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The Influence of Chili Input and Technical Efficiency of Chili Farmers in Lingga Village, North Sumatera Province

Helena Tatcher Pakpahan
Lecturer of Agriculture Faculty, Methodist Indonesia University – Medan
University of Methodist Indonesia, Jl. Harmonika Baru, Tanjung Sari
Medan 20132, Indonesia

Manaor Bismar Posman Nababan
Lecturer of Agriculture Faculty, Methodist Indonesia University – Medan
University of Methodist Indonesia, Jl. Harmonika Baru, Tanjung Sari
Medan 20132, Indonesia

***Abstract* — Lingga village is a center of chili production in Karo District. The problems that often occur in the village due to the traditional chili cultivation (still using simple cultivation technology) and chili plants were susceptible to the rainy season. Based on these problems, this study aims to find inputs that affect the production of chilies and efficiency of chili farmers in Lingga Village. Chili production function in Cobb-Douglas model shows farm size, labor, and fertilizer which positively influence to chili production. Pesticides do not affect pepper production due to an inefficient wet season of pesticides. The efficiency measurement of chili farmers with DEA model shows an average efficiency of 0.940. The value means that farmers should reduce input use by 6 percent for farmers to be efficient in input allocation. Efficient farmers numbered 16 people or equivalent to 53.34 percent. The rest of the farmers are not efficient in the allocation of pepper inputs.**

Keywords --- Chili, Input, Efficiency.

I. Introduction

Karo district is the most fertile area in North Sumatera because of it's located between two volcanoes, namely: Sinabung and Sibayak Mountain. The soil fertility in Karo District causes the area to be a horticultural production center. Horticultural crops produced include chili, tomato, potatoes, and carrots.

Chili plants one of the favorite plants because people love chili as a spice in cooking. The taste of the community makes chili high economic value for farmers. Reference [1] mentioned the area of harvesting of chili plants in **Karo** District is 4,661 ha and chili production is 36,635 ton in 2014.

The most extensive chili production in Karo district located at the intersection of Simpang Empat sub-**districts**. Chili production in the area is 9,369 ton in 2015. Chili production in the area has increased from 2012 with an average increase in production of 104.31 percent per year.

Increased production is proportional to the increase in harvested area. Based on reference [2] regarding the area of chili crops, there is an increase of 101.5 percent of chili harvested area per year. Increased production and area of chili harvest due to the price of chili tends to grow every year.

Chili price increases are due to higher chili demand than chili offers. Problems will be present if the price of chili has decreased in the market. Farmers must be optimal in using inputs so that **farmers** do not experience losses when the amount of chili falls on the market.

Reference [3] mentioned that chili farmers are not an optimal use of input because the cultivation of chili is still traditional. They are still affected by the weather conditions. The rainy season causes the land of chili flooded. Waterlogged areas and high rainfall cause plants to become susceptible to disease. The ultimate impact is the failure of chili harvest

Corresponding Author: Helena Tatcher Pakpahan

Pesticides are used by farmers to avoid chili harvest failure. The use of pesticides is routinely done every growing season causing immunity to **plant** pests so that the failure of chili harvest is difficult to avoid. The use of pesticides carried out in the rainy season also resulted in an increase in labor used.

The increased use of chili inputs occurring in the rainy season to produce chilies is done by farmers because chili farmers do not have better **technological** options. Better technology for example greenhouses or proper drainage.

Based on the above facts then this research needs to be done to find the factors that **affect** the production of chili and technical efficiency in chili farmers.

II. Method Of Research

A. *Quantitative Approach*

This research uses quantitative approach. Reference [4] and [5] explain why a researcher chooses a quantitative approach. The first reason is the research aimed to test the hypothesis, that there are input variables that affect the production of chili and chili farmers are not efficient in allocating inputs. The next reason is the data collected consists of the inputs used and the resulting output (in the form of numbers), the specific variables used, the type of data analysis in the form of identification of the relationship between input and output variables. The last reason is the result of this study in the way of statistical reports of the relationship of variables and relationships that are statistically significant. This research is expected to find out how the connection of input with output and variable input significant to production.

According to [5] and [6], there are several types of quantitative research: **survey**, correlational, experimental, and causal-comparative. This study is included in the correlational analysis because it measures correlation coefficient between input and output variables. Correlation coefficients in the form of the number of inputs that should be used and find efficient farmers (worth = 1) and inefficient (worth < 1). Correlation coefficients can also determine the negative or positive relationship between the dependent and independent variables.

B. *Study Area*

Simpang Empat Sub-District has 17 villages. Linga village is the area that has the **most** extensive harvest area for the Simpang Empat Sub-District. The area of chili harvest in linga village is 738 ha. The production of Lingga village chili is 9,369 ton. Thus, the productivity of chili in the village is 12.6 ton per ha from Central Bureau Statistics of Karo as in [2]. Based on the **data** above, the research conducted in Lingga village.

C. *Sampling Procedure*

The sample for this research is 30 peasants in Lingga Village. Determination of research sample done by stratified random sampling method. The method based on farmland area of chili. The land area under 1000 square meters is represented by eight farmers while 22 farmers represent the land area above 1000 square meters.

D. *Data Collection And Analysis*

The type of data used is primary data. The method of data collection is done by **direct** interview method on farmers. Data collected from chili farmers consist of: total chili production, farm size, labor, fertilizer, and pesticide, mulch, and chili seeds. Data collected based on the period of chili cultivation during the rainy season.

E. *Chili Production Function*

The production function is the physical relationship between independent variable (X) and the dependent variable (Y). The independent **variable** is called the input (factor of production), and the dependent variable is called the output. The production function in this study is as follow:

$$Y_t = f\ (X_1, X_2, \ldots\ldots, X_n)$$

Y_t is output; $X_1, X_2, \ldots\ldots, X_n$ is input (factor production).

The relationship of input and output on the production function also illustrates the scale of production of chili farmers in Lingga Village. Reference [7] mentioned that production scale there are three types, namely: increasing the return to scale (IRS), constant **return** to scale (CRS), and decreasing return to scale (DRS). Constant return to scale is a rational area of production for chili farmers while other production scales are irrational areas for chilli production

The Cobb Douglas model is often used in production research because it has several advantages. Reference [8] mentioned that advantage of the Cobb Douglas model lies in the production elasticity being constant and the elasticity of the input substitution into one. The elasticity of input substitution is worth one because of the limitation of input technology in the company. Reference [9] mentioned that advantage of the Cobb Douglas model lies in the ease of manipulation of the **production** function and the interpretation of the input elasticity coefficient of output. Reference [9] also mentioned that advantage of the Cobb

Douglas model lies in the relatively small sample size that the model can use.

Based on the facts of Cobb-Douglas model, the specific chili production function in **the** Linga Village is:

$$\ln Y_t = \beta_o + \beta_1 \ln X_1 + ... + \beta_4 \ln X_4 + \mu$$

Where, Y_t is total **production** of chili (kg), X_1 is farm size (m^2), X_2 is labour (man days), X_3 is fertilizer (kg), X_4 is pesticides (liter), ln is logaritma natural, β_0 is constanta, $\beta_1 ... \beta_4$ are parameters to be estimated, μ is errors.

Chili production function in this study is multiple linear regression. According to [10], the accurate multiple linear regression models if it **meets** several criteria, namely: unbiased, consistent, and efficient.

An estimator is unbiased if the expected regression coefficient value matches the parameter value found in the population. An estimator is **consistent** if the estimated value of dispersal goes to the correct parameter value according to the sample size in the study. Estimates produced by the estimator are said to be efficient if the smallest variance obtained.

A Classical assumption test needs to be done to measure the interference due to the dependent variable relationship (Y) with independent (X). In addition to measuring disturbances, the classical assumption test was used to see the relationship between independent variables co**n**tained in the study. Several types of classical assumption tests are often performed on multiple linear regression research, namely test: multicollinearity, normal distribution of errors, heteroscedasticity, and linearity.

1) ***Normal distribution of errors***. This test is not required to check for an unbiased, consistent, and efficient regression coefficient, but this test required for confidence in the disturbance (errors) distribution interval of the study sample. The distal distribution interval must be at the hill condition of the disturbance distribution being in the middle between the two valleys. The shape of the interval is called normal distribution of errors. If the hill from the disturbance distribution tends to lead to one valley left or right then the disturbance is not normally distributed.

2) ***Multicollinearity*** is a test to assess the relationship between independent variables. The presence of multicollinearity causes the value of variable variables to be tremendous. The value of the variance affects the coefficient value of the allegedly unstable regression and implies the magnitude and direction of the variable coefficient becomes invalid for interpretation.

3) ***Heteroscedasticity*** is an error that appears in the population regression function has a variant that not fixed. Heteroscedasticity affects the biased results of t test and F test. Therefore, this study should have a fixed variant on errors. Errors that have fixed variance are called homoscedasticity.

4) ***Linearity***. The production function can be in the form of linear and quadratic functions. Linearity test needs to be done on chili production function in this research. Linearity test used to check whether the independent and dependent variables on the production function have a linear relationship or not.

F. Efficiency Of Chili Production

Chili production efficiency is used to measure the use of chili input in chili cultivation. An efficient farmer is worth one while an inefficient farmer is worth less than one. The efficiency measurement model uses the DEA model. The model is a nonparametric efficiency measurement model. The DEA model used to measure the efficiency of chili production, as follows:

$$Min\ \theta_0 - \epsilon \sum_{j=a}^{b} s_{jk}^{+} - \varepsilon \sum_{i=a}^{d} s_{ik}^{-}$$

θ_0 =Overall technical efficiency (OTE); s_{jk}^{+}= addition (*slack*) chilli; s_{ik}^{-}= reduction (*slack*) input of chili; x_{ik} =input of chlli farmers; x_{aik}= farm size (m^2); x_{bik} =labour (man days); x_{cik} = chili seed (plants); x_{dik} =mulch (kg);x_{eik} =organic fertilizer (kg); x_{fik} = chemical fertilizer (kg) ;x_{gik} = pesticide (liters); y_j= o; y_{ajk}= chili (kg)

The formula of PTE was useful in measuring the efficiency of production of chili farmers based on VRS (variable return to scale) assumption. The marginal in the constraint on the OTE formula. The last was SE formula which was useful to know the scale production of red chili farmers. The existence of SE formula was as for the ratio between the value of OTE and PTE.

This study uses chili input based on research recommendations [11] and [12]. Chili inputs used in [11] research is the land area, seed, fertilizer, labor, and pesticide. The differences in this study with Mohammed et al. lies in the use of fertilizers divided into chemical and organic fertilizers. Chili inputs used in [12] researches are family labor, out-of-family labor, and fertilizer prices. The differences in this study with Asravor et al. lies in the incorporation of family and non-family labor. In addition to labor, this study uses the quantity of fertilizer while the previous research using the cost of fertilizer.

G. The Explanatory Variables

The explanatory variables introduced in the empirical model (both model of Cobb-Douglas and DEA) are: total production of chili (kg), farm size (m^2), labour (man days), chilli seed (plants), mulch (kg), organic fertilizer (kg), chemical fertilizer (kg), and pesticide (liters).

Total production of chili: This variable is representative of the chili farmer's harvest at the last planting season. The total chili production unit used is kg (kilogram).

Farm size: This variable is representative of the area of chili cultivation. The unit of land used in the research area is rante.1 rante equivalent to 400 square meters. Thus, the unit for farm size is m2 (square meter).

Labour: This variable is representative of the labor used for chili cultivation. The workforce selected for this research is labor in the family and outside the family. Workforce work from land-processing to harvesting activities. Calculation of employment based on man's working day

Chili seed: these variables are representative of pepper seedlings planted by farmers. The appropriate unit for chili seedlings is plant.

Mulch: This variable is used by farmers starting from the planting of chili seedlings. Mulch is useful for improving crop yields, resistant to extreme weather, and resistant to pests and diseases.

Organic fertilizer: Farmers use this variable at the beginning of planting. Organic fertilizer obtained from animal waste and other crop residues. The unit used is kg (kilogram).

Chemical fertilizer: Farmers use this variable during the productive time of chili plants to stimulate flowering and fertilization. Chemical fertilizers used for the provision of additional nutrients needed by chili plants. The unit used for this variable is kg (kilogram).

Pesticide: Farmers use this variable during the productive time of chili plants to control diseases and pests. Pesticides used by farmers are liquid. The unit used for this variable is the liter.

III. Results And Discussion

A. Data

Data based on direct interviews with 30 chili farmers. Chili production data collected during the cultivation period of chili in the rainy season.

The output used in this research is the total production of chili. Inputs collected to measure the chili production factor are farm size, labor, fertilizer, and pesticides. Other inputs (mulch, organic fertilizer, chemical fertilizers, and seeds) are used to measure the efficiency of chili production. The statistical summary of the sample study data presented in Table 1.

Table 1: Summary Statistics Of Data Sample

Variabel	Minimum	Maximum	Mean	Standar Deviation
Chili production	800.00	6500.00	1807.67	1167.93
Farm size	300.00	6000.00	2110.00	1221.46
Labour	44.10	149.90	70.33	22.04
Mulch	10.00	50.00	20.33	11.89
Chili seed	1000.00	6300.00	2293.33	1366.33
Organic fertilizer	10.00	8000.00	1059.67	1443.29
Chemical fertilizer	5.00	900.00	135.23	154.52
Pesticides	6.10	50.00	9.60	7.80

Sources: *Data of Chili Farmers in Lingga Village (2017)*

B. Normal Distribution Of Errors

The normal distribution test error is the first test of the classical assumption test for multiple linear regressions. Testing using Kolmogorov-Smirnov test. The SPSS software shows the significance of all variables below 5 percent. The results of the Kolmogorov-Smirnov test show that normally distributed errors.

C. Multicollinearity

The multicollinearity test is the second test of the classical assumption test. Reference [13] explain that multicollinearity results in R^2 values being small, the difficulty of determining the decision of each independent variable because of the correlation between independent variables, and the prediction of each independent variable is unstable due to the increased variance of each independent variable coefficient.

The multicollinearity test of the collected data shows the variance of inflation factor of all independent variables worth less than 10. According to [14], the value means no multicollinearity in this study.

D. Heteroscedasticity

The heteroscedasticity test is the third test of the classical assumption test. Reference [13] mentioned an equal variance among the research subjects (samples) and constant among all variables. The balance of variance is called homoscedasticity.

Heteroscedasticity test using Spearman's rho test. The SPSS software shows residuals of all variables valued above 0.05. The value means no heteroscedasticity or all variance of the research data is homoscedasticity.

E. Linearity

Linearity test is the fourth test of the classical assumption test. All variables in multiple linear regressions must be consistently linear. According to [13], violation of linear assumptions results in a bias study on r square, regression coefficients, standard errors, and statistical significance.

Test linearity using Ramsey test. The result of the Ramsey test is worth 6.23. F value of the above statistical F table so that it concluded all research variables are linearly related.

F. The Relationship Between Input And Chili Production

The input and output relationships have passed the classical assumption test. The next stage described the relationship between input and chili production. The description of input and chili production relationships consists of production scale and influence of input to output.

The scale of production explains how a proportional increase of all inputs to the output. The sum of all input variable coefficients of the Cobb-Douglas production model will produce a scale of chili production. The result of the sum of coefficients (β_1 + β_2 + β_3 + β_4) in Table 2 is 1.281. The value of 1.281 shows that the scale of chili production in Lingga Village is in increasing the return to scale (IRS). IRS means the condition that the percentage of output increase is greater than the percentage of input additions. Scale production in this study is different from other studies. Research [9] and [11] find that the scale of chili production at the study sites is in decreasing return to scale (DRS). DRS means the percentage of output addition is lower than the input addition.

TABLE 2: RESULTS FROM CHILI PRODUCTION FUNCTION

Variabel	**Para Meters**	**Coefficients**	**Std. error**	**T-value**
Constant	β_0	0.795	0.625	1.272
farm size	β_1	0.378**	0.057	6.605
Labour	β_2	0.689**	0.189	3.643
Fertilizer	β_3	0.087**	0.036	2.407
Pesticide	β_4	0.127	0.128	0.992

Note: **significant at 1% level of probability

Input variables that significantly affect the production of chilli consist of farm size, labor, and fertilizer. The only insignificant variable is the pesticide variable. Significant input variables have a positive influence on chili production. A positive relationship means the increase of all these inputs leads to an increase in the production of chili.

The farm size variable is the first variable described. A one percent increase in farm size variables led to an increase in chili production by 0.378 percent. The results of this study are consistent with research [11].

The labor variable is the second variable described. A one percent increase in labor led to an increase in chili production by 0.689 percent. The results of this study are similar to that research [9] and [11].

The following variable described is the fertilizer variable. An increase in fertilizer by one percent led to an increase in chili production by 0.087 percent. The results of this study are similar to research [11].

Pesticide variable is not the significant variable in this research. The results of this study are following research [9] and [11]. The cause of pesticide variables is not significant because the administration of pesticides is not efficient in the rainy season.

G. Technical Efficiency Of Chili Farmers

The efficiency values of red chili farmers presented in Table 2. The efficiency of OTE was the efficiency based on CRS production scale (Constant Return to scale). The average values of OTE were 0.940. The values of the OTE meant that the farmers should reduce the input used as much as 6percent to make the farmers were efficient. The efficiency of PTE was they efficiency based on VRS production scale (Variable Return to Scale). The benefits of PTE efficiency to see the source of inefficiency of red chili farmers. The average values of PTE were 0.978. The value of PTE meant that the farmers should reduce the input used by 2.2 percent to make the farmers were efficient. The efficiency scale was the ratio between the PTE and OTE values. The average values of SE were 0.961. The values of SE meant that the farmers should reduce input used by 3.9percent to make the farmers were efficient.

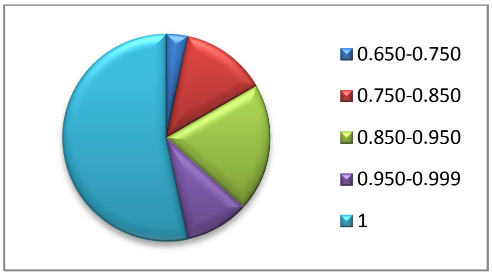
TABLE 3: TECHNICAL EFFICIENCY OF CHILI FARMERS

Types of Efficiency	Description of Statistic	Values of Efficiency
OTE	Minimum	0.664
	Maximum	1.000
	Mean	0.940
	Standard deviation (SD)	0.087
PTE	Minimum	0.765
	Maximum	1.000
	Mean	0.978
	Standard deviation (SD)	0.055
SE	Minimum	0.828
	Maximum	1.000
	Mean	0.961
	Standard deviation (SD)	0.055

Source:Results of Treatment DEAP 2.1

Figure 1 describes the composition of chili farmers based on efficiency values. Efficient farmers get the most significant circular slice of 53.34 percent or equivalent to 16 chili farmers. The second most significant circular slice found on farmers with an efficiency value of 0.850-0.950. Chili farmers in the area of 20 percent or equivalent to 6 farmers. The smallest slices found in farmers with an efficiency value of 0.650-0.750. Chili Farmers in the area of 3.33 percent or equivalent to 1 farmer.

The efficiency scale is used to determine the scale of production of each red pepper farmer. Farmers on the CRS production scale will be worth SE = 1 while the IRS and DRS production scale rated as SE <1. According to [15] indicate that not always the SE = 1 value is found on the CRS production scale because of the value of OTE <1 and PTE <1. The error that occurred in the DEA results corrected by the researcher by saying that the scale of production is not on the scale of CRS production. In this study, there were no errors such as research [15].



Figures 1.Chilifarmes based on efficiency value

The scale of chili farmers' production found on three production scales, namely CRS, IRS, and DRS. Chili farmers on the CRS production scale mean the percentage increase in input is equal to the output. The efficiency value of red chili farmers on CRS production scale is 1. Chili farmers on CRS production scale are 16 people or equal to 53.34 percent of total farmers.

TABLE 4: SCALE PRODUCTION OF CHILI FARMERS

No	The Production Scale	The Determination of Production Scale	The Percentage of Farmers
1	CRS (*Constant return to scale*)	$\sum_{k=1}^{30} \lambda_{k,CRS} = 1.000$	53.33
2	IRS (*Increasing return to scale*)	$\sum_{k=1}^{30} \lambda_{k,CRS} < 1.000$	43.33
3	DRS (*Decreasing return to scale*)	$\sum_{k=1}^{30} \lambda_{k,CRS} > 1.000$	3.34

Chili farmers on the IRS and DRS production scales have an efficiency value of <1 with a total of 14 people. Chili farmers on the IRS production scale numbered 13 people, equivalent to 43.33 percent of the total farmers. IRS production scale means the percentage increase in input is lower than the percentage increase in output.

Chili farmers in the DRS production scale amounted to 1 person or equivalent to 3.33 percent of the total farmers. DRS production scale means the percentage increase in input is higher than the percentage increase in output. Determination of production scale on DEA model according to [16].

IV. CONCLUSIONS

This research applies Cobb-Douglas production function and DEA model to measure factors affecting chili production and technical efficiency of chili farmers in Lingga Village.

The results showed variables of farm size, labor, and fertilizer affecting chili production. The positive effect of these three inputs means that increased use of input causes an increase in output. The pesticide variable does not affect the production of chili because it is inefficient to treat the disease and eliminate the pest disturbance in pepper plants.

This study also shows the average technical efficiency of chili farmers is worth 0.940. The value means that chili farmers are advised to reduce input use by 6 percent.

Technically efficient chili farmers (value of efficiency equal to 1) amounted to 16 people or equivalent to 53.34 percent. Such efficient farmers are at an inefficient scale of CRS production. The farmer's number 14 people, equivalent to 46.66 percent. Inefficient farmers are at the scale of production of the IRS and DRS.

Based on the above results it is concluded that farmers are not efficient in using inputs. Farmers are advised to use skilled labor to treat plant diseases and cope with pest problems during the rainy season.

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References

[1] Central Bureau Statistics of North Sumatra website (2015) [Online]. Available: https://sumut.bps.go.id/publication/download.html?nrbvfeve=YjU3MjMzNjAwMThiMzQ4NTQ0YTAzZGI0&xzmn=aHR0cHM6Ly9zdW11dC5icHMuZ28uaWQvcHVibGljYXRpb24vMjAxNS8xMi8wNC9iNTcyMzM2MDAxOGIzNDg1NDRhMDNkYjQvcHJvdmluc2ktc3VtYXRlcmEtdXRhcmEtZGFsYW0tYW5na2EtMjAxNS5odG1s&twoadfnoarfeauf=MjAxOC0wMi0wMSAxMjoxNjoyOA%3D%3D

[2] Central Bureau Statistics of Karo website (2016) [Online]. Available: https://karokab.bps.go.id/publication/download.html?nrbvfeve=MmJkYjQ5YzkwMzNlNjc2ZmY0MTNhMjBj&xzmn=aHR0cHM6Ly9rYXJva2FiLmJwcy5nby5pZC9wdWJsaWNhdGlvbi8yMDE2LzA3LzE1LzJiZGI0OWM5MDMzZTY3NmZmNDEzYTIwYy9rYWJ1cGF0ZW4ta2Fyby1kYWxhbS1hbmdrYS0yMDE2Lmh0bWw%3D&twoadfnoarfeauf=MjAxOC0wMi0wMSAxMjozNTo0NA%3D%3D

[3] Prajnanta. *Agribinis Chili Hybrids*, Jakarta, Indonesia: Swadaya Spreader, 2005.

[4] B. Johnson and L. Christensen, *Educational Research: Quantitative, Qualitative, and Mixed Approaches*, Thousand Oaks, CA: Sage Publications, p. 34, 2008.

[5] O.D. Apuke, "Quantitative Research Methods a Synopsis Approach," Arabian Journals of Business and Management Review (Kuwait Chapter), vol. 6, no. 10, pp. 40-47, 2017. Homepage: www.arabianjbmr.com

[6] S. Sukamolson, *Fundamentals of Quantitative Research*. Language Institute Chulalongkorn University, p. 1-20, 2007.

[7] J. Benicio, J. C. S. de Mello, "Productivity Analysis and Variable Returns of Scale: DEA Efficiency Frontier Interpretation," *Information Technology and Quantitative Management*, vol. 55, pp. 341-349, 2015.

[8] W. Krasachat, "Technical Inefficiency of Chili Farms in Thailand ", *Contributed paper prepared for presentation at the 91st annual conference of the Agricultural Economics Society, the Royal Dublin Society, Dublin, Ireland*, 24th-26th April 2017.

[9] A.S.M.A. Huq and F. M. Arshad, "Technical Efficiency of Chili Production", *American Journal of Applied Sciences*, vol. 7, no 2, 2010.

[10] M. N. Williams, C. A. G. Grajales, and D. Kurkiewicz, "Assumption of multiple regression: correcting two misconceptions", *Practical Assessment Research & Evaluation*, vol. 18, no. 11, pp. 1-14, September 2013.

[11] B. Mohammed, B. Ahmed, and Z. Abdulsalam, "Technical efficiency of chili pepper production in Kaduna state, Nigeria," *American Journal of Experimental Agriculture (AJEA)*, vol: 9, no. 5, pp: 1-9, 2015

[12] J. Asravor, E. E. Onumah, and Y. B. Osei-Asare , "Efficiency of chili pepper production in the Volta Region of Ghana," *Journal of Agricultural Extension and Rural Development*, vol: 8, no. 6, pp: 99-110, 2016.

[13] K. A. Pituch and Stevens JP, *Applied multivariate statistics for the social sciences*, 6th ed., Routledge, New York, USA, 2016.

[14] D. M. Gujarati, *Basic Econometrics*, 4th ed., New York, United States of America: McGraw-Hill, p.341-375, 2003.

[15] J. Johnes, "Data envelopment analysis and its application to The measurement in higher education", *Economics of Education Review*, vol 25, 2006

[16] Kumar S and Arora N, "Evaluation of Technical efficiency in Indian sugar industry: an application of full cumulative data envelopment analysis," *Eurasian Journal of Business Economics*, vol. 5, no. 9, pp 57-58, 2012.