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Determinant Analysis on the Efficiency of Small-scaled Corn Agribusiness: Empirical Evidence from Central Java, Indonesia

Sri Rahayu
Universitas Darul Ulum Islamic Centre Sudirman GUPPI

ABSTRACT

This research aims to identify the efficiency of corn agribusiness in Central Java Indonesia and the factors affecting it. The research method used was DEA (Data Envelopment Analysis) with output-oriented assumption to measure each of the LKMA being observed. Afterwards, the researchers used Ordinary Least Squares (OLS) regression analysis to analyze the factors affecting the level of efficiency of the corn agribusiness. The findings show that majority of corn agribusiness is inefficient. Based on the DEA-CRS calculation, 11 (18.33%) corn agribusinesss are efficient, while based on the DEA VRS calculation, 18 (30%) corn agribusinesss are efficient. Arable land size, corn agribusiness' experience, and land ownership status are affecting the level of efficiency.

KeyWords: Efficiency, DEA, Corn Agribusiness, Governance.

INTRODUCTION

In Indonesia, corn is one of the strategic agricultural commodities. Corn is also potential to support the food security (Ariani dan Pasandaran, 2016), as well as as a strategy to increase the capital income and improve the farmers' welfare. (Tangendjaja et al., 2016). Viewed from food security, corn can be consumed as it is as staple (besides rice), or as a foodproduct (Ariani & Pasandaran, 2017). Corn commodities (the leaves as well as the seed) are also needed foranimal feed which indirectly support the people's animal protein need (Tangendjaja et al., 2016). Besides in the form of rice, corn as a staple, corn can also be used as a snack and intermediate goods. Therefore, rice as a staple can be replaced by corn, without changing the people's habit in terms of the type of the staple (Ariani & Pasandaran, 2017). Corn is used as a raw material in almost every province in Indonesia. Corn food product as homemade traditional

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foods varies. The raw materials vary from the corn seeds, baby corns, corn bran, broken corn, and cornstarch. Besides in the form of food product, corn can also be used as food industry and non-food industry raw materials, either in home industry level or in a big industry level. Usually, home industry can be found in rural area, while middle level industry can be found in rural urban area with adequate equipments. In middle-higher level industry, the corn processing is done by using machines as well as advanced and complex technologies. Corn demanded by the modern food industry has to pass certain requirements including the measurement of the color, aroma, and water content (Ariani &Pasandaran, 2017).

The middle-higher food industry products are various, ranging from intermediate product to consumables. Products with corns as the raw materials are intermediate product, cookie, chip, frying oil, soft drink, instant porridge, sauce, and instant flavoring. Meanwhile, intermediate products are cake ingredient, baby instant porridge, coffee ingredient, low calorie corn syrup, and corn oil (Ariani dan Pasandaran, 2017). These products are produced by both national and multi-national producers licensed by the Indonesian government.Throughout the years 1990 to 1995, there was an increasing number on the corn industries from 2,976 in year 1990 to 4,007 in year 1995. The increasing number of maize indsutries is higher than the corn industries. However, the data on the type of corn used in middle level industries cannot yet be investigated further. Actually, there is no difference between maize and corn. Consequently, the type of corn needed by each industry cannot be identified even though the data are very important in variety-based corn production planning (Ariani & Pasandaran, 2017).

The other potential of corn processing is for non-food industries for example for ethanol materials, though this industry in Indonesia has not been yet developed more. However, the international price for corn influences much on the domestic price. For comparison, the corn price in the global market in 2004 was USD 111.8 /ton, became USD 160.9 /ton thorughout january-august 2007. The price kept rocketing, in year 2016, the corn price in Indonesia and Malaysia was Rp. 15,000/kg, in Canada was Rp. 30,000/kg, in English was 25,500/kg, and in Saudi Arabia was Rp. 36,000/kg due to the increasing of ethanol industry demand for biofeuls. This increasing price is due to the crude oil price which almost reaches USD 100/barrel. This potential growth requires integrated action for every corn supplier based on the accurate infomation and the collaboration of public and private sectors. Value chain analysis is needed to understand the relation between the buyer supplier and the other market participant (Wenz and Bokelmann, 2011).

Central Java and East Java aretwo of the main corn production centers in Indonesia. In year 2015, Central Java and East Java have production share rate on 31.26% and 16.38% respectively. However, there are characterstics of demand on corn commodity in several regions. In these two provinces, majorly, corn is sold in the market along with the increase of corn demand for farm.The major corn types being produced are hybrid and composite corns. In West Nusa Tenggara and East usa Tenggara, many of the corns are not sold, yet only used as rice subtitute. The main production on these provinces is local corn which has low productivity, yet with sweeter taste.

Government has undergone several attempts to increase the income of corn farmers from lending the govrnment agriculture land, providing farming facilities, providing pumps, providing financial support, to developing farming institutions (Deptan, 2007). Unfortunately, these attempts are not yet successful to improve the farmers' welfare. Corn agribusiness has not yet given economic welfare affected by the land ownership, technological, and financial access. Several corn central production areas in Indonesia use unirrigated land and rainfed land, and many of them suffer poverty. 59% of corn farming in Indonesia use unirrigated land (Kasryno et al., 2008), though some areas already developed corn farming in irrigated land; and the arable land is quite narrow. (for about 0.3 ac/farmer). As a comparison, corn farmers in developed country like US (Tangendjaja, 2016), generally, have a wide arable land (for about 190 ac/farmer), are supported by modern financial and agricultural systems (seeding, cropping pattern, cultivation mechanism, post-harvest, supply management, market and climate information, and soil analysis), and have short chain value.The corn seed is selected based on the age, climate, yields, and water/disease resistance; while in Indonesia the options are limited to hybrid or not. The soil analysis is conducted every year with zigzag sampling to measure the level of fertility and the use of calx and fertilizer. The result of the analysis rises the number of cornd demand every year, yet it is not yet significant to improve the farmers' income.

Some farmers stay on farming local corn which has no good economic prospect. Although there are hybrid and composite variants, some farmers still focus on cultivating local variant due to the fact that it is staple for them. The farmers do not think visionary how the corn can be sold, instead they just think that corn can be consumed by their family for a season. In other words, food secruity is the priority. Although, people may say that the income of corn selling can be used to pay the daily need, some of our farmers do not think that way. They do not want to take a risk twice, taking risk on the production success rate and the risk on the price ration. The farmers prioritize more on the food security, then if the production is more than the need, the corn is sold to fulfill the secondary need.

The survey conducted by Kasryno et al.,(2008) shows that from 418,000 household samples, the farmer household income average is Rp 2.2millions per month or Rp. 550,000 per capital per month (with assumption the average number of family members is four people per family). This income is actually two times higher compared to village poverty minimum income Rp 286,000 (BPS (Badan Pusat Statistik – Statistics Indonesia), March 2014). This number is the average of the national UMR (Upah Minimum Regional – regional minimum wage). There are several literatures expounding about corn agribusiness (Kasryno et al., 2008; Tangendjaja, 2016), yet some of these literatures have not yet discussed about the comparison among several types of farmers in terms of land ownership (owner farmers, sharecroppers, landowner farmers, land tenant farmers). This difference can affect the characteristics of resources access and cultivation system. Although the income on corn farming in unirrigated landis quite low, recently many large-scale land-tenant farmers begin to appear in unirrigated land like what happens in Grobogan. These land-tenant farmers, generally, have capital, information technology access, and market access better than low level farmers. On the other hand, sharecroppers have low land, financial, technology, and market access. This problem is not yet discussed much by the experts. The other problem that only discussed by few experts is on the seed selection and market access. Based on the initial observation, it is found that land tenant farmers commonly cultivate hybrid corn, while some of the landowner farmers and sharecroppers stay cultivating local farmers for daily consumption due to its sweeter taste. These problems have no been discussed much by the experts.

MATERIALS AND METHODS

This research is conducted with a survey on 100 corn farmers in corn central production Grobogan Central Java Indonesia. Corn commodity chosen as the object of the research is hybrid corn which is mainly cultivated for animal feed. The obtained data are then analyzed by using *Data Envelopment Analysis* (DEA) method. The input variables in this research arelabor cost,

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seed, fertilizer, insectiside, and land lease. The level of efficiency of corn agribusiness is defined as a ratio between total weighted output and total weighted input. The criteria used to measure the corn agribusiness efficiency are technical efficiency. Technical efficiency is obtained from the output ratio towards the resulted input. The efficiency ratio ranges from 0-1 (0%-100%). The data used in this research can be seen in the above table which are analyzed by using Data Envelopment Analysis (DEA). The steps in measuring the efficiency score in DEA method are as follows:

1. Determining the DMU (*decision making unit*)
2. Determining the input variabel and output variabel
3. Doing an analysis to obtain the relative efficiency score. There are two models frequently used for this analysis, *Constant Return to Scale (CRS) and Charnes-Cooper-Rhodes (CCR) Super Efficiency*
4. DEA CRS (*Constant Return to Scale*) model also known as DEA CCR (*Charnes-Cooper-Rhodes*) model. This model introduces efficiency measurement for every single DMU which is the maximum ratio between the weighted output and the weighted input. Each weight score used in this ratio is determined with a limitation that the same ratio for every DMU must have score less or equal to one. The mathematic equation for DEA CRS model can be formulated as follows:

Maximizing the DMU:

$$E_k = \sum_{r=1}^{s} U_{rk} * Y_{rk} \qquad (1)$$

With limitation:

$$\left(\sum_{r=1}^{s} U_{rk} * Y_{rj}\right) - \left(\sum_{i=1}^{m} V_{rk} * X_{rj}\right) \leq 0 : j = 1, \dots\dots.., n$$

$$\sum_{i=1}^{m} V_{ik} * X_{rj} = 1$$

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$U_{rk} > 0 \; ; r=1 \; , \ldots\ldots\ldots\ldots\ldots, s$

$V_{rk} > 0 \; ; i=1, \ldots\ldots\ldots\ldots\ldots, m$

Where:

Y_{rk} = the total output of farmer k

X_{rk} = the total input of farmer k

Y_{rj} = the total output of farmer j

X_{rj} = the total input of farmer k

s = the number of analyzed sectors

s = the total input used

U_{rk} = weighted weight from the r output of farmer k

V_{ik} = weighted weight from the jinput of farmer k

E_k = relative efficiency indicator value

This mathematic equation is then analyzed by using DEAP software version 2.1. The relative efficiency value obtained by using DEA CRS model ranges from 0% to 100%. Agribusiness work quality is getting technically more efficient if the value is close to 1 (100%) and is getting worse if the value is close to 0 (0%).

Meanwhile, to identify the effect of the cultivation system towards the corn agribusiness efficiency is by using multiple linier regression analysis as follows.

$$YY' = \delta_0 + \delta_1 SIZE + \delta_2 OWN + \delta_3 FET + \delta_1 TRAC + \delta_2 IRIG + \delta_3 SAL1 + \delta_1 SAL2 + \delta_2 SAL3 + \varepsilon (1)$$

Where:

Y-Y'	:	Corn agribusiness efficiency
SIZE	:	Arable land size (1= < 0.25ac, 2= 0.25ac-1 Ha, 3= > 1ac)
OWN	:	Land ownership (1= sharecroppers, 2= land tenant farmers, 3= landowner farmers)
FET	:	Seed technology access (1=premium seed, 0= local seed)
TRAC	:	Land cultivation technology access (1=tractor, 0=without)
IRIG	:	Irrigation access (1=technical/semi-technical, 0=without)
SAL1	:	Marketing channel 1 (1= sold to an aggregator, 0= the other)

SAL2 : Marketing channel 2 (1= sold to a merchant, 0= the other)

SAL3 : Marketing channel 3 (1= sold to a cooperation, 0= the other)

δ : intercept and slope

ε : Error

Goodness of fit statistic can be measured from the F value and coefficient of determination.Coefficient of determination (R^2) is used to determine dependent variable change percentagecaused by the dependent independent. F-test is an equation significance testing used to determine how the independent variabe affects the dependent variable (Y). *P-value*is the probability to reject the null hypothesis if the testing is valid. The level of significance is 1% (very significant), 5% (significant) dan 10% (moderately significant). If the p-value is lesser than the level of significant, the researchers can conclude that the effect being studied does not only reflect sampling error, but also the population characteristics (Cowles & Davis, 1982).Before conducting the analysis, prerequisite tests, classic assumption test, need to be conducted involving normality, autocorrelation, and multicollinearity tests conducted on the three regression models. Normality test is done to know whether the variables (dependent, independent, or both of them) normally distribute or not. The normality test is done by using *Kolmogorov-Smirnov*teston theunstandardized residual. If the *Kolmogorov-Smirnov* p-valueon the unstandardized residual < 0.05, it shows that the data do not normally distribute, and vice versa. Autocorrelation can be defined as the correlation among the members being observed which is sorted based on the time series and cross sectional sorting. Meanwhile, in order to indentify the autocorrelation problem, *Run test* is used. Criteria used to know whether or not there is an autocorrelation among the residual data (non-random residual data) if the run test significance on the residual data < 0.05.Multicollinearity test is used to test whether there is a correlation among the independent variables on the reggression model. The identification of multicollinearity is based on the tolerance value and VIF. There is no multicollinearity among independent variables if the tolerance value for all of the independent variables > 0.1 and VIF value less than 10(Ghozali, 2010: 95).

RESULTS AND DISCUSSION

Data Description

Hybrid corn is the main type of corn cultivated in Grobogan. The corn agribusiness cost is classified into labors cost, production cost, and the other costs. The number of labor in the corn agribusiness can be identified by the result of interview with the corn farmer, which the result can be seen on the Table 2. The labors cost includes pre-harvest, harvest, and post-harvest labors cost. Pre-harvest activities involve seeding, land cultivating, plating, fertilizing, weeding, (once), and pest controlling (twice). Post-harvest activities involve shelling, clearance, containing, drying, and storing. The labors are from their own relatives and hired labors. The latter is being much considered since it requires a real cost to pay, while the former does not require a real cost to pay.

Some of the corn farmers are landowner farmers who own the arable land and it is close to the house, some others are sharecroppers, and few others are land tenant farmers. Based on the Table 5.1, it can be seen that commonly, the sharecroppers and the landowner farmers labors are from the relatives, while the rest hire the labors. The highest total labors cost is for owner farmers, followed by the land tenant farmers, then the landowner farmers, and the lowest is for the sharcroppers. This is due to the arable area is wider. Hal ini karena rata-rata luas lahan yang lebih besar. Production cost includes the cost on seed, fertilizer, pesticide, herbicide, and fungicide. The other cost includes the cost on the land tenance. The detailed statistic on the production unit and unit cost of corn agribusiness can be found from the interviews on the corn farmers, and the result can be seen on the Table 2.

The corn farmers' total revenue is determined by the multiplication result of the production farm and the unit price. Based on Table 3, it can be seen that corn agribusiness on various types of ownership and marketing objectives has >1 R/C ratio and positive B/C ratio. It means that the income of corn agribusiness is higher than that of the cost. Positive B/C ratio shows that corn agribusiness is profitable.

The highest R/C ratio and B/C ratio is owned by land tenant farmers, owner farmer, and land owner farmer. The R/C ratio and B/C ratio of the farmers who sell their crop to the cooperative is higher than those who sell their crop to PPD and PPK. This happens since the selling price in cooperative is higher. However, only few farmers sell their crop to cooperative since: 1) not all farmers become the members of cooperative (KUD, Gapoktan, LMDH), 2) cooperative usually pays the corn to the farmers after being paid by the factory; whereas the farmers need cash funds,

3) the farmers who live far away from the cooperative prefer to sell their crop to the PPD because it is more convenient.

DEA Analysis

The result of data analysis on both the input and output by using DEA software shows that the efficiency level on corn farming is as follows:

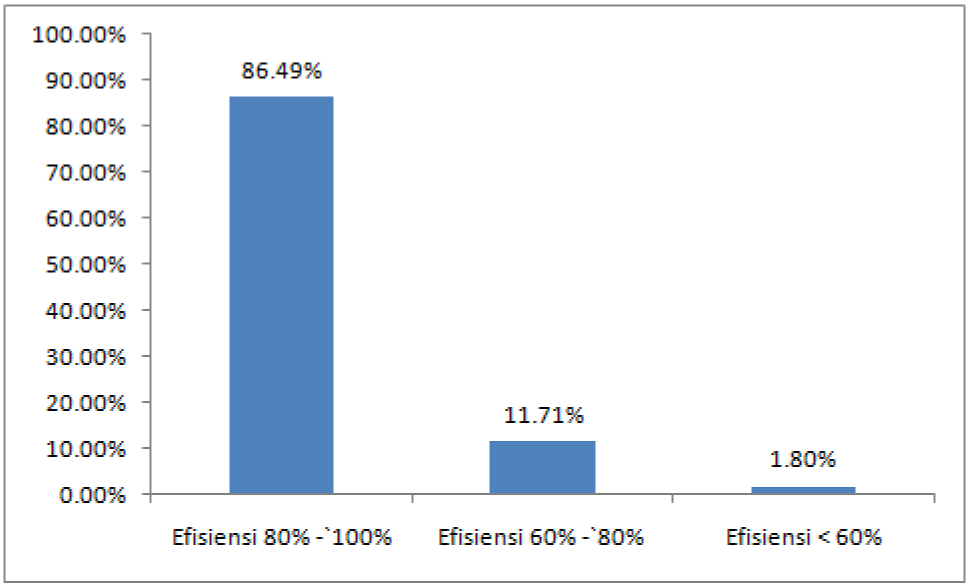

Figure 6.1 Efficiency Level on Corn Agribusiness
Source: analyzed based on the data of a survey on corn farmers (2017)

The data analyzed by using *Data Envelopment Analysis* (DEA) illustrated on Figure 6.1 shows that most of corn agribusiness (86,49%) in Central Java have high level of efficiency. The level of efficiency ranges from 80% - 100%. Only 11,71% of corn agribusiness show 60%-80% level of efficiency and 1,8% has level of efficiency below 60%.

Table 2 The Summary of Corn Agribusiness Efficiency based on DEA Analysis

Parameter	**Percentage (%)**
Efficiency	
The Mean of Efficiency (%)	88,63%
Standard Deviation Efficiency (%)	0,93%
Minimum Efficiency (%)	58,88%

MaximumEfficiency (%)		100,00%
Frequency		
	The Number LKMA (n)	LKMA Percentage (%)
Efficiency 80% -`100%	96	86,49%
Efficiency 60% -`80%	13	11,71%
Efficiency < 60%	2	1,80%
Total	111	100,00%

Source: analyzed based on the data of a survey on corn farmers (2017)

The Factors Influencing LKMA Efficiency

From the result of data normality test, the value of *Kolmogorov-Smirnov* is Z = 1,005 (*p-value*= 0,265> 0,05) (Tabel 6.3). This show that the data have normal distribution. Based on the autocorrelation test, the statistical significance shows that (*p*) *run-test* = 0.702. It means that there is no autocorrelation on the residual data. In terms of multicolinearity test, the tolerance value of all independent variables is 0,1 and VIF value is >10 (Ghozali, 2010). The test result clarifies that there is no multicolinearity on the regression model.The classical assumption regression test result explains that the data fulfil the assumption of normality, autocorrelation, and multicolinearity so that the data are able to be analyzed.

Tabel 3Classical Assumption Test

Z-test	Result
Kolmogorov-Smirnov Test	
Z-test	1.005
Z-test (p-value)	0.265
Autocorrealtion Test	
DW-test	2.365
run-test	0.338
run-test (p-value)	0.958

Multicolinearity Test

	Tolerance	*VIF*
The Area of Arable Land	0.560	1.785
Land Tenure	0.760	1.315
Seed Technology Access	0.482	2.075
Land Processing Technology Access	0.457	2.188
Irrigation Access	0.514	1.947
Marketing Channel-1	0.559	1.789
Marketing Channel -2	0.370	2.703
Marketing Channel -3	0.497	2.013

Source: analyzed based on the data of a survey on corn farmers (2017)

Regression Analysis and Hypothesis Testing

The summary of regression analysis on the factors that influence the efficiency of corn farming is illustrated in Table 6.

Tabel 6. The summary of regression analysis on the factors influencing the efficiency of corn farming

Independent Variable	**LKMA Efficiency**	
	β	*p*
(Constant)	60341,000	0,000
The Area of Arable Land	0,845	***) 0,004
Land Tenure	0,104	0,446
Seed Technology Access	1,118	***) 0,007
Land Processing Technology Access	-0,137	0,741
Irrigation Access	0,454	*) 0,086

Marketing Channel-1	-0,361	0,297
Marketing Channel-2	-0,857	***) 0,002
Marketing Channel-3	0,591	**) 0,030
R-squared	0,934	
F-statistic	68,198	
Prob(F-statistic)	0,000	

Note: ***) having significant influence, α 1%, **) having significant influence, α 5%,*) having significant influence, α 10%.

Source: analyzed based on the data of a survey on corn farmers (2017)

The result of regression equation on the factors that influence the efficiency of corn farming shows that F-test is 68,198. It has significant influence with α 1%. This result also shows that the factors simultaneously influence the efficiency of corn farming. From the regression equation, it is found out that R^2 is 0,934 or 93,4%. It shows that all the independent variables are able to explain the increase or decrease of the effciency of corn farming as the dependent variable. Meanwhile, the rest 6,6% is influenced by other extraneous variables.

Based on the result of regression equation, six factors influence the efficiency of corn farming significantly. Those factors are the area of arable land, land tenure, seed technology access, land processing technology access, irrigation access, and marketing channel. The wider the arable land, the more efficient the corn farming is. The farmers, who own their own arable land, apply mechanized agriculture, have irrigation access, and have direct marketing channel; have higher corn farming efficiency.

The area of arable land also positively influences the efficiency of corn farming (p= 0,000 < 1%). The wider the arable land, the more efficient the corn farming is and vice versa. The regression coefficient is β=6,658). This clarifies that if the area of arable land increases 1 ha, the efficiency of corn farming increases 6,658% and vice versa. However, this result requires that all variables remain constant. Thus, the wider area of arable land improves the farming scale. Large scale farming demands more input

Irrigation system as one factor being ivestigated does not influence the efficiency of corn farming significantly (p= 0,722 > 5%). This happens since the need of liquid fertilizer on semi-technical irrigation system is higher than the need of liquid fertilizer on technical irrigation system. On the technical irrigation system, the irrigation is done by channeling the water from the reservoir. Meanwhile, on the semi-technical irrigation system, the water is pumped from groundwater. This occurs since the nutrient on the technical irrigation system is higher than that of semi-technical irrigation. Therfore, the need of fertilizer on semi-technical irrigation is higher than that of technical irrigation system. Moreover, the need of liquid fertilizer on semi-technical irrigation system is higher than on rainfed field. Irrigation system enables the corp to absorb more fertilizer. The arable land that is connected to irrigation system; is flatter, more accessible, and more resistant to various rainfall so that the farmers face less risk if they use fertilizer intensively (Akpoko & Yiljeb, 2001, Akpan et al. 2012; Assa et al., 2010; Suma, 2007).

CONCLUSION

The findings of the research show that the efficiency of corn farming varies from76,84% - 104,18%. Most of corn farming (92,79%) in Central Java is efficient. The level of efficiency is around 80% - 100%. Only 7,21% of corn farming having the level of efficiency below < 80%. The mean of efficiency level is 89,37%. This percentage indicates that the corn farming is efficient since the level of efficiency is 80%-100%.

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