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Resource use efficiency and economies of scale for ginger production in Ilam district, Nepal

Anish Shrestha[1,*] Shiva Chandra Dhakal[2] Rishi Ram Kattel[3] Ankit Koirala[4]

[1]Agribusiness Promotion Support and Training Center, Khajura, Banke
[2,3,4]Agriculture and Forestry University, Rampur, Chitwan

[*]Corresponding Author: anishshrestha474@gmail.com

Abstract

This study was conducted in the Ilam district of Nepal to analyse resource use efficiency and economies of scale of ginger farming. A total of 160 farmers and 20 traders (collector, wholesaler and retailers) from the study area were randomly selected as the sample. The pre-tested systematic questionnaire, fitted in KoBo Toolbox, was used to obtain the primary data through face to face household interviews. The production function of ginger farming was in increasing return to scale, with a score of 1.1356. The result showed that expenditure on seed and labour was over utilised. Except for these two, other inputs of ginger farming were underutilised. Economies of scale for ginger production was 44 quintal in production quantity and 5.68 ropani (1 hectare=19.66 ropani) in area. To obtain economies of scale, ginger production and size must be increased by around double the present context. The study concluded that to increase the profitability of ginger farming, resources must be utilised in optimum conditions, and production scale must be increased.

Keywords: Economies of scale, Ginger farming, Resource use efficiency, Return to scale

Introduction

Ginger (*Zingiber officinale*) is an important commercial crop of Nepal, involving seventy thousand farming families among 3.8 million farming families of the nation (Pandey, 2012). Ginger is mainly being cultivated in the mid-hill region and on a small scale in the terai areas of Nepal. Ginger is an important, highly valued spice crop in the international market for its aroma, pungency, oil and oleoresin (ANSAB, 2011; Paudel and Timsina, 2017). Even though Nepal has an agriculture-based economy, it imports lots of agricultural goods. The import-export ratio of Nepal stands at 12.2, and to reduce that nation should look toward high-value crops such as ginger for the betterment of the economy (DOC, 2020; Karki, 2015). Nepal is the world's fourth largest ginger exporter in the world, after China, Netherlands and India, with the 24 MT of annual export. Main industrial buyers of gingers are the food, pharmaceutical and cosmetics industries. Nepal mostly exports ginger in fresh form and traditionally dried form as Sutho**.** Besides those, different forms of ginger, such as powder, candy, oil, pickle, etc., are also potential products for domestic and foreign markets (Adhikari, 2016; GIZ, 2017).

Nepal has a comparative advantage in ginger production due to the lower labour cost, well adapted local varieties, climatic suitability, low cost of production inputs etc. (TEPC, 2017). Even though ginger has such potential, most farmers are reluctant toward ginger farming on a commercial scale. To attract farmers toward the ginger farming first thing that needs to be ensured is its profitability. To ensure higher profitability and contribution of ginger in improving the livelihood of farmers, efficient cost structure and appropriate level of input utilisation must be understood and recommended (Pandey, Adhikari, Dhakal, and Timsina, 2015; Sonwani, Koshta, and Tigga, 2018). So, this study was conducted in the Ilam district of Nepal to analyse resource use efficiency and economies of scale of ginger farming.

Materials and methods

Study area

The study was conducted in the Ilam district of Nepal, which lies in a mid-hill region of eastern Nepal. The district covers a 1073 Km^2 area and

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Orcid: Anish Shrestha: https://orcid.org/0000-0003-2941-9828 , Shiva Chandra Dhakal: https://orcid.org/0000-0002-2801-8937 , Rishi Ram Kattel: https://orcid.org/0000-0002-6234-5595 , Ankit Koirala: https://orcid.org/0000-0001-9258-5509
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consists population of 290,254 (CBS, 2011). Most of the area is covered by sub-tropical (40.1%) and upper tropical (33.5%) climatic zone (Lilleso et al., 2005). Four villages of Ilam district, namely Ekatappa, Bhanjyang, Barbote and Mage, were selected as the study area, as they were the district's main ginger-producing sites (DADO, 2016).

Selection of respondents

All the Ginger growing farmers, ginger traders, and other personals linked with ginger production and trading in Ilam were the study's target population. From those four villages, a total of 160 farmers and 20 traders (collector, wholesaler and retailers) were randomly selected as the sample.

Data collection and analysis

The pre-tested systematic questionnaire, fitted in KoBo Toolbox, was used to obtain the primary data through face to face household interviews in February 2018. Additional data were obtained through five focus group discussions (FGD) and key informant interviews (KII). Information obtained from interviews was cross-checked during FGD and KII. Stata and Microsoft Excel were used for data import, management and analysis processes. Secondary data were also used for cross-checking and interpretation.

Cost of production

Production is the process where inputs are transformed into outputs, which can produce utilities. Cost of production is the sum of expenditure on inputs for any kind of production (Raju and Rao, 2019). The cost of all the variable inputs of ginger farming was included in the estimation of production cost.

Total Cost = Cost of (Land rent + Seed + Nutrients + Protection measures + Labor)

Benefit-cost analysis (B:C ratio)

Benefit-cost analysis is the process of analysing the economic performance of an enterprise. B:C ratio represents the proportion of total return to the total cost of production. It represents the total return per unit of input expense (Shrestha, 2017; Baral, Marahatta and Shrestha, 2021), which was estimated using the following formula

B:C ratio = Total return/Total cost

Profit analysis

Profit is the financial gain obtained from expenditure on inputs. It is the surplus return after detecting the total cost of production (Debertin, 2013; Baral, Marahatta and Shrestha, 2021). Thus, net profit for any farm business can be written as;

$\Pi = TR - TC$

$\Pi = \sum P_y \times Y - \sum P_{xi} \times X$

Where,

Π = net profit TR = total return

TC = total cost Y = quantity of output

Xi = quantity of i^{th} input Py = price of output

Pxi = price of i^{th} input

Factors affecting ginger production

To estimate the factors affecting ginger production, the Cobb-Douglas production function was used. Such a production model was implemented by Islam et al. (2012) and Baral, Marahattha and Shrestha (2021). The production value was the dependent variable, and the cost of production inputs (seed, nutrients, protection measures, labour, and land rent) were the independent variables.

The estimating model for the coefficients of ginger production is the following:

$Yg = a\, L^{b1} S^{b2} N^{b3} P^{b4} Lr^{b5} eu$

By taking log on both sides, that can be presented in linear form as follows;

$\ln Yg = \ln a + b1 \ln L + b2 \ln S + b3 \ln N + b4 \ln P + b5 \ln Lr$

Where, Yg= Ginger production (NRs),

L = Land rent (NRs)

S = Cost of seed (NRs)

N = Cost of nutrients (FYM + chemical fertilizer)

P = Cost of protection measures

Lr = Cost of labor (included animal cost)

a = Intercept

bi = Slope coeeficient

The sum of elasticity of production bi represent returns to scale. Returns to scale can be defined as the variation in output caused by given proportionate variation in all the factors of production simultaneously (Barkley and Barkley, 2013; Debertin, 2013).

Analysis of resource use efficiency

The resource use efficiency of ginger farming was estimated by dividing Marginal Value Product (MVP) to Marginal Factor Cost (MFC) of variable inputs (Rahman and Lawal, 2003). The resource use efficiency of ginger farming was estimated by using the following formulae and concepts (Abid et al., 2011; Karthick, Alagumani, and Amarnath, 2013; Mohammed, Abubakar, and Haruna, 2014; Ibitoye, Shaibu, and Omole, 2015; Umar and Abdulkadir, 2015);

R = MVP/MFC

Where,

R = Efficiency Ratio

MVP = Marginal Value Product

MFC = Marginal Factor Cost

The values of efficiency ratio were interpreted as follow,

a) If R < 1, it means that resources are over utilised. Therefore, if the quantity of such input is increased, profit will decrease, and for higher efficiency quantity of such input must be decreased.

b) If R > 1, it means that resources are underutilised. Therefore, if such input is increased, profit will increase, and form will be more efficient.

c) If R = 1, it means that the resource was being efficiently utilised, and no change in the quantity of such inputs is desired.

The value of MVP was estimated using the regression coefficient of each production input and the price of output, MVP = MPPxi × Py

And, MPPxi = dy/dxi = biY/Xi

Where,

bi = Estimated regression coefficient of input xi

Py = Unit price of output

Y = Geometric mean value of output

Xi = Geometric mean value of input being used

The current market price of input at the time of the study was used as MFC.

MFC = Pxi

Where, Pxi = Unit price of input xi

Again, the relative percentage change in MVP of each resource required to obtain optimal resource allocation or efficient production system, i.e. R = 1 or MVP = MFC, was estimated using the following equation;

D = (1 –MVP/MFC) × 100%

Or, D = (1 –1/R) × 100%

Where,

D = Absolute value of percentage change in MVP of each resource (Mijindadi, 1980)

Short-run cost function

Short-run average cost functions were estimated and plotted against the output of ginger farming. The average cost and quantity of output produced were assessed utilising the quadratic cost function. Short-run average cost functions were fitted and interpreted to determine the least cost of production or economies of scale of ginger production. Economies of scale are the level of production, where the cost of production per unit becomes lowest. The function of the following form was used in the study (Greer, 2011; Raju and Rao, 2019);

Average Cost = f (Quantity produced)

Which can be written as;

$Y_{ac} = a_1 + b_1 Q + b_2 Q^2$

Where, Y_{ac} = Average cost (NRs./quintal)

Q = Output quantity (quintal)

Q^2 = Square of output quantity

a = Intercept

bi = Slope coefficient

Result and discussion

Cost of ginger production

The average cost of ginger cultivation per ropani and Kg were estimated to be NRs. 12,400 and NRs. 16, respectively. ANSAB (2011) and Timsina (2010) suggested a similar cost of production in their findings, and contrary to that, Pandey et al. (2015) reported production cost to be 1.5 times more than the finding of this research. The seed cost was the highest contributor to the total cost, with a proportion of 42.31%. Similar to the findings of this research, ANSAB (2011), Timsina (2010), and Sonwani et al. (2018) all reported the cost of seed as the main contributor of ginger farming cost. Although Pandey et al. (2015) and Paudel et al. (2016) suggested a similar scenario, they suggested the share of the seed's cost to be almost 1.5 times more than a finding of this research.

Table 1. Cost of Ginger production in study area per ropani.

Particulars	Total (NRs.)	Share (%)
Seed	5250	42.34
Labor	3950	31.85
Land rent	2000	16.13
Nutrients	1050	8.47
Pesticides	150	1.21
Grand total cost	12400	100
The average cost of production (per Kg)	16	

Cost, return, profit and B:C ratio of ginger cultivation

The average cost, return and profit from ginger cultivation per ropani was NRs. 12,400, NRs. 17,050 and NRs. 4,650, respectively. Luitel (2009), Timsina (2010) and DADO (2016) suggested a similar cost of production but reported higher return and profit compared to this finding. That might result from a partial ban on import from the Indian Government and increased cases of root rot infestation (Adhikari, 2016). Average B:C ratio of ginger farming was estimated to be 1.38, with the range of 1.10 to 1.78. Similar results were also stated by Nmadu and Marcus (2012), Pandey et al. (2015) and DADO (2016). But Timsina (2010), Bhat et al. (2012) and Paudel et al. (2016) reported the B:C ratio of ginger farming at least twice of our findings.

Factors affecting ginger production

The result showed that labour cost and seed cost were significant at 1% level, while cost of nutrients and land rent were significant at 5% and positively affected ginger production. The cost of plant protection chemicals had a positive but insignificant effect on ginger production. Similarly, Paudel et al. (2016) and Islam et al. (2012) suggested that the cost of seed, labour, land rent and nutrient cost have a positive and significant effect on ginger farming. But, Paudel et al. (2017) suggested that the cost of plant protection measures also positively and significantly impacts ginger production.

The F value of the model was significant at a 1% level with a score of 107.70 that indicates independent variables of the model largely contributes to the total variation of the model. The sum of the coefficients was estimated to be 1.1356, which implies production function is an increasing return to scale. The result implies that if all the inputs specified in the function are increased by 100% return will increase by 113.56%. Similar to our finding, Ayodele and Sambo (2014) and Sakamma, Umesh, and Rangegowda (2018) suggested increasing return to scale, but Paudel et al. (2016) reported decreasing return to scale for ginger production function. The coefficient of multiple determinations (R^2) was estimated at 0.78 that indicates 78% of total variations of production function caused by independent variables of the model. Other details of resource use efficiency or factors contributing to ginger production or return are shown in Table 3.

Resource use efficiency and required adjustment in marginal value product (MVP) of each resource

The result showed that expenditure on seed and labour was over utilised. Except for these two, other inputs of ginger farming were underutilised. The findings of the study showed that utilisation of production inputs was not at the optimum level. The level of resource utilisation must be adjusted to ensure efficient resource utilisation and optimum economic gain.

Similar to the finding of this research, Sakamma et al. (2018) and Anamayi and Anamayi (2018) reported that nutrients and plant protection are being underutilised and, seed and labour are over utilised. Contrary to our finding, Anamayi and Anamayi (2018) reported that nutrients and land are overutilised, and Mathew et al. (2017) reported underutilised seed and labour. Such findings show that resource use efficiency heavily relies on farmers' farming system, management, and cultivation practice.

Table 2. Cost, return and profit of ginger cultivation per ropani (NRs.) in the study area

Description	Minimum	Maximum	Mean
Cost	8310	16624	12400 (1408)
Return	12474	23760	17050 (1793)
Profit	1357	8802	4650 (1631)
B:C ratio	1.1	1.78	1.38

Note: Figures in parentheses indicates standard deviation

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

Factors	Coefficient (bi)	Std. Error	t-value	P> | t |
Labor cost	0.1264***	0.0479	5.64	0.003
Seed or rhizome cost	0.3046***	0.0539	3.47	0.001
Land rent	0.3941**	0.0724	5.44	0.011
Cost of nutrients	0.2927**	0.0608	4.82	0.032
Cost of plant protection	0.0178	0.0131	1.35	0.178
Constant	2.4032	0.4504	5.34	0.000
F-value	107.70***			0.001
R square	0.78			
Adjusted R-square	0.77			
Return to scale	1.1356			

Note: *** and ** indicate 1% and 5% levels of significance, respectively.

Table 4. Estimated resource use efficiency and required adjustment in MVP of each resource for ginger production

Inputs	Bi	MVP	MFC	R	D-value	Decision
Labor cost	0.1264	0.55	1	0.55	-81.81	Over utilised
Seed or rhizome cost	0.3046	0.99	1	0.99	-1.09	Over utilised
Land rent	0.3941	3.36	1	3.36	70.24	Underutilised
Cost of nutrients	0.2927	4.75	1	4.75	78.95	Underutilised
Cost of plant protection	0.0178	2.02	1	2.02	50.50	Underutilised

Economies of scale for ginger production

It was determined that ginger production economies in the study area were 44 quintals in quantity term and 5.68 ropani in area term. Comparing these economies of scale with the current context of farming (2.74 ropani and 21.24 quintal), ginger farming is operating way below its optimum condition. To obtain the least cost condition or economies of scale, ginger production and area must be increased by around double the present context. Further details are shown in Table 5.

Table 5. Cost function used to derive economies of scale for ginger production

Explanatory variables	Coefficient	Std. error	T	P>t
Production (Quintal)	-21.068	3.609	-5.84	0.001
Square of production (Quintal)	0.241	0.042	5.68	0.001
Constant	1899.508	50.961	37.27	0.001
Economies of scale = 44 quintal = 5.68 ropani area under ginger production per farm				

N = 160, F (2,157) = 17.24, Prob > F = 0.001, R-squared = 0.18 and adjusted R-squared = 0.17

Conclusion

A study of resource use efficiency and economies of scale for ginger production showed that ginger farming performs with very low profit on expenditure. As average B:C ratio of ginger farming was estimated to be just 1.38. This showed that the production level of ginger farming is not at its optimum level. It is supported by the findings of this research, as analysis of production function showed that production of ginger farming was in increasing return to scale (RTS=1.13). That clearly indicates increased production level can increase the profitability of ginger farming. Besides that, analysis of cost function also showed that to obtain the least cost condition or economies of scale, ginger production and area must be increased by double the present context in the case of an individual farming family. Expenditure on seed and labour was over utilised, but other inputs of ginger farming were underutilised. The utilisation of production inputs was not at the optimum level. The level of resource utilisation must be adjusted to ensure efficient resource utilisation and optimum economic gain. To sum up the research findings, it can be stated that to increase the profitability of ginger farming, resources must be utilised to optimum condition, and production scale must be increased.

Compliance with Ethical Standards

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

Corresponding author conducted the research and prepared manuscript. Other authors contributed in research design. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before

Ethical approval

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Data availability

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