Technical Efficiency of Pole Snap Bean (*Phaseolus vulgaris* L.) Farmers in Nueva Vizcaya, Philippines

Gayon P. Sarmiento[1]

[1] Department of Agribusiness, Nueva Vizcaya State University, Bayombong 3700, Nueva Vizcaya

Keywords:

Technical efficiency, pole snap bean production

ABSTRACT

Productivity of pole snap bean farmers can be improved by adoption of better production technologies, or improvement of production efficiencies, or both. However, since producers of pole snap beans are marginal farmers on marginal lands, adoption of improved production technologies are very slow; hence, improvement in efficiency becomes the better option. This study determined efficiencies of pole snap bean farmers in Nueva Vizcaya, Philippines. Multistage random sampling was adopted with a total of 90 farmers interviewed. The stochastic production frontier was used to estimate technical efficiency. The Cobb-Douglas production function was applied since this function fits agricultural data well. Results revealed that pole snap bean production in Nueva Vizcaya is technically inefficient. Technical efficiency estimates showed that seed was significant at 10%, while fertilizer, insecticide, fungicide and herbicide were significant at 1%. This implies that the amount of seed, fertilizer, insecticide, fungicide and herbicide applied have significant effects on the production of pole snap beans. Improving technical efficiency of farmers therefore, may result in better yield, lesser cost and higher net returns. Socioeconomic factors of farmers such as years of schooling and access to credit significantly influenced the farmers' technical efficiency. Moreover, results showed that pole snap bean producers lack technical knowledge particularly on the use of commercial inputs. Government interventions, such as seminars and trainings, may then be necessary to improve efficiency of pole snap bean farmers. Farmers' associations and cooperatives may be of help for farmers to have access to formal credit.

SIGNIFICANCE OF THE STUDY

The economy of Nueva Vizcaya is basically agricultural. Majority of its population depend on agriculture as their source of livelihood. Pole snap bean is one of the vegetables produced in the province and is considered a priority crop according to the Department of Agriculture. However, even if it is a priority crop, research on this crop is lacking. Most researches are centered on rice, citrus, tomatoes, eggplants and other high-value crops. Hence, studying this commodity may help marginal farmers improve their production in areas where high value crops could not be planted.

Increasing production and productivity of pole snap bean farmers is important in alleviating poverty and increasing their income. This may, in effect, improve the economy of the province. The volume of production of pole snap beans in Nueva Vizcaya is increasing (with a slight decrease in year 2011) however; this may be due to increase in area planted and not due to efficiency in production (Appendix-Table 2).

One way of increasing production is to examine how farmers are efficiently using their resources or inputs of production. If resource used is inefficient, making adjustments in the use of factors of production in an optimal direction can increase production. If it is efficient, other sources of productivity growth such as adoption of modern inputs and improved production technology may be identified.

OBJECTIVES

The general objective of this study was to evaluate the economics of resource utilization of farmers and determine technical efficiency of farmers producing pole snap beans in Nueva Vizcaya, Philippines.
Specifically, the study aimed to:

1. describe the socioeconomic characteristics of pole snap bean farmers;
2. examine the technical efficiency of pole snap bean farmers;
3. recommend policies to improve the income of pole snap bean farmers.

LITERATURE REVIEW

Barno (1993)'s investigation on farmers' resource allocation for vegetable crops in Benguet province identified optimal resource allocation using a linear programming model. In the input use efficiency analysis using a production function, most of the factors considered to determine output were insignificant. Land was the only factor that significantly accounted for the variation in output.

The study of Anupama, Singh and Kumar (2005) on technical efficiency in maize production made use of the frontier production function with labor, fertilizer, capital (which included expenditure on animal and machine labor, seeds and pesticides) as variables. They found out that technology adoption of the farmers is poor.

CONCEPTUAL FRAMEWORK

The basic model used to measure technical efficiency in a one-variable input and one output case is illustrated in Figure 1. The curve Y frontier is the highest possible output that a farmer can achieve. The curve Y average shows the average output as input X increases. Since the Y frontier is the maximum possible output that the farmer can achieve, then all the points lying below are technically inefficient because they give less output at given levels of input.

Distance A is the farmer's inefficiency because the farmer is not operating in the Y-frontier. Inefficiency would be A. Technical inefficiency is therefore the failure of a farmer to operate on the production frontier (the maximum possible production output that a farmer can achieve) due to errors in the timing or method of application of inputs. Likely causes of inefficiencies may be inadequate information, insufficient technical skills and untimely use of input.

The Cobb-Douglas production

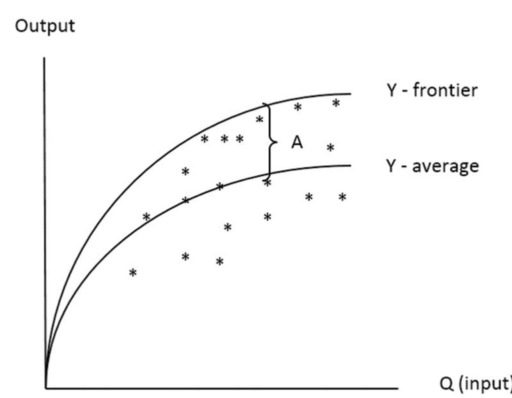

Figure 1. Average and frontier production functions

function was used since it fits agricultural data well; it exhibits many properties, which makes it very useful for studies of this type, in that the estimated coefficients would be the output elasticity of the respective input variable. The sum of the coefficients would give the returns to scale of the inputs. If the sum is greater than 1 then there is increasing returns to scale, if equal to 1, there is constant returns to scale, and if less than 1, then a decreasing returns to scale.

The Cobb-Douglas function is presented in the following general form:

(1) $Yj = \Pi X_{ij}^{bi} e_j$

where:

Π is the total productivity
Yj is the output;
Xi are the variable inputs;
bi are the regression coefficients of the Xi respectively;
u is the random disturbance term; and
e is a natural exponent

Equation (1) is estimated using ordinary least squares (OLS). In this case, about half of the observations will lie above and half will be below the OLS estimation function.
To estimate technical efficiency, equation (1) must be transformed into a stochastic function with a decomposed error term.

(2) $e_i = v_i + u_i$

The error component v_i is a normal, $N(0, \sigma_v^2)$, stochastic disturbance. It represents error or any random, two-sided shock in the production process not explained by differing levels of efficiency across firms. The value of v, therefore, may either be positive, negative, or zero. The component *u* is a one-sided non-negative error. The economic meaning of the *u* component is that each firm must lie either on or below the production frontier (Lee and Tyler, 1978). If *u* takes the value less than zero, the firm is not technically efficient and the firms obtain their outputs lesser than the possible maximum output. But if the firm is technically efficient, *u* takes the value zero and the firm obtains the maximum possible output. The negative value of *u* will vary among firms depending on the technical efficiency, i.e. how close they are to the frontier.

It is further assumed that the average level of technical inefficiency is a function of factors believed to affect efficiency as shown below:

(3) Ui = δ0 + δZi

where:

Zi = a column vector of hypothesized efficiency determinants, and
δ0 and δi = unknown parameters to be estimated.

METHODOLOGY

Sampling Design

Multistage random sampling was adopted in this study. The 15 municipalities of Nueva Vizcaya were ranked according to elevation. The top, middle and lowest elevations were selected as sample municipalities. From each municipality, the highest producing barangay was selected, from which 90 respondents were randomly selected.

The Variables and Estimation Models

The frontier production function was estimated using Maximum Likelihood Estimation (MLE) technique where technical inefficiency index was estimated. Equation (1) is linearized by transforming the function into logarithm form:

(4) $\ln Yj = A + b_1 \ln X_1 + \ldots + b_6 \ln X_6 + (v_i - u_i)$

where:

Y_j is the output of the jth farm
A is the intercept,

X_1 is the amount of seeds planted in kilograms
X_2 is the amount of fertilizer applied in bags of 50 kilograms
X_3 is the amount of insecticide applied in liters
X_4 is the amount of fungicide applied in kilograms
X_5 is the amount of labor input in mandays
X_6 is a dummy for herbicide, and
b_1 to b6 are the parameters estimated
u_i would account for technical inefficiency

The efficiency function was specified as:

(5) $T.E. = Q_0 + Q_1Z_1 + Q_2Z_2 + Q_3Z_3 + Q_4Z_4 + Q_5Z_5 + e$

where:

T.E. = technical efficiency
Z_1 = age of farmer
Z_2 = years of schooling
Z_3 = farming experience
Z_4 = Household size
Z_5 = Access to credit (dummy)
1 = access
0 = no access

RESULTS AND DISCUSSION

The study area

Nueva Vizcaya is approximately 60.21% mountainous, characterized by very steep to steep landforms. About 25.41% is rolling to moderately steep and 14.38% is gently sloping to undulating and flat to near flat. Most of the latter are agricultural areas. The province has an elevation ranging from 100-2,000 meters above sea level (ASL). It is dominated by soil complexes which is a combination of different soil types/texture. Upland soils are considered well drained internally and externally. These characteristics make the area ideal for various agricultural productions even if this is considered a typhoon belt with several typhoons hitting the province in a year (Socioeconomic profile of Nueva Vizcaya, 2008).

Technical Efficiency

The production function estimate (Table 1) shows that seed was significant at 10%, fertilizer, insecticide, fungicide, and herbicide were significant at 1%. The coefficients are in effect the output elasticity of the variables; hence the results show that herbicide had the greatest effect on yield, followed by seed, fungicide, and fertilizer. This means that for every 10% increase in seed, pole snap bean output will increase by 4.3%. For every 10% increase in fertilizer, output will increase by 2.9%. For every 10% increase in fungicide, output will increase by 2.6% and for every 10% increase in herbicide, output will increase by 6.3%. Increasing herbicide per se would not mean an increase in output, but it is the control of weeds that contribute to the increase in output. For every 10% increase in insecticide, output will decrease by 1.5%. The negative coefficient of insecticide implies that there was insecticide over usage. These results show the relative importance of the inputs in pole snap bean production.

The results further show that the gamma value is 99%, an indication that 99% of the variation in output is attributed to technical inefficiency of farmers. However, gamma value is not significant. The sigma square is 0.34 and significant at 1% indicating the correctness of the specified assumptions of the distribution of the composite error term.

Table 2 shows that only years of schooling and credit access are significant at 1% and 10%, respectively. This shows that increasing the number of years of schooling of pole snap bean farmers would increase their efficiency. Access to credit will likewise eventually result in increased production.

Implications

The significant and positive coefficients for seed, fertilizer, fungicide and herbicide imply that increasing utilization and application of these inputs would transform

Table 1. Production function estimates

Variable	Parameter	Coefficient	t-ratio
Constant	X0	6.16	0.49***
Seed	X1	0.43	0.28*
Fertilizer	X2	0.29	0.05***
Insecticide	X3	-0.15	0.03***
Fungicide	X4	0.26	0.03***
Labor	X5	0.002	0.02ns
Herbicide dummy	X6	0.63	0.06***
Sum of elasticity		1.48	
Log likelihood function		-75.64	
$\sigma^2 = \sigma^2_u + \sigma^2_v$		0.34	(0.03)***
$\gamma = (\sigma^2_u) / \sigma^2_u + \sigma^2_v$		0.99	0.004

*Note: *** significant at 1%, ** significant at 5%, * significant at 10%*
Source: Output of Frontier 4.1 by Coelli

Table 2. Determinants of technical efficiency of pole snap bean farmers.

Variable	Parameter	Coefficient	t-ratio
Intercept	Z_0	0.31	1.00
Age	Z_1	-0.15	1.85
Years of schooling	Z_2	0.73	2.67***
Farming experience	Z_3	0.08	0.55
Household size	Z_4	-0.11	1.24
Credit access	Z_5	3.04	1.27*

into an increase in output. Insecticide is highly significant but negative, implying unduly excessive application of insecticide.

The value of γ (99%) implies that 99% of the variability in output is due to technical inefficiency. This implies that a lot of the farmers are technically inefficient. The amount of inputs applied is far from the optimal. The farmers are not operating on the production frontier, but are rather operating below the production frontier. This indicates that there are opportunities for improving the technical efficiency of pole snap bean farmers.

Socioeconomic factors such as years of schooling and access to credit are significant factors that affect inefficiency. Improving the education of farmers will lessen inefficiency. Likewise, access to credit for these farmers may decrease inefficiency.

CONCLUSION

The study revealed that farmers who are producing pole snap bean in Nueva Vizcaya are technically inefficient. Their inefficiency was determined using the stochastic production frontier. The estimates show that seed has a coefficient of 0.43 and was significant at 10%, while fertilizer (with a coefficient of 0.26), and herbicide (with a coefficient of 0.63) were significant at 1%. These figures imply that the amount of seed, fertilizer, fungicide, and herbicide applied have significant effects on the production of pole snap beans. Improving technical efficiency of pole snap bean farmers may result in better yield, lesser cost, and higher net returns. The socio-economic factors of farmers such as years in schooling and access to credit significantly influenced the farmers' technical efficiency. Moreover, results show that pole snap bean producers lack technical knowledge particularly on the use of commercial inputs. Thus, government interventions, such as seminars and trainings, may be necessary to improve efficiency of pole snap bean farmers. Farmers' associations and cooperatives may be of help for farmers to have access to formal credit.

RECOMMENDATIONS

The study found out that in general, pole snap bean production is technically inefficient. Improving the technical efficiency of the farmers would therefore result in better yield, lesser cost and higher net returns. Institutional arrangements in the form of intensified support services, extensions and trainings may be necessary to improve efficiency of pole snap bean farmers. Information dissemination on the proper use of insecticides and other appropriate technologies is critical. Government interventions may also be in the form of assistance to the growers in accessing to credit through financing institutions such as farmer associations and credit cooperatives with lesser and easier requirements in availing of loans.

Availability of farm inputs is necessary to achieve higher technical efficiency. This may be made possible by improving farm accessibility and organizing marketing associations. Accessibility may imply better roads for easier transport of farm inputs and farm produce.

Results also showed that there is an over application of fertilizer, yet yield is low. This may be due to degradation of the soil. Soil degradation worsens with continuous application of inorganic fertilizers and pesticides. Normally, the soil gets acidic, thereby decreasing the availability of soil nutrients for plant absorption. Use of inorganic fertilizer in pole snap bean in the province is extensive.

Use of herbicides significantly increased yield of pole snap beans. Farmers, however, must be cautious in using them. Continuous and indiscriminate use may not be sustainable in the long run because toxic residues may gradually accumulate and destroy the physical properties of the soil.

LITERATURE CITED

Anupama, J., R.P. Singh, and R. Khumar. 2005. Technical Efficiency in Maize Production in Madhya Pradesh: Estimation and Implications. Agricultural Economics Research Review, 18:305-315.

Barno, A.K. 1993. Decision making of farmers towards optimal allocation of resource, Benguet, Philippines. MS thesis, BSU.

Coelle, T.J. 1994. A Guide to Frontier Version 4.1: "A Computer Program for Stochastic Frontier Production and Cost Function Estimation," Department of Econometrics, University of New England, Armidale, Australia, 1-33pp.

Farell, M.J. 1957. The measurement of productive efficiency. Journal of the Royal Statistical Society Series A (General), 120(3): 253-290.

Herdt, R.W. and A.M. Mandac. 1981. Modern technology and economic efficiency of Philippine rice farmers. Economic Development and Cultural Change, 29: 375-398.

Lee, L.F. and W.G. Tyler. 1977. The stochastic frontier production function and average efficiency. Journal of Econometrics, 7:385.

Pate, N.T. and A. Tan-Cruz. 2007. Technical Efficiency of Philippine Rice-Producing Regions: An Econometric Approach. Paper presented at the 10th National Convention on Statistics, EDSA Shangri-La Hotel, October 1-2, 2007.