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DETERMINANTS AND COMPARATIVE PROFITABILITY OF ORGANIC AGRICULTURE IN INDO-CHINA ROAD CORRIDOR OF NEPAL

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ABSTRACT

Nepalese economy is dominated by agriculture contributing 28.89% to GDP. Chemical fertilizer is one of the important inputs in agriculture and total fertilizers used in Nepal are imported. Nepal has investing about Rs. 5,000 million every year in fertilizer subsidy but its demand (700,000 MT) have never met (<50% is supplied). In one hand rate of chemical fertilizer use in Nepal is low (about 30t/ha), on the other unbalanced use induced soil and environmental degradation in some commercial pockets. As organic is commonly perceived as less profitable farmers are reluctant to adopt such techniques. To study the relative profitability of organic production and determinants of organic adoption, a study was conducted with 250 farmers selected from Sindhupalchhok, Dhading, Gorkha, Chitwan and Rupandehi districts of Nepal. Study found that except highly commercialized vegetables, many crops can be produced profitably by organic technique. If appropriate system of organic certification and price premium is provided, organic would not be less profitable compared to inorganic one. Organic was found 12% less to 73% more profitable compared to inorganic ones. Unavailability in time and in required quantity was found to be the major bottleneck to farm level availability of chemical fertilizer and poor quality of organic fertilizers was the major problem of organic fertilizer. Household head's education, experience in farming, training and membership on organization have significantly affected the farmers' decision about organic adoption. However, age of household age and land holding associated negatively but insignificantly with organic adoption.

Keywords: Fertilizers, organic farming, determinants of adoption, profitability, sustainability

1. INTRODUCTION

The Nepalese economy is predominantly agriculture based and the agriculture sector contributes to approximately one third of Gross Domestic Product (GDP). Agriculture is the main source of livelihood of 65.6% population of the country and this sector contributes 28.89% to total GDP [1].

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

The growth rate of the agriculture sector in the year 2016 was found to be 0.4% and that in 2017 was 7.5%. The average growth rate remained 4.3% in last decade with 2.9% of agriculture and 4.9% of non-agriculture sector respectively [2]. Since, average size of the agricultural land is 0.68 ha and holdings operating less than 0.5 ha are 51.6% [3], increased productivity is utmost necessary to feed ever increasing population of the country.

Agriculture Development Strategy (ADS) has targeted 5% average annual growth of agricultural sector from current 3% [4]. It has highlighted importance of timely access to quality agricultural inputs at affordable price for increased agricultural productivity. The 14th interim plan (2016/17-2018/19) of the country also aimed at agricultural transformation which has targeted the annual economic growth rate of 7.2 percent, with growth rates in the agricultural sectors by 4.7% [5]. The plan had also expected the increased production of organic products.

At present farmers use 2.5-3 ton/ha of organic manure for fertility management. The national average use of chemical fertilizer is about 30 kg/ha which is not possible to meet the nutrient demand of crops (Proceeding of a workshop on IPNM, 2000). Thus, there is a large gap between nutrient uptake from soil by crop plants and nutrient supply into the soil resulting into a decline in soil fertility year after year.

Organic farming (also known as chemical free farming) may be the useful approach, which can substitute the costlier chemicals by locally available cheap and environment friendly organic materials. Organic production methods entail significant restrictions on the use of fertilizers and pesticides, which may have detrimental effect on the environment [6]. It is concerned not only with simply replacing the chemical fertilizers and pesticides but is rather more a holistic cultivation system whereby an agriculture site is viewed as an organism. Organic production therefore is more than a system of production that includes or excludes certain inputs Four fundamental principles of organic farming as per the definition IFOAM are principle of health, principle of ecology, principle of fairness and principle of care.

In global contest, nearly 70 million hectares of farmland are organic. The global organic market is growing worldwide and has reached 97 billion $ in 2017 when 2.9 million organic producers were reported [7]. A study in UK found the gross margin and net margin 746 and 397, and 505 and 189 £/ha respectively for organic and conventional pea [8]. US survey conducted in 2001 studied on 150 reasons for various crops reveals that organic yields were 95-100 percent of conventional. Similarly, one study conducted by Cornel University in 2005 concluded that organic corn and soybean yields a conventional ones [9].

Organic vegetable can fetch at least 30 percent more than conventional ones [10]. SAN stated that initially, a decline in yields occurs during the conversion to organic production [11]. However,

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

once the transition period over (generally 3-5 years) organic crop yields within 90-95 percent of conventional yield. It also stated that once the farming system has been certified, price premiums together with reduced production costs, help boost profitability.

Dasgupta through her study in rice in Bangladesh concluded that Integrated Pest Management (IPM) is more profitable than conventional system [12].

Despite lower yields, organic farming financially performs better than intensive conventional. Indeed, when organic premiums are not taken into account, the benefit/cost ratios are significantly lower than conventional farming (-27 to -23%). However, when actual premiums are applied, organic farming is significantly more profitable than conventional farming: the benefit/cost ratios are 20 to 24% higher. Total costs for organic and conventional farming are relatively similar [13]. Considering the current global situation of availability of organic materials, it is advised to apply nutrients from inorganic and organic sources at 75:25 ratio instead of full amount through organic materials only. Further, organic nutrients alone are not sufficient to increase crop yields and achieve food security [14].

Nepalese government initially provided 50% subsidy in purchase of machine used in organic fertilizer production. In addition, MOAD provided price subsidy at the rate of Rs 10/kg of product or 50% of the sell price whichever is less to the farmers for maximum of 1500 kg to a farmer @50 kg/kattah or 75 kg/ropani. Bulkiness of product and difficulty in transportation and lack of quality assurance are the major issues for low consumption of organic fertilizers at farmers' level [15]. Nutrients from fertilizing with manure seem to substitute for chemical fertilizer use in Nepal [16]. This however is contradictory to findings from Niger that these two were complementing each other [17]. Increased use of inorganic fertilizer in smallholder farming systems can significantly raise crop productivity, enabling farming households to improve their food security both directly, through greater food supply, and indirectly, though higher agricultural incomes, and to set themselves economically on a pathway out of poverty [18].

With commercialization of agriculture, demand for fertilizers has been continually increasing. As there is no any fertilizer plant in the country Nepal should rely on its importation from foreign countries. Unavailability of fertilizers in time and required quantity hampers crop production to great extent. Importation of chemical fertilizers from foreign country leads to long time of acquisition and high cost. Fluctuation of fertilizer price in international market heavily affects supply of chemical fertilizer in Nepal. Nepal has investing huge money (Rs. 5000 million on an average) every year in fertilizer subsidy. It has continuously increasing financial burden to the nation. Subsidy is introduced with the objective to save farmers against high cost of fertilizer. However, subsidy could not bring favorable environment insuring assured supply of fertilizer in the country. Uncertainties in supply, imbalanced use, government's financial burden, land

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

degradation and non-sustainability of agricultural production systems are major bottlenecks of fertilizer sector in Nepal. On the other hand misunderstanding about real profitability of organic production system prevails among farmers. Most people think organic as less profitable thus farmers hesitate to adopt this technique.

Supply of essential chemical fertilizer in Nepal is far below the total demand at present (less than 50% of potential demand i.e. 700000 MT). Study on economics of organic production will generate valuable information in relation to whether it will be the viable alternative to the imported chemical fertilizer without hampering the overall agricultural productivity. Whether organic is less profitable as perceived by the farmers, can organic substitute costly inorganic production system and what are the major determinants of organic adoption are the research questions considered in the research. The study thus, aimed at achieving the following objectives:

1. To analyze the comparative profitability between organic and inorganic agricultural production techniques,
2. To study the determinants for adoption of organic production technique, and
3. To assess the problems of chemical as well as organic fertilizer acquisition and use in farm level.

2. METHODOLOGY

Study area

Five districts - Sindhupalchhok, Dhading, Gorkha, Chitwan and Rupandehi (one line from district bordering to China to that to India) and villages within each district were selected purposively for household survey. Melamchi of Sindhupalchhok, Aginchhok of Dhading, Chhoprak of Gorkha, Mangalpur and Fulbari of Chitwan and Manigram of Rupandehi were selected for the survey.

Data collection methods

Key Informant Interview, Focus Group Discussion and Household Survey were employed for data collection. Representatives from AICL, STCL, MOAD and SMD, cooperatives, agro-vets (10 in each district), organic fertilizer producing companies served as key informants. One group discussion was done with cooperative members and progressive farmers (16-28 and 31% female participants in total) in each district. The group discussion also identified the major fertilizer related problems of the district. A total of 200 inorganic producers (40 from each district) were selected randomly and interviewed by administering semi-structured questionnaire. Similarly, a

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

small group of 10 purposively selected farmers in each selected district who are involved in organic crop production were interviewed.

Sources of Data

Both primary and secondary data were collected for the attainment of research objectives. Data obtained from household survey, KII and FGD constituted primary sources and that obtained from printed as well as electronic sources (published and/or unpublished) served as the secondary sources.

Data analysis methods

Collected information were processed, validated and analyzed basically my using Microsoft EXCEL and the latest version of SPSS programmes. Following analyses were done for the accomplishment of the research objectives:

Probit regression analysis: Probit regression was used to assess determinants of the organic production technique among farmers of Chitwan and Rupandehi. Decision on adoption of organic production technique was regressed against age, sex, occupation, education, experience on farming, and involvement of household head in different social organizations; land holding; training in organic production; ethnicity and farm income as dependent variables.

Probit equation

The response variable here is binary (adoption=1, non-adoption=0). The model used was as follows:

$$\Pr(Y=1|X) = \Phi\,(X^{T}\beta),$$

Where, Pr denotes probability, Φ is the cumulative distribution function of the standard normal distribution. The parameters β are estimated by maximum likelihood. The Probit regression model specific to this research was as follows:

$$Y(\text{Adopter}=1) = \beta_0 + \beta_1\,\text{Age of HHH(years)} + \beta_2\,\text{Sex of HHH (male=1, mefale=0)} + \beta_3\,\text{Education of HHH (years)} + \beta_4\,\text{Primary occupation of HHH (agriculture=1, non-agriculture=0)} + \beta_5\,\text{Ethnicity (Brahmin/chhetri=1, others=0)} + \beta_6\,\text{Land holding (ha)} + \beta_7\,\text{Experience in farming (years)} + \beta_8\,\text{Training in organic technique(training=1, no training=0)} + \beta_9\,\text{Farm income (Rs)} + \beta_{10}\,\text{Membership in social organizations(member=1, non-member=0)} + \ldots\ldots\ldots\ldots + \varepsilon_i$$

Where, adopters were those who involved in organic crop production and the adoption status was taken as dependent variable.

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

Indexing: Indexing technique was used to identify major farm level constraints of chemical as well as organic fertilizer acquisition and use in study area. Following formula was used to estimate the index of importance of each problems identified during FGD:

$$I_{imp} = \sum \left(\frac{SiFi}{N} \right)$$

Where,

I_{imp} = Index of importance

Si = Scale value

F_i = Frequency of importance given by the respondents

N = Total no. of respondents

Gross margin: Gross margin was estimated for conventional (chemical) as well as organic production of crops for comparison of profitability of these crop production techniques.

3. RESULTS AND DISCUSSION

General household characteristics

Average size of household in study area was estimated to be 4.9. Economically active population (age group 18-59) constituted the highest proportion (58.7%) of total population. Out of total population of sample households 24.2% were adolescence (5-17 years), 9.8% old (≥60 years) and 7.4% child (<5 years). Out of 250, 212 (84.8%) of sampled households of the study area had been headed by the male members of the household. Regarding the average age of the household, it was estimated at 47.4 years which was ranged between 19 and 85 years. Result indicates that middle aged member of the household rather than young and too old serve as the head of household in study area. Janajati was found to be the dominating (35.6%) ethnicity in the study area which was followed by Bhramin (28%) and Chhetri (19.6%). Composition of Dalit and Madhesi were estimated to be 8.8 and 8% respectively.

Agriculture was the primary occupation of high majority of household heads in the study area. Out of 250 household heads, 197 (78.8%) have been involved in agriculture as their main occupation. Household heads involved in service, business, foreign employment and private job were found to be 11.6, 5.6, 3.2 and 0.8% respectively. Out of 250 household heads, 31 were illiterate. Majority (64%) has attended basic level education (1-8 class) which was followed by those having secondary education (9-12 class) i.e. 17.6%. household heads having university level education were only 15 (6%). Exactly 60% of the household head were found to be involved in different types of social organizations. Out of those participating in different organizations, 59% were involved in non-agricultural organizations and participation in agricultural organization was about 41%.

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

Majorities (59.2%) of farmers selected as sample in the study area were small farmers holding less than 0.5 ha of total land (both cultivated and uncultivated). About one-third of the farmers (33.2%) were medium and only 7.6% were large farmers with ownership of more than 1 hectare total land. Distribution of land was found highly unequal deviating significantly which ranged from 0.04 to 7.5 hectare. Average holding size in Sindhupalchhok, Dhading, Gorkha, Chitwan and Rupandehi were estimated to be 0.41, 0.37, 0.54, 0.66 and 1.02 respectively with the average of 0.6 hactare.

Main source of the household income in the study area was non-farm income comprising salary, business, remittance and other non-farm employments. Non-farm sources shared 70.1% of total income of the households on an average. Farm income (crop and livestock) constituted 24.5% and the off-farm one 5.4% of average annual household income. Total household income on an average of all districts was estimated to be Rs. 2,33,497.

Problems of farm level availability of fertilizers

Poor quality, unavailability in required quantity, lack of knowledge about the fertilizer and its use and high price were found to be the major farm level problems of organic fertilizer. Out of total respondents, 87% have reported that poor quality (low nutrient content) of the product, 67% unavailability in required quantity and time, 62% lack of knowledge about fertilizer and its use, 55% high price and 31% difficult in transportation as major problems associated with organic fertilizer.

The index of importance for the problem poor quality of fertilizer was estimated to be 0.6. It has indicated that most importance problem associated to organic fertilizer in Nepal is low nutrient content of the product. Price and transportation were prioritized as less important problems though many farmers reported these problems. Indices of importance as obtained from indexing technique for different problems of organic fertilizer are presented in Table 1.

Table 1: Index of importance for different problems of organic fertilizer as responded by the respondents

Problem	**Intensity of problem (No. of respondents)**					
	Severe	High	Moderate	Slight	Negligible	**∑si.fi/N**
Poor quality of fertilizer (Low nutrient)	67	44	52	27	28	0.60
Unavailability in required quantity and time	23	34	30	35	45	0.36
Lack of knowledge about fertilizer	28	24	29	33	41	0.34

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

and its use						
High price of fertilizer	21	30	19	35	32	0.31
Difficult in transportation	23	25	23	30	27	0.30

Source: HH Survey, 2016

Regarding the problems of chemical fertilizer acquisition and use, farm level study identified unavailability in time and required quantity (92%), lack of knowledge about the fertilizer and its use (75%), low quality of fertilizer (74%), high price (64%) and difficult in transportation (54%) were identified as major ones. Index of importance showed that major problem of chemical fertilizer acquisition and use in the study area is unavailability of the fertilizer in required quantity and at the time of need. Lack of knowledge among the farmers about the appropriate use and function of the fertilizer was also identified as major problem. Though price is the major issue in almost all forums discussing on chemical fertilizer, farmers in study area do to put much focus on it as major problems. It has clearly indicated that availability in time and required quantity is important over all other issues of chemical fertilizer.

Table 2: Index of importance for different problems of chemical fertilizer as responded by the respondents

Problem	**Frequency**					
	Severe	High	Moderate	Slight	Negligible	Index
Unavailability in required quantity and time	63	72	40	25	31	0.64
Lack of knowledge about fertilizer and its use	42	55	51	29	11	0.52
Poor quality of fertilizer (Low nutrient)	35	32	38	40	40	0.43
High price of fertilizer	30	42	28	27	32	0.39
Difficult in transportation	17	19	16	36	47	0.26

Source: HH Survey, 2016

Comparative economics between organic and inorganic production

Human labour constituted 63-75% of total cost of production. Shares of fertilizer and manure costs ranged between 11 and 15%. In majority of crops selected for comparison yields were found higher in inorganic compared to the organic produced in same site. However, in case of rice yield was found higher from organic. Higher yield of organic rice was due to higher amount of FYM (26.2t/ha) compared to inorganic (12.4t/ha). Organic rice was found to be grown in smaller area (0.09 ha on an average) with high management in the study area.

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

For almost all crops, organic product fetched slightly higher price over the inorganic ones. Price however, was not found adequately high to attract more farmers in organic production and to compensate the reduced yield. Regarding the cost, slightly higher cost was estimated for inorganic production basically due to additional cost of chemical fertilizers and other plant protection chemicals. Net returns in all crops except tomato and cauliflower were found higher from inorganic production techniques. Reason might be the higher doses of chemicals under these crops as both are produced in off-season. However, higher B/C ratios we estimated among organic except tomato. No consistent results in favour or against the organic production were found in the study. However, the results fairly indicated that organic production of crops are not less productive and less profitable compared to inorganic ones.

Organic compared to inorganic technique in overall were found profitable in almost all crops across the study villages expect tomato in Dhading. Reason might be that Dhading is one of the highly commercial districts in Nepal where use of chemicals was noticed very high compared to other vegetable producing districts selected in this study.

Table 3: Production (kg/ha), cost and return (Rs/kg) analysis of organic and inorganic crop production techniques in study area

District	Crop	Product	Av. production	Av. price	Gross return	Cost of cultivation	Net return	B/C ratio
S.Palchhok	Potato	Organic	19247	25.4	489066	244709	244357	1.99
		Inorganic	19131	21.6	413804	243603	170201	1.7
Dhading	Tomato	Organic	13446	57.6	774624	263478	511146	2.94
		Inorganic	15520	54.6	848168	269260	578908	3.15
Gorkha	Gourd	Organic	19864	29.3	582611	145887	436724	3.99
		Inorganic	20126	28.6	574799	154034	420765	3.73
Chitwan	Rice	Organic	4820	24.9	120018	113910	6108	1.05
		Inorganic	4780	24.7	118066	114582	3484	1.03
Rupandehi	Cauli	Organic	7651	42.6	326331	112528	213803	2.91
		Inorganic	9533	38.3	365320	146121	219199	2.54

Source: Household survey, 2016

Profitability of organic was found to be attributing to price incentives compensating reduced yield. However, price premium in some crops (especially cereals) were not found enough to compensate the reduced yield. Therefore, profitability of organic production basically depends upon how remunerative price the organic products fetch in the market.

Factors affecting adoption of organic technique

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

The adopters in the Probit model were categorized based on binary response. The respondent growing organic crops were designated as adopters (1) and those involved in inorganic production were categorized as non-adopter (0). The Pseudo R^2 in the model was 0.781 indicated that the independent variables included in the model explain 78% of probability of household decisions to adopt or not the off-organic crop production. The Log-likelihood Ratio was found to be significant at 1% level of significance that means all the explanatory variables included in the model jointly influence farmers' probability of adoption of organic crop production. The model estimated predicted probability of adoption to be 0.747. This means that there is about 75% probability that farm household in the study area are willing to involve in organic production. Thus it can be stated that the model used is consistent and meaningful.

Probit regression had shown statistically significant effect of education, experience on farming, training and membership on social organizations. Years of schooling was found positively significant at 10% level which indicates that adoption of organic production increases with the increase in years of schooling. Result showed that with one year increase in year of schooling the level of adoption increases by 6.2% others things remaining same. This is consistent with the literature that education creates a favorable mental attitude for the acceptance of new practices. [19] Result also matches the findings from Nepal [20]. Negative effect of years of formal education in overall decisions to adopt some technologies was also marked by Yaron et al. [21].

Table 4: Factors affecting adoption of organic production technique in crop production among sampled households of study area

Variables	Coefficients	P>|Z|	Standard error	dy/dx[b]	S.E.[b]
Age of HHH (year)	-0.010	0.783	0.045	-0.003	0.013
Sex of HHH (male=1, female=0)	0.321	0.692	0.845	0.093	0.282
Years of schooling of HHH (year)	0.217*	0.094	0.131	0.062	0.441
Primary occupation of HHH (Agriculture=1, non-agriculture=0)	1.319	0.341	1.282	0.417	0.492
Ethnicity (upper=1, others=0)	0.139	0.992	1.051	0.039	0.276
Land holding (ha)	-0.179	0.498	0.387	-0.071	0.131
Years of farming (year)	0.372**	0.027	0.159	0.104	0.049
Training on organic production (Training=1, No training=0)	2.101**	0.044	1.056	0.510	0.361
Farm income of household (Rs.)	0.010	0.129	0.010	0.002	0.000
Membership on social organization (Yes=1, No=0)	1.520**	0.022	0.598	0.481	0.243

ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

Constant	-4.590	0.056	2.875	-	-

*** Significant at P=0.05; *Significance at P≥0.1*

[b] *Marginal change in probability evaluated at the sample means*

The coefficient of experience on farming was found positive and significant at 5% level. It is found from the analysis that with one year increase in involvement in farming adoption of organic technique increased by 10.4%. As farmers gain experience on farming they can know merits and demerits of inorganic as well as organic production thus may shift to later one to reduce hazardous effects of former one. Similarly, training on organic production affected adoption significantly as 5% level. It revealed that adoption of organic production technique increases with training in such techniques. Analysis showed that adoption increases by 51% if farmers are trained. The finding is also supported by the findings of Rosegrant and Cline (2003) and Feder, (1987).

Involvement in social organizations was also found to be positively associated to the adoption organic agriculture which to be significant at 5% level. This reveals that households are more likely to adopt organic production technologies if they are the members of different social organization. As such organizations provide forum for getting information, knowledge, experience and increases social responsibilities farmers will keen to adopt organic technology.

Age of household head and land holding are negatively associated with the adoption of organic agriculture which both were found statistically insignificant. It indicated that adoption varies inversely with the age of household head and the sizes of holding i.e. large farmers are somehow reluctant to adopt organic practice. Determinants like farm income, primary occupation of household head, their gender and ethnicity have not any significant effect on adoption of organic agricultural technologies.

4. CONCLUSION

Organic production is not less profitable as simply perceived by the farmers. However, chemicals cannot be completely substituted immediately by the organic materials. In large scale farming, combination of organic and inorganic fertilizers may maintain production without hampering the profitability. In small scale farming, organic should be promoted by price premium, assured market and improvement of FYM, compost and green manuring. Expansion of organic production not only reduce government's financial burden invested in importation and subsidizing chemical fertilizers but also maintain productivity and ensures long term sustainability.

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Volume: 04, Issue: 04 "April 2019"

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ISSN: 2455-8834

Volume: 04, Issue: 04 "April 2019"

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