Research Article

PRODUCTIVE EFFICIENCY OF ORGANIC VEGETABLE GROWN IN KITCHEN GARDEN OF CHITWAN, NEPAL

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ABSTRACT

Kitchen gardening in general and organic vegetable production in particular are gaining popularity, and have been becoming indispensable component of Nepalese farming system. This concept could be promoted in order to reduce market dependency for vegetables; increase access to pesticide free products for home consumption, and for minimizing malnutrition and poverty. This research was done to estimate the cost, return, profitability and productive efficiency of organic vegetable grown in kitchen gardens of Chitwan using primary data, obtained from 123 randomly selected households. Samples were selected using simple random sampling techniques, and data were analyzed using Stata-12 for estimating descriptive statistics, Cobb-Douglas production function, allocative efficiency and frontier production function. Average size of holding for organic vegetable production was 0.65 kattha with gross margin of NRs. 9,312 per kattha and benefit cost ratio 2.19. Human labor, seed and organic manure significantly and positively contributed to the productivity of organic kitchen gardening, resulting return to scale value at 0.57. Majority of inputs, such as seed, organic manure, and irrigation were underutilized, and human labor was over utilized. Labour has been utilizing at technically efficient level in spite of its overutilization in allocative efficient measure. Almost all kitchen garden firms were operating at 90% efficiency and they require about NRs. 17,116 annual income per kattha for achieving this efficiency level. Organic vegetable production in kitchen garden system is profitable and there is scope to increase the expenditure on better seeds, organic manures, and irrigation for achieving the maximum productive efficiency by about 69, 61, and 496%, respectively. Policy support for promoting the distribution and adoption of vegetable seeds of improved varieties, composting, green manuring and increased use of irrigation seems fruitful to increase the productive efficiency of organic vegetable grown in kitchen garden of Chitwan district, Nepal.

Key words: Profitability, allocative efficiency, technical efficiency, benefit cost ratio

INTRODUCTION

Kitchen gardening is the traditional practice of growing vegetable and fruit in small piece of land adjacent to home particularly for meeting household demand of fruit and vegetables (Rai, 2017). It is becoming an indispensable part of Nepalese farming system for producing seasonal fruit and vegetables needed for household consumption which are daily sources of nutrients- protein, vitamins, minerals, fats and carbohydrates; the lack of which results in malnutrition and poverty (Subedi, 2007). Besides, Kitchen gardens also contribute to the functioning and sustainability of the larger agricultural ecosystem by providing shelter to many crops, insects and microbes (Engels, 2001); controls erosion and generally reduces application of pesticides (Daniels & Kirpatrick, 2006). About 72% of Nepalese households have kitchen gardens, occupying 2-11% of their total own land holding and supplies about 44% of total meal of households (Gautam et al., 2004). The practice of kitchen gardening is gradually becoming more popular even in urban and peri-urban areas of the country due to peoples' consciousness about the health hazards of pesticides, higher price of vegetables specially in off season, and for personal physical exercise as well.

Organic farming is one of the rapidly growing sectors in global food industry (Ellis et al*.,* 2006). It is defined as "a process that develops a viable and sustainable agro ecosystem" (IFOAM, 2000). Organic farming shies away from the use of inorganic chemical fertilizers and pesticides, and adopts crop management practices such as crop rotation, mix cropping, and sufficient incorporation of organic matters in the soil (Kuo et al., 2004). Nutrient management in organic farming systems is often based on soil fertility building via nitrogen fixation, nutrient recycling of organic manures and specific parts of plant like leaves and stalk/stem. Monoculture is another important reason for demanding more pesticides in the production of crops (Richards, 2001). But, Kitchen gardens are primarily focused for the production of family food products in mix cropping, rotational cropping, relay cropping, multistoried cropping, and thus helps to minimize the larger dose of pesticides use. In addition to this, gradual increasing peoples' awareness on health hazards of pesticides has motivated them to grow at least certain fruit and vegetables in pesticide free environment in their kitchen gardens.

Households have been trying to grow diverse species of vegetables and fruit in their kitchen garden focusing on organic by default system. It seems rational to assess some location specific findings on the productive efficiency of vegetable production on this system for promoting productivity, profitability and efficiency of inputs used.

Productive efficiency is the product of technical and allocative efficiency. Technical efficiency is the ratio of the observed output to corresponding frontier output in the given constant technology. Whereas, allocative efficiency is the capacity of firm to produce targeted quantity of output at the least cost (Farrel, 1957). In this context, this research was done with the objectives of estimating cost, return, profitability, allocative efficiency, and technical efficiency of organic vegetable grown in the kitchen gardens of Chitwan district of Nepal. The findings of the study could support in promoting organic vegetable production in Kitchen gardens through the suggestions related to the efficient use and combination of different factors of production.

METHODOLOGY

Study area and sampling

The study was done in the six geographical clusters (former VDCs) namely Padampur, Jutpani, Phulbari, Mangalpur, Meghauli, and Sukranagar in Chitwan district of Nepal. Two farmers' group formed through the initiation of Global Pollination Project (GPP) were selected purposively from each cluster to study different ten eco-friendly practices including kitchen garden. A total of 300 farmers were selected randomly using simple random sampling technique to study different eco-friendly practices from these selected 12 groups and 123 households were found adopting organic system of vegetable production in their kitchen garden.

Collection and analysis of data

Primary data were collected with the use of structured questionnaire by adopting face to face interview technique. After the collection of necessary information, it was coded and entered in SPSS data entry sheet, and analyzed by using Stata-12. Collected data were analyzed with descriptive and statistical methods. The budgeting technique employed in the study was the gross income and gross margin. Analytical tools such as mean, frequency, percentage, Cobb-Douglas regression technique, and frontier regression techniques were used to analyze the data.

Cost, return and profitability

All variable inputs such as human labor, seed, organic manures and irrigation cost were considered, and valued at current market prices to calculate cost of production.

Total variable cost = $C_{labour} + C_{seed} + C_{manure} + C_{irrigation}$

Where,

C_{labor} = Cost on human labor used (NRs./kattha), C_{seed} = Cost on seed (NRs./kattha), C_{manure} = Cost of manure (NRs./kattha), and C_{irri} = Cost on irrigation (NRs./kattha)

Gross return was calculated by multiplying the total volume of vegetables production based by the average market price at harvest season (Dillon & Hardaker, 1993). Thus gross return was calculated by using following formula:

Gross return (NRs./kattha) = Total quantity produced (kg/kattha) × Price of vegetables (NRs./kg)

Gross margin calculation was done to have an estimate of the difference between the gross return and variable costs. Gross margin was calculated by using the method given by Olukosi et al. (2006), using following formula:

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

Furthermore, average cost of per kilogram of vegetable production was calculated as the ratio of total variable cost (NRs./kg) to productivity (kg/kattha). Similarly, average gross margin (NRs./kg) was calculated as the ratio of gross margin (NRs./kattha) to productivity (kg/kattha).

Undiscounted benefit cost ratio was estimated as a ratio of gross return and total variable cost. Thus, the following formula:

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

Production function analysis

Cobb-Douglas production function is the most widely used multiplicative and non linear form of production function related to the agricultural research, and is convenient for the comparison of the partial elasticity coefficient (Prajneshu, 2008). The marginal productivity of factors, marginal rate of substitution, and the efficiency of production can be calculated directly from parameters in Cobb-Douglas type of production function. Thus, Cobb-Douglas production function of the following form was fitted to examine the resource productivity, efficiency and return to scale:

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

Where,

Y= Gross return (NRs./kattha),

X_1= Cost on seed (NRs./kattha),

X_2= Cost on tractor labor (NRs./kattha),

X_3= Cost on organic manure (NRs./kattha),

X_4= Cost on irrigation (NRs./kattha),

e=Base of natural logarithm,

u = Random disturbance term,

a=Constant, and

b1, b2,.....b4=Coefficients of respective variables.

The Cobb-Douglas production function in the form expressed above was linearised to a logarithmic function with a view of getting a form amenable to practical purposes using Ordinary Least Square (OLS) technique as expressed below:

$lnY= lna+b_1lnX_1+b_2lnX_2+b_3lnX_3+b_4lnX_4+u$

Where,

ln= Natural logarithm, and u= error term.

For the calculation of return to scale on organic vegetable production, coefficients from Cobb-Douglas production function was used, and calculation was done by using the following formula:

Return to scale (RTS)= $\sum bi$

Where, bi = Coefficient of i^{th} explanatory variables.

Return to scale with value greater than unity represents increasing return to scale, value equal to unity represents constant return to scale, and value less than unity represents decreasing return to scale.

Resource use efficiency (Re)

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

r= MVP/MFC

Where, r= Efficiency ratio, MVP= Marginal value product of a variable input, and MFC= Marginal factor cost (Goni et al., 2007)

The standard way to examine such efficiency is to compare MVP with the MFC of each variable input. If MFC_{Xi} divides MVP_{Xi}, the results will be equal to the value of MVP_{Xi} because MFC at all cases is equal to Re. 1. As the MFC is price of input per unit, the MFCs of all the inputs will vary while calculating the ratio of MVP to MFC. However, the denominator will always be one, and therefore, the ratio will be equal to their respective MVP (Majumder et al., 2009). The marginal value productivity of a particular resource represents the additional gross return in value term caused by an additional one unit of that resource, while other inputs are held constant. The most variable, perhaps the most useful estimate of MVP is obtained taking resources as well as gross return at their geometric means (Dhawan & Bansal, 1977). Since all the variables of the model were measured in monetary value, the slope coefficients of the explanatory variables in the function represent the MVP, which was computed by multiplying the production coefficient (elasticity, in this particular case) of a given resource with the ratio of geometric mean value of output and input variables (Rabbani et al., 2013). Therefore, MVP_{xi}= dy/dxi, which is the product of regression coefficient with ratio of geometric mean of gross return to the level of use of i^{th} resource.

According to the conventional neo-classical test of economic efficiency, decision rule for resource use efficiency is made based on the value of efficiency ratio (r). Efficiency ratio equal to unity indicates the optimum use of that factor, the ratio more than unity indicates that gross return could be increased by using more of the resource and the ratio of less than unity indicates the excess use of resource which should be decreased to minimize the loss. Again, the relative percentage change in MVP of each resource required to obtain optimal resource allocation, i.e. r=1 or MVP= MFC was estimated using the following equation:

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

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

Where, D= absolute value of percentage change in MVP of each resource and r = efficiency ratio (Mijindadi, 1980).

Technical Efficiency (TE)

Stochastic frontier production model suggested by Battese and Coelli (1995) was used for determining technical efficiency of organic vegetable production in the study. The stochastic frontier production function differs from traditional production function as it consists of two error terms. The first error term accounts for technical efficiency and the second error term for factors such as measurement error in the output variables, weather condition, and combined effects of unobserved inputs. According to Battese and Coelli (1995), the stochastic production frontier to estimate the technical efficiency for the study was defined as:

Technical Efficiency (TE)=Yi/Yi^*

Where,

Y_i^*=Frontier output

The following forms of Cobb-Douglas frontier production function was used to estimate the function required for estimating the technical efficiency:

$$LnY_i = B_o + B_1 LnX_1 + B_2 LnX_2 + B_3 LnX_3 + B_4 LnX_4 + V_i - U_i$$

Where,

Y_i is annual value of vegetable produced in NRs. per kattha

X_1 is cost of human labour in NRs. per kattha

X_2 is cost of seed in NRs. per kattha

X_3 is cost of organic manure in NRs. per kattha

X_4 is cost of irrigation in NRs. per kattha

U_i is random error

V_i is technical efficiency, and

B_0, B_1------B_5 are coefficients to be estimated

RESULTS AND DISCUSSION

Cost of production

Human labor rendered the largest cost component in organic vegetable production in the kitchen garden. It was required for different operations, such as land preparation, organic manure preparation and application seed sowing, irrigation, and other intercultural operations. The cost of human labor in kitchen gardening (per kattha[1]) was estimated as NRs.5,053 (Table 1). Labor cost accounted 64.75% of total variable cost. It is revealed that kitchen gardening activity in the study area is labor intensive. To produce organic vegetables, per kattha cost on seed accounted NRs. 523.83, that constituted about 6.71% of total variable cost of production. Similarly, cost of

1 1 ha=30 kattha

irrigation per kattha was NRs. 384.35 that accounted about 4.92% of total cost of production. The major source of irrigation water for kitchen garden was tube well, assisted with electric water lifting pump (Table 1).

Table 1. Cost of production (NRs./kattha) of organic vegetable production in kitchen garden

Items of cost	Mean	Percent of total cost
Human labor	5,053.01	64.75
Seed	523.83	6.71
Organic manures	1,843.02	23.62
Irrigation	384.35	4.92
Total cost	7,804.21	100.00

Returns and profit

The average size of kitchen gardening, as revealed in this study was 0.65 kattha of land (Table 2) whereas gross return, and total cost of production was estimated as NRs. 17116.4 per kattha and NRs. 7804.21 per kattha, respectively. Gross margin was NRs. 9312.19 per kattha. It was known that the overall undiscounted cost benefit ratio considering total variable cost was 2.19. Thus, production from kitchen gardening was logically profitable in the study area (Table 2).

Table 2. Economic statement of organic vegetable production

Measuring criteria	Average value
Area (kattha)	0.65
Gross return(NRs./kattha)	17,116
Total cost (NRs./kattha)	7,804
Gross margin (NRs./kattha)	9,312
Benefit cost ratio	2.2

Resource use and allocative efficiency

Multiple regression analysis is a statistical tool that allows researchers to examine how multiple independent variables are related to a dependent variable (Higgins, 2005). Estimated values of coefficient, and related statistics of multiple form of regression function of kitchen gardening are shown in Table (3). Among four explanatory variables, labor costs and organic manure costs were significant ($p<0.001$). The regression coefficient for labor cost was 0.22, meaning, 100% increase in costs on labor, gross return would increase by about 22%. Similarly, with the increase in organic manure cost by 100%, gross return would increased by about 26% (coefficient, 0.264) which might have resulted due to high productivity related to the fertile soil condition. This result is in contrary to the findings of Abdulai (2006) as the study reported labor cost to be insignificant on resource use efficiency in vegetable production in the case of smallholder farmers in the Kumasi metropolis of Ghana. The sum of all regression coefficients of different inputs stood at 0.57 for vegetable production in kitchen garden. This indicates that the production function exhibited a decreasing return to scale. This implies that if all the inputs specified in the function are increased by 100%, income will increase by only about 57%. Similar result of having decreasing returns to scale in organic vegetable production was also reported in Swaziland (Kongolo, 2014).

Table 3. Estimated values of coefficients and related statistics of Cobb-Douglas production function

Factors	Coefficient	Std. Error	t-value	Sig. level
Constant	5.23**	0.568	9.36	0.010
Human labor cost (NRs./kattha)	0.218**	0.06	3.61	0.001
Seed cost (NRs./kattha)	0.094*	0.472	2	0.047
Organic manure cost (NRs./kattha)	0.264**	0.573	5.57	0.001
Irrigation cost (NRs./kattha)	-0.005	0.037	-0.04	0.969
F-value	16.53**			0.001
R^2	0.36			
Adjusted R^2	0.338			
Return to scale	0.571			

Note: **Significant at 1% level of confidence * Significant at 5% level of confidence

The adjustment in the MVPs for optimal resource use presented has been presented in Table (4) which indicates that seed cost and organic manure cost were underutilized and required to be increased by about 69% and 61%, respectively. Increased expenditure on seed cost and organic manure cost can be utilized by purchasing improved seed and quality organic manure. In the case of labor cost, it is over utilized, and it should be decreased by about 30%.

Table 4. Allocative efficiency of inputs used in organic vegetable production in study area

Inputs (NRs./kattha)	Geometric Mean	MVP	MFC	MVP/MFC	Efficiency	Adjustment required (%)
Human labor	4,726.51	0.76	1.00	0.76	Over utilized	-30.43
Seed	488.87	3.19	1.00	3.19	Under utilized	68.71
Organic manure	1,721.18	2.55	1.00	2.55	Under utilized	60.77
Irrigation	329.23	-0.25	1.00	-0.25	Under utilized	496.13

Technical efficiency

Labour cost, seed cost, organic manure cost, and irrigation cost were four productive factors used to measure technical efficiency of vegetable production in Kitchen gardens of the study area. All factors of production included in the analysis had positive effect on gross return. Labour had significant effect ($p<0.001$) with its coefficient as 0.245 which suggest that with 10% increase in labour cost, there would be 2.55% increase in the output. Use of more labor for better vegetable production practices could increase the yield/outputs. Similar result was also reported by Bajracharya and Sapkota (2017). Almost all kitchen garden firms were operating at 90% technical efficiency and they required NRs. 17,116 annual income on per kattha basis to achieve such efficiency level (Table 5).

Table 5. Technical efficiency of organic vegetable production in kitchen garden system in Chitwan, Nepal

Parameters	Coefficient	Std. error	Z	p-value
LN labour cost	0.245	0.067	3.65	0.001
LN seed cost	0.068	0.051	1.33	0.182
LN manure cost	0.047	0.057	0.83	0.404
LN irrigation cost	0.014	0.040	0.35	0.729
Constant	6.790	0.687	9.88	0.000
LNsig2v	-3.089	0.127	-24.18	0.001
LN sig2u	-11.58	110.96	-0.10	0917
Sigma_v	0.213	0.013		
Sigma_u	0.003	0.169		
Sigma2	0.045	0.005		
Lambda	0.014	0.171		
No. of observations				123
Wald Chi-squared				29.90
P-value for Chi-squared				0.001
Percentage of kitchen garden firms with more than 90% efficiency				100
Level of per katha annual income in NRs. for achieving 90% efficiency				17,116

CONCLUSION

Organic kitchen gardening was adopted on an average of 0.65 kattha of land with estimated gross margin of about NRs. 9312 per Kattha in Chitwan. It was learned that the overall undiscounted cost benefit ratio considering total variable cost was 2.19. Labor seed, and organic manure significantly contributed to the productivity of organic kitchen gardening, resulting return to scale value at 0.57. In organic kitchen gardening practice, inputs such as seed, organic manure, and irrigation were underutilized, and labor was over utilized. However, labour has been utilizing at technically efficient level in spite of its overutilization in the measure of allocative efficiency. Use of more labor for better vegetable management practices could increase the production, but at decreasing return to scale. Almost all kitchen garden firms were operating at 90% efficiency and they require NRs. 17,116 annual income on per kattha basis to achieve such efficiency level. Thus, it is well revealed that organic vegetable production in kitchen garden system is profitable, and it has potentiality to increase the expenditure on better seeds, organic manures, and irrigation for achieving the maximum productive efficiency. Policy support for promoting the distribution and adoption of vegetable seeds of improved varieties; increased use of farm yard manure, green manure and compost; and enhanced level of irrigation seems fruitful to increase the productive efficiency of organic vegetable production grown in the kitchen garden.

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