higher proportion of households are from Hills and Tarai regions, and also higher proportion of households are applying chemical fertilizers in rice field.

Table 5: Descriptive statistics of the variables applied in Cobb-Douglas Production function

Variables	Sample size	Minimum	Maximum	Mean	Standard Deviation
Production (ton)	310	0.1	25.0	3.1	3.7
Area (ha.)	310	0.1	9.3	1.0	1.2
Labor (man-days)	310	22.5	230.0	86.9	31.8
FYM (doko)	310	0	5970	356.9	529.0
Tractor (dummy)	310	0	1	0.4	0.5
Chemical fertilizer (dummy)	310	0	1	0.7	0.5
Irrigation (dummy)	310	0	1	0.5	0.5
Mountain (dummy)	310	0	1	0.9	0.3

Result of Cobb-Douglas function to estimate coefficient of explanatory variable determining production of rice was as follows

Pdn = 0.30 + 0.69lnarea + 0.30lnlab + 0.012lnFYM + 0.09dumtrac + 0.046dumchfer + 0.10dumirri - 0.09dummount

(0.00**) (0.00**) (0.59) (0.00**) (0.03*) (0.00**) (0.002**)

9.98 4.08 0.53 4.39 2.11 5.5 -3.12

(Figures in the parentheses are P values and figures italicized are t-statistics)

R^2 = 0.913, Adjusted R^2 = 0.912 and F ratio =455.35** (Note: * and ** indicate significance levels at 5% and 1%, respectively).

The explanatory power of the explanatory variables in the model is significant i.e. 0.912. The t-statistics and P-value of the model shows that area under rice cultivation, and numbers of labors employed have positive significant relationship with the production, i.e 1% increase in area under rice cultivation and labor leads to 0.69% and 0.3% increase in rice production, respectively. This signifies that we can increase production of rice significantly by increase in area under rice cultivation and number of man-days labors' involvement. Although FYM use shows the positive association with production, the association is non-significant. FYM is an important means of sustainable soil fertility management in rural areas of Nepal. However, the practice of FYM application in the field, exposing it directly to sunlight for more than a week before field preparation, would result into loss of valuable soil nutrients that otherwise could be available to the plant. Some farmers also perceive that indiscriminate use of chemical inputs adversely affected the soil health. Therefore, soil these days is less responsive to use of FYM application demanding more and more application of FYM. However, given no change in number of livestock holding, farmers are not able to increase the application of FYM in rice field. Dummy on tractor use, chemical fertilizer use and irrigation shows the positive significant association at 1%, 5% and 1% respectively. The coefficient indicates that, the use of tractor resulted into 9% increase in production. Similarly, application of chemical fertilizer and irrigation resulted into 5% and 10% increases in yield, respectively, *cetaris paribus*. Dummy for mountain region however shows negative significant association with production of rice. This means the production of rice can be increased by 9% with shift of 1 ha of rice cultivation from mountain region to other ecological region, *cetaris paribus*

3.6. Economics of rice production

The calculation of production cost is the most important factor in the cultivation of rice that influences the profitability of its production showing the efficiency of the various inputs used by the farmers. However, due to the complexities involved in the calculation of total production cost, only primary production cost that assesses return to land is used here. In addition, small tools like sickle, spades, etc. that has multiple uses within the household whose valuation amount is very small, are not included either.

Table 6: Economics of rice production by development region

Development region	Attributes			
	Primary production cost (Rs/ha) (± Standard error)	Gross return (Rs/ha) (± Standard error)	Net return (Rs/ha) (± Standard error)	B/C Ratio (± Standard error)
Eastern	18,478.4 ± 662.4	32,709.1 ± 1190.8	14,230.7 ± 1390.5	1.9 ± 0.1
Central	15,354.7 ± 488.1	36,940.6 ± 1360.8	19,237.8 ± 1280.4	2.3 ± 0.1
Western	27,068.0 ± 1110.4	34,592.5 ± 1369	98,72.5 ± 1668.9	1.5 ± 0.1
Mid-Western	29,977.7 ± 2081.4	52,821.8 ± 4068.1	22,844.1 ± 3463.8	1.8 ± 0.1
Far Western	22,755.9 ± 2657	33,599 ± 1547.1	10,843 ± 2760.2	1.8 ± 0.1
Over all	23,495 ± 872.4	39,642.3 ± 1339	16,147.2 ± 1231.9	1.8 ± .04

Source: Field Survey, 2003.

Results show that the average primary production cost is Rs 23,495 per ha (Table 6). It is as low as Rs 15,355 per ha in Central Development Region and as high as Rs 29,978 per ha in Mid-Western Development Region. The high cost of production in the latter is mainly due to the high level of cost involved in inputs transportation and haphazard use of costly inputs. In contrast to this the easy access to these inputs and their proper use, i.e., dose, time and place results in low production cost in Central Development Region and Eastern Development Region.

Average gross return from the rice cultivation is Rs 39,642 per ha. The highest return is in Mid-Western Development Region, i.e., Rs.52, 822 per ha. This higher return is mainly due to the higher price of the Jumli rice, special rice with good flavor and taste, which has good price in the market. Consequently, overall net return is Rs 16,147 per ha, the highest being in Mid-Western Development Region (Rs. 22,844 per ha) and the lowest in Far-Western Development Region (Rs 10,843 per ha). However, the highest benefit cost ratio is in Central Development Region (2.3). This signifies that the most efficient production is in Central Development Region. General farm gate price of the rice is also better here. Regardless of that, the majority of the farmers are not satisfied with the level of benefit compared to the necessary investment in labor and other inputs for the rice cultivation.

3.7. Production problems of rice growers

Farmers of the study areas are facing several problems related to production. The problem identified in relation to rice production is presented in Table 7. Lack of technical know-how is perceived as the most important production problem leading to the inefficient use of the production inputs. This problem is prevalent all over the country.

Irrigation facility, the crucial factor determining rice production, is a problem in Eastern Development Region and Mid-Western Development Region, and to a lesser extent in Central Development Region. Lack of organized capital facility to purchase inputs at the time of cultivation, which forced the farmers to acquire loan from traders at higher interest rate and compelled to sell their harvest immediately at lower price is a problem for farmers of Mid-Western Development Region and Far-Western Development Region. Lack of quality seed and chemical fertilizer at the time of

cultivation are other important production problems faced by the significant proportion of the farmers, especially from Western Development Region and Mid-Western Development Region. Diseases and pests however, are perceived as problem by 112 farmers out of 310.

Table 7: Production problems of rice as perceived by farmers by development region

Attributes	Development region					Overall
	Eastern	Central	Western	Mid-Western	Far western	
Lack of technical know-how	53 (47.3 **)	50 (39.2**)	52 (49.1**)	78 (52.5**)	58 (52.3**)	291 (238.6**)
Lack of irrigation facility	40 (11.4**)	35 (4.7*)	33 (3.2)	70 (30.7**)	35 (1.6)	213 (43.4**)
Lack of organized capital facility	34 (3.1)	32 (1.8)	32 (2.3)	60 (11.6**)	42 (9.6**)	200 (26.1**)
Lack of quality seed	32 (1.5)	29 (0.3)	31 (1.5)	53 (3.7*)	36 (2.4)	181 (8.7**)
Lack of quality fertilizers	32 (1.5)	28 (0.1)	36 (6.8**)	55 (5.5*)	36 (2.4)	187 (13.2**)
Problem of diseases and pests	21 (3.1)	18 (6.0*)	18 (5.4*)	33 (5.5*)	22 (4.3*)	112 (23.8**)

Source: Field Survey, 2003.
Note: Figures in parentheses indicate Chi-square value.
* and ** indicate significance levels at 5% and 1%, respectively.

4. Conclusion and recommendations

Rice is grown in all of the five development regions with equal importance except in Eastern Development Region. Western Development Region and Eastern Development Region are the most successful in terms of average production of rice due to the highest average production, area and yield. Market potential, influential factor for production, is the highest in Central Development Region and Western Development Region. Farmers are using higher seed rate compared to the standard recommended dose of 15-25 kg/ha in transplanted condition. Limited access and use of chemical fertilizer and application of irrigation, the most important factors in rice production, are the main reasons for the lowest yield in Mid-Western Development Region. Comparatively efficient use of labor and seed, higher proportion of farmers using chemical fertilizers and irrigation, and use of cost effective local resources to control pests and diseases are the main reasons for lower primary production cost in Central Development Region. The gross return analysis showed that the rice cultivation is one of the profitable options for the farmers in Central Development Region followed by Eastern Development Region. Farmers are using some components of improved technology, such as, improved seed, chemical fertilizers and other inputs. However, lack of proper knowledge on rational use of these inputs results into benefits lower than it actually should be, which leads to lower benefit cost ratio. Thus, knowledge on the use of these inputs such as appropriate time of application, proper dose, and proper place should be disseminated more effectively among the farmers so that the existing production system will become more efficient and result into increased production. Quality and timely availability of these inputs needed to be secured as well. Lack of irrigation is another hindering factor for rice production.

Therefore, rice production can be encouraged in the areas of comparative advantage like Central Development Region, Eastern Development Region and Western Development Region where irrigation availability is high and other essential inputs like fertilizer, seed and pesticides can be easily available. Knowledge on the use of improved technology should be disseminated among the farmers right from the time of cultivation to the time of harvesting

and post harvest handling so that production can be increased even under existing input use situation by increasing efficiency of those inputs. Government should not only support farmers for irrigation and timely availability of those basic inputs but also ensure credit facilities at the time of cultivation to reduce the burden of trader bounded credit, which have higher interest rate and bind the borrowing farmers, generally small farmers, to sell their product at cheaper rate during harvesting time almost in a distressed way.

As rice is important stable food crop in Nepal such measures would ultimately encourage the farmers to undertake rice cultivation and the country becomes self sufficient in rice production, once again, and that could lead the country to achieve the sustainable food security.

Endnotes

[1] System of land tenure under which both landlord and tenant have right on the same piece of land
[2] Local measurement unit equivalent to 25 Kg
[3] n is same for all the following tables hereafter.
[4] Process of walking draft animal over rice straw after threshing, which has dual function of softening straw in order to make it palatable for livestock and collect grains left in the straw after threshing.

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