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RESEARCH ARTICLE

Economics of Cereal and Vegetable Crops under Organic and Conventional Production Systems in Nepal

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ABSTRACT

Chemical fertilizers have a great contribution in agricultural production in Nepal. So far, only about 50% of total demand for chemical fertilizer has been met. Government has been providing subsidy protecting farmers from high cost of imported fertilizers. However, the supply of chemical fertilizer is not smoothened as expected. With the tragedy of different problems of fertilizer importation, distribution, and use, stakeholders have started thinking organic production as an alternative of conventional agriculture in Nepal. However, transforming from conventional to organic agriculture is questioned because of conflicting finding regarding the real profitability of organic production technique. Responding to the situation, a study was conducted to analyze comparative economics of organic and conventional production system using gross margin and cost-benefit analysis covering five selected crops (rice, tomato, potato, bitter gourd, and cauliflower). The study was carried out by random sampling of 250 producers where 200 were conventional and 50 organic farms from five rural/municipalities of Sindhupalchhok, Dhading, Gorkha, Chitwan, and Rupandehi districts. Estimated gross margins and benefit cost analysis indicated that organic products are as profitable as conventional products except in tomato. In overall, vegetables were more profitable than cereals both for organic and conventional systems.

Key words: Profitability, price premium, fertilizer, sustainable agriculture

INTRODUCTION

Agriculture in Nepal is the main source of livelihood for 60.4% population and this sector contributes 24.9% to total gross domestic product (GDP) of the country.[1] The 15th periodic plan of the Nepal aimed at achieving 10.1% annual growth with 5.4% of agriculture sector. One of the national strategies of the plan is to enhance the agricultural production and productivity through assured availability of fertilizer and seeds along with other production inputs.[2] However, the grown rate of agricultural GDP was 3.85% in the year 2020/21 which remains <3% for the past 2 years and will be even less (2.3%) in the year 2021/22.[3]

Chemical fertilizers have a great contribution in agricultural production in Nepal. The country has a total demand of 700,000–800,000 MT of chemical fertilizer out of which, only about 50% of total demand is met from formal source.[4] Total sell of major fertilizer products (Urea, DAP, and Potash) from formal sources (Salt Trading Corporation Limited and Agriculture Inputs Company Limited) was 379,152 MT in the year 2020/21.[3] All the chemical fertilizers used in Nepal are imported. Every year, Government of Nepal allocates a huge

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sum of the budget in fertilizer subsidy. Government has allocated Rs. 15,000 million for fertilizer subsidy for fiscal year 2022/23.[5] However, subsidy could not assure the fertilizer supply in Nepal.[6] Because of uncertain availability of chemical fertilizer along with its high price, illegal trading, poor quality, imbalance use, and soil degradation as well as the loss of government revenue, organic production is considered as the alternative. Nepalese government is also encouraging production and use of organic fertilizers by providing subsidy on both activities. However, due to uncertainties associated to production and marketing of organic products along with lack of price incentives, farmers hesitate to shift to organic production.

One of the 17 goals of the Sustainable Development Goals is to end hunger, achieve food security, and improve nutrition and promote sustainable agriculture (United Nations Development Program.[7] It has realized the need of promoting organic agriculture as means of achieving sustainability. In global context, nearly 70 million hectares (ha) of farmland is organic. In 2017, global organic market continued to grow worldwide and has reached 97 billion US dollars and about 2.9 million organic producers were reported all over the world.[8]

In spite of the ever-increasing concern, lots of controversies have been observed regarding the profitability of organic production technique. Whether or not, the organic production is profitable to the farmer was the major research question of this study. Main hypothesis of the research was that "gross profit from organic production is not significantly different from conventional production." The study on gross margin of organic production generated valuable information supporting the organic production as one of the viable alternatives to replace the imported chemical fertilizers without hampering agricultural productivity. General objective of the study was to analyze the profitability of organic production technique against conventional production. However, the specific objectives were:

a. To analyze cost, return, profit and gross margin of major cereal and vegetable crops under organic and conventional production systems, and
b. To assess the overall profitability of organic products against conventional products.

MATERIALS AND METHODS

Study Site

Sindhupalchhok (Duwachhour-8), Dhading (Aginchhok-5), Gorkha (Chhoprak-8), Chitwan (Fulbari-3), and Rupandehi (Devdaha-10) districts were selected purposively for the study as both, organic and conventional producers of selected crops, were found in those villages during the preliminary survey.

Data Collection

Household (HH) survey was employed for data collection. All the crop producing farmers of the village constituted the study population. A total of 200 conventional producers (40 from each ward of rural/municipality randomly) and 50 organic producers (10 from each ward of rural/municipality purposively using snow-ball sampling technique) were interviewed by administering semi-structured questionnaire. Respondents were enumerated by face-to-face interview technique. The information was also supplemented with qualitative field survey (Key Informant Interview and Focus Group Discussion) and literature review.

Data Analysis

Descriptive statistics were mostly applied for data analysis. This study used benefit-cost analysis and gross margin analysis to compare economics of conventional production with organic production of selected vegetables and cereal crops. Analytical tools used in the study are briefly outlined below.

Benefit-cost Analysis

Benefit-cost ratio (BCR) is an indicator used in cost-benefit analysis to show the relationship between cost and benefit of an enterprise. The BCR is calculated by dividing the total cash benefits by total cash costs.[9]

Young *et al*.[10] used BCR for analyzing the economics of foot and mouth disease control in Cambodia. Similarly, Borrengo-Marin and Berbel[11] used this criterion in analyzing the economics of irrigation modernization and Wassmann and Pathak[12] for

analyzing cost effectiveness of greenhouse gas mitigation. To study ecosystem service tradeoff between traditional and modern agriculture in China, Zhang *et al*.[13] used benefit cost ratio. Seawright *et al*.[14] for analyzing economic implication of biological pest control in USA and Singh *et al*.[15] for evaluation of agriculture, forestry, and agroforestry in India had also used benefit cost ratio. Following formula was used in estimating BCR ratio:

$$\text{BCR} = \frac{\text{Gross return}}{\text{Total cost}}$$

Gross return was calculated by multiplying the total production with average price of the product. Similarly, total cost was calculated by summing up all the fixed and variable costs including expenses on labor, machinery, power, inputs, rent, and interest as well as the depreciation.

Gross Margin

Gross margin was estimated for conventional as well as organic production of crops for comparison of profitability. Following formula, as suggested by Berman and Knight,[16] was used in estimating gross margin:

$$\text{Gross margin} = \frac{\text{Gross profit}}{\text{Revenue}}$$

Gross profits for selected crops, *namely,* potato, tomato, bitter gourd, rice, and cauliflower were calculated by subtracting total cost from the revenue. Revenue (gross return) was computed by multiplying the total output (both main product and byproduct) with its price. Byproduct's value was estimated only for rice as the straw had significant market value.

Two-Independent Sample Mean Test

Two independent sample t-test (two-tailed) was used for the test of significance in the study. The t-test is an appropriate test for judging the significance of difference between the means of two samples in case of small sample(s) when population variance is not known.[17] Following formula as suggested by Spiegel and Stephens[18] was used for estimating test statistics, t:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sigma\sqrt{1/N_1 + 1/N_2}} \quad \text{Where,} \quad \sigma = \sqrt{\frac{N_1 S_1 + N_2 S_2}{N_1 + N_2 - 2}}$$

Where,

$\bar{X}_1$ and $\bar{X}_2$ are means, S_1 and S_2 standard deviations and N_1 and N_2 sizes of the samples.

The best statistical decision strategies for comparing two independent groups are Mann–Whitney U-test and the t-test of Yuen Welch.[19] Even for small samples, the Pearson Chi-squared test and the two-independent-sample t-test are robust.[20] Emerson[21] also suggested the application of t-test for mean comparison of two independent samples.

RESULTS AND DISCUSSION

General Characteristics of Households

Average size of HH in study area was 4.9. Economically Active Population was 58.7% of total population of sampled HHs [Table 1]. About 85% of sampled HHs were headed by the male and 15% by female. It indicated weak participation of women in HH decision-making process. Average age of the HH heads (HHHs) was 47.4 years. Results indicated that middle aged members of the HHs served as HHH in study area.

Agriculture was the primary occupation of majority of HHHs in the study area. About 79% of total HHHs have been involved in agriculture as their main occupation [Table 2]. Service and business provided employment to about 12% and 6% of HHHs, respectively. HHHs with foreign employment was 3.2% and involved in private job were <1%.

Out of 250 HHHs, 31 (12.4%) were illiterate. Only 37.5% HHHs have attended university (+2 and above) level education. Majority (64%) had attended primary (1–8 class) level education. Results showed that most of the HHs in the study area have been headed by the members having lower-level formal education.

Table 1: Population distribution by economically active members, family size, average age, and sex of household heads

Study site	EAP (%)	Av. family size	Av. age of HHH (year)	Female headed HHs (%)
Duwachhour	56.9	4.3	51.3	22
Aginchhok	62.1	5.7	49.6	14
Chhoprak	51.6	3.7	50	14
Fulbari	73.6	4.6	43.4	16
Devdaha	49.2	5.98	42.7	10
Average	58.7	4.9	47.4	15.2

Source: Field survey, 2019

Land Holding and Household Income

The average size of holding was found to be 0.6 hectare (ha) per HH [Table 3]. Majority (59.2%) of HHs were small farmers holding <0.5 ha of total land (cultivated and uncultivated). About one-third of the HHs (33.2%) were medium and only 7.6% large farmers with ownership of >1 ha. Distribution of land was found highly unequal which ranged from 0.04 to 7.5 ha.

Major portion of the income of the sample HH was obtained from non-farm sources like salary, business, remittance, and other employments which comprises about 70% of the total HH income. Farm income (crop and livestock) constituted about 25% of average annual HH income. Off-farm sources contributed least and negligible to the total HH income. Total HH income on an average in the study area was estimated to be Rs. 233,497 [Table 3].

Cost, Return and Gross Margin

Human labor constituted 63–75% of total cost of production in study area. Shares of fertilizer and manure cost ranged from 11% to 15% of total cost. In majority of crops, yields were found higher in conventional compared to the organic methods. However, in case of rice, yield was higher from organic technique, which would be due to heavy use of Farm Yard Manure (26.2 t/ha) in this system compared to conventional one (12.4 t/ha). In study area, organic rice was found to be grown in smaller area (0.09 ha on an average) per family with better management.

In all crops, organic products fetched slightly higher price over the conventional ones. According to Ali,[22] price is an important factor in determining profit from vegetable cultivation. Cost of cultivation was slightly higher in conventional system than organic (except potato), which was mainly due to additional cost of chemical fertilizers and plant protection chemicals [Table 4]. Both the gross return and net return were higher in organic production system except in tomato and cauliflower. Reason might be the higher doses of chemicals in tomato and cauliflower as both were mostly produced in off-season. A study by Abbasi *et al*.[23] found that marketable yield and total yield of tomato was increased by 33 and 16%, respectively, by compost amendment in organic production technique. The average yield of all cultivars of tomato with organic method is estimated about 63% of conventional yield.[24] Similarly, according to Lo Scalzo *et al*.,[25] organic cauliflower yields 25% less than the conventional one on an average of all cultivars and management systems.

BCRs for all organic crop productions were higher as compared to conventional methods except tomato in Dhading where use of chemical fertilizers and pesticides is very high compared to other districts selected in this study. It indicated that organic crop, in overall, is profitable over conventional.

Gross profit of organic potato was found significantly higher over conventional as t estimate was found to be –7.31 (R: |t|>2.7). Gross profit of organic tomato was found significantly lower (at 5% level) than the conventionally produced tomato. The estimated t was found to be 1.93 against the table value 1.68 (R: |t|>1.68). Mean gross profit differences of gourd and cauliflower between organic and conventional production techniques

Table 2: Distribution of household heads in study area based on their ethnicity, education, and occupation

Occupation	Agriculture	Service	Business	Foreign employment	Private job
	197 (78.8)	29 (11.6)	14 (5.6)	8 (3.2)	2 (0.8)
Education	Illiterate	Primary	Secondary	University	Total
	31 (12.4)	160 (64.0)	44 (17.6)	15 (6.0)	250 (100)

Source: Field survey, 2019; Figures in parentheses indicate percentage

Table 3: Distribution of households by land size and average annual income

Land holding	**No. of holding**			**Average holding (ha)**
	Small (<0.5 ha)	Medium (0.5–1.0 ha)	Large (>1 ha)	
	148 (59.2)	83 (33.2)	19 (7.6)	0.6
Av. Income (Rs)	Farm	Off-farm	Non-farm	Total
	57,522 (24.6)	12,545 (5.4)	163,629 (70.1)	233,497 (100)

Source: Field survey, 2019; Figures in parentheses indicate percentage

Table 4: Economic analysis of organic and inorganic production systems in five selected crops

District	Crop	Product	Av. production (kg/ha)	Av. price (Rs/kg)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Netreturn (Rs/ha)	BCR
Duwachhour	Potato	Organic	19,247	25.4	489,066	244,709	244,357***	1.99
		Conventional	19,131	21.6	413,804	243,603	170,201	1.7
Aginchhok	Tomato	Organic	13,446	57.6	774,624	263,478	511,146*	2.94
		Conventional	15,520	54.6	848,168	269,260	578,908	3.15
Chhoprak	Bitter gourd	Organic	19,864	29.3	582,611	145,887	436,724	3.99
		Conventional	20,126	28.6	574,799	154,034	420,765	3.73
Fulbari	Rice	Organic	4820	24.9	120,018	113,910	6108**	1.05
		Conventional	4780	24.7	118,066	114,582	3484	1.03
Devdaha	Cauli-flower	Organic	7651	42.6	326,331	112,528	213,803	2.91
		Conventional	9533	38.3	365,320	146,121	219,199	2.50

Source: Field survey, 2019; ***significant at 1%, **significant at 5%, *significant at 10% levels of significance

were statistically insignificant. Organic rice was found significantly profitable (at 5% level) compared to conventional one (R: |t|>2.02) with the t estimate of –2.23. Lower profitability of rice would be due to lower production and lower price, but higher cost of production as compared to the vegetables and due to lower allocative efficiency of chemical fertilizers. Abiola *et al*.[26] stated that among many inputs, allocative efficiency of fertilizer in rice was found lowest (0.06) which was too low than the optimal allocative efficiency.

The nutrients from manure seem to substitute chemical fertilizer in Nepal.[27] This finding, however, is contradictory to findings from other countries. In Niger, these two were complementing each other.[28] Small-scale farmers converting to organic agriculture require substantial external production-related, marketing, and certification support. Organic farmers in China felt that organic adoption had improved prices, incomes, and market access. Thus, organic agriculture may be a development path for small farmers if the supports are provided.[29]

Organic agriculture is proposed as a promising approach for achieving sustainable food system, but its feasibility is contested.[30] They reported that 100% conversion to organic agriculture needs more land than the conventional agriculture. Firth[31] in his study to compare organic and conventional pea in United Kingdom found the gross margin and net margin 746 and 397, and 505 and 189 £/ha, respectively. United States survey conducted in 2001 studied on 150 regions for various crops revealed that organic yields were 95–100% of the conventional. Similarly, a study conducted by Cornel University in 2005 concluded that organic corn and soybean yield as conventional ones.[32]

Organic vegetable can fetch at least 30% more than conventional ones.[33] Sustainable agriculture network[34] stated that initially a decline in yields occurs during the conversion to organic production. However, once the transition period is over (generally 3–5 years), organic crop yields within 90–95% 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[35] through her study in rice in Bangladesh concluded that Integrated Pest Management (IPM) is more profitable than conventional system. She also found that share of pesticide to total variable cost is 2.9% and 8.1% for IPM and conventional systems, respectively. It justifies that use of chemicals does not necessarily yield higher profit.

Among many farming alternatives to intensive conventional systems, organic agriculture is one.[36] Despite lower yields, organic farming financially performs better than intensive conventional.[37] Indeed, when organic premiums are not taken into account, the BCRs 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 BCRs are 20–24% higher. Similarly, organic farming has been shown to be 2.7–3.8 times more profitable than conventional farming where prevailing price premiums are considered.[38]

Besides, in terms of cost structure, Crowder and Reganold[37] found that the total (variable and fixed) costs for organic and conventional farming systems

were relatively similar. Labor cost for organic was higher than for its conventional counterpart. However, this higher labor cost was offset by the limited use of purchased inputs (chemical pesticides and fertilizers).

Timsina[39] based on his review about current global situation of availability of organic materials advised to apply nutrients from inorganic and organic sources at 75:25 ratio instead of full amount through organic materials only. He further stated that organic nutrients alone are not sufficient to increase crop productivity and achieve food security. Organic crops (wheat, maize, and soybean) can produce up to 90% of conventionally produced counterparts.[40] They concluded that diverse and low input cropping system can be as productive as conventional system per unit of land.

Gross margins for all crops included in this study were higher from organic compared to conventional system except the tomato (organic 66% and conventional 68.3%) [Figure 1]. Compared to vegetables, gross margins of both organic and conventional rice were found very low. Thapa and Poudel[41] also found that the cost of production of vegetable is higher than that of cereal and the average net return from vegetable is 5–7 times more than the cereals. They further reported that profitability is higher in vegetables compared to other crops which was consistent with the finding of Ali[22] who reported that vegetables are more profitable than cereals both in terms of BCR and net return per unit area. Kunwar[42] from his study in eastern hills of Nepal found BCR of tomato, cabbage, cauliflower, and cucumber at 3.6 on an average against 1.1 of maize.

Result showed that almost 4% (average of organic and conventional) of every sales rupee from rice the producer got to use in the business and they must pay out remaining 96% of the rupee in direct costs to produce the rice. Gross margins of both the conventional and organic gourds were highest with an average of 74% in the study area. The reasons were the high productivity and low cost of production of the gourd compared to other vegetables. In overall, vegetables were found more profitable than rice in the study area. Organic vegetables were found even more profitable than conventional ones with average gross margins of 64% and 61%, respectively.

Profitability of organic production was found to be attributing to price incentives compensating

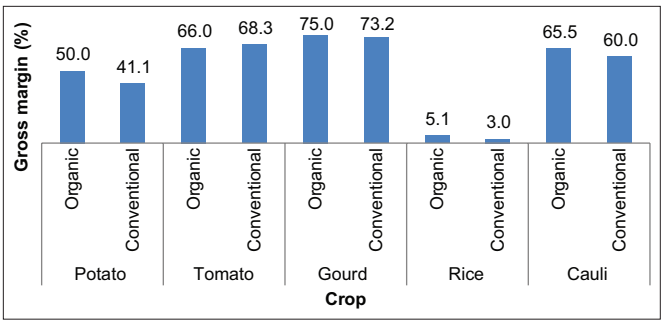

Figure 1: Gross margins of organic and conventional farming in the selected crops in the study area. Source: Field survey, 2019

reduced yield. However, price premium in rice was not found enough to compensate the reduced yield. Therefore, profitability of organic production basically depends on production and price of the organic products in the market.

CONCLUSION

Organic production is the issue of growing concern both in global and Nepalese contexts. Vegetables and potato are more profitable than cereals. Organic production of vegetables is equally profitable to conventional production in small scale farms. However, profitability of organic production depended on price premium, availability of appropriate organic substitutes of chemical inputs, and government's supports on transforming conventional production systems to the organic ones. Therefore, organic production technique is to be promoted among small farms particularly for vegetables and cash crops with the recycling of local resources and promotion of organic manures. In addition, comprehensive supportive policy, legislation, and institutional mechanisms are needed to promote organic farming in Nepal.

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