IMPACT OF INFRASTRUCTURE AND GOVERNMENT SUPPORT ON CORN PRODUCTION IN INDONESIA: A Case on Integrated Crop Management Farmer Field School

Dampak Infrastruktur dan Dukungan Pemerintah terhadap Produksi Jagung di Indonesia : Kasus pada Sekolah Lapang Petani Pengelolaan Tanaman Terpadu

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ABSTRACT

Corn is the second most important food crop after rice in Indonesia. It is a versatile crop and also the second biggest contributor to crop sector's GDP. However, domestic supply of corn has not been able to meet demand satisfactorily. To address this problem, the Indonesian government since 2009 has implemented the Farmers' Field School of Integrated Crop Management (ICM-FFS) program on corn production. But, the success of this program is also dependent on the infrastructure available and government support where the program is implemented. The study found that good infrastructure and government support increased ICM-FFS corn farms productivity by 9.81%, with 5.62% as a direct impact and 4.19% as an indirect impact. The production difference due to infrastructure and government support was contributed by pure yield effect (52.85%) and pure area effect (42.73%). The income per corn farmer differential of Rp 1.50 million arising from good infrastructure and government support was attributed to yield effect (36.79%), area effect (29.75%), and price effect (25.42%). Road conditions and market infrastructure improvement, government support enhancement and provision of competitive input and output markets could be considered as policy directions to improve corn production in Indonesia.

Key words : *corn, Indonesia, Farmer Field School, productivity, production, farmer's income*

ABSTRAK

Di Indonesia, jagung merupakan komoditas terpenting kedua setelah padi. Selain mempunyai banyak fungsi, jagung juga sebagai penyumbang terbesar kedua terhadap PDB sektor tanaman pangan. Namun demikian, produksi jagung dalam negeri belum mampu memenuhi permintaannya secara memuaskan. Untuk mengatasi permasalahan ini, Pemerintah Indonesia sejak 2009 melaksanakan SLPTT jagung. Namun demikian, keberhasilan program ini juga ditentukan oleh ketersediaan infrastruktur dan dukungan pemerintah dimana program ini dikembangan. Hasil penelitian menunjukkan bahwa infrastruktur dan dukungan pemerintah yang bagus mampu meningkatkan produktivitas SLPTT jagung sebesar 9,81persen dimana 5,62 persensebagai dampak langsung dan 4,19 persen sebagai dampak tidak langsung dari infrastruktur dan dukungan pemerintah. Mereka juga mampu meningkatkan produksi jagung, dimana 52,85 persen berasal dari kontribusi produktivitas dan 42,73 persen berasal dari kontribusi lahan. Selain itu, mereka meningkatkan pendapatan petani sekitar Rp 1,5 juta, dimana masing-masing 36,79, 29,75, dan 25,42 persen berasal dari kontribusi produktivitas, lahan, dan harga jagung. Kondisi jalan dan dukungan pemerintah yang semakin baik serta penyediaan pasar input dan output yang lebih bersaing diharapkan mampu meningkatkan kinerja SLPTT jagung ke depan.

Kata kunci : *jagung, Indonesia, SLPTT, produktivitas, produksi, pendapatan petani*

INTRODUCTION

Today, corn is the second most important food crop after rice in Indonesia. It has an important role in national economic growth being the second biggest contributor after rice to crop sector's GDP. Its real contribution was steadily increasing, from only Rp9.4 trillion in 2000 to Rp10.6 and Rp17.1 trillion in 2003 and 2009, respectively (Statistics Indonesia, 2010). As a versatile crop, corn is being used as a raw material for a diverse range of industrial products, both food and feed. Specifically, corn making it the most popular ingredient of manufactured animal feed. It comprises 51.4% of feed ingredients (Tangendjaja, *et al*., 2003).

However, demand for corn is rising faster than domestic supply that causes continuously importation of corn. During the period 1990-2008, imported corn was approximately 10% of the total demand (FAO, 2010).

Some efforts were done to accelerate corn production. One of these was the Mass Guidance Program (BIMAS) for secondary crops that was started in 1973 (Directorate General of Food Crops and Horticulture, 1995). The other program, which started in 1983 promoted the use of corn hybrid seeds. At that time, it only focused on eleven provinces. Since 1998, the Indonesian government had also implemented a self-reliant program to increase soybean and corn production (GEMA PALAGUNG). This program had been implemented in almost every provinces.

However, all those programs have not shown satisfactory results. The productivity of corn remains below 3.5 tons per hectare. Aware that corn production is still low, the Indonesian government exerted efforts to find out a breakthrough program that will address the corn supply problem. In 2009, Indonesia started to implement the Farmer Field School of Integrated Crop Management (ICM-FFS) program on corn production which was inspired by the successful experience of the Farmer Field School of Integrated Pest Management (IPM-FFS) in the past. This approach is expected to increase corn productivity and input use efficiency. However, the success of the corn production is not determined by the performance of ICM-FFS program alone. It is also dependent on the infrastructure available and government support where the program is implemented. To date no study has been conducted to evaluate the performance of ICM-FFS and the contribution of infrastructure and government support service.

Based on the issues and information stated above, this study aims to: (i) analyze the impact of available infrastructure and government support on ICM-FFS performance in producing corn in Indonesia; (ii) analyze the contribution of yield, area, and price on increasing corn productivity, production, and income of ICM-FFS considering difference in available infrastructure and government support; and (iii) provide policy recommendations to improve the performance of ICM-FFS program in the next implementation. The infrastructure available in this study was represented by road condition and market infrastructure, meanwhile the government support was represented by sufficiency of number of extension workers and pest and disease observers at sub-district and village levels.

THEORETICAL FRAMEWORK

The Effect of Good Infrastructure on Output and Input Prices in Competitive Market

As shown in Figure 1, initially the equilibrium at farm level ($S_y f = D_y f$) is at point A in which corn price and the quantity of corn are P_{yf} and Y, respectively. The equilibrium at retail level ($S_y r = D_y r$) is at point B in which corn price and quantity of corn are P_{yr} and Y, respectively, with marketing margin of MM.

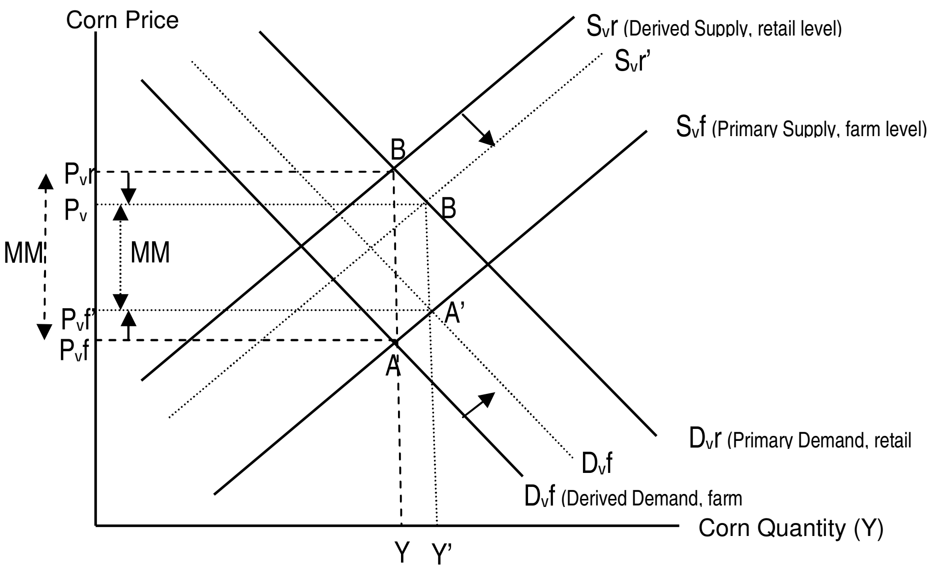


Figure 1. Effect of Good Infrastructure on Corn Prices at Farm and Retail Levels

Supposing there is infrastructure improvement (road and market information) that leads to a decrease in transport cost. Thus, reduction in transport cost enables the middleman to buy more corn from farmers, thus shifting D_yf to D_yf'. This in turn causes retail supply to shift from S_yr to S_yr'. At new equilibrium at farm level (point A') and retail level (point B'), the price of corn at farm level is higher, from P_yf to P_yf'; and the price of corn at retail level is lower, from P_yr to P_yr'. Consequently, the marketing margin is reduced from MM to MM'.

Figure 2 shows that without infrastructure and market information improvement, the initial equilibrium at fertilizer plant level ($S_xp = D_xp$) and retail level ($S_xr = D_xr$) are at points A and B, respectively. The farmers buy fertilizer at price level of P_xr while at the plant or factory level, the price is P_xp. This condition yields marketing margin for fertilizer dealers of MM and X represents the quantity of fertilizer.

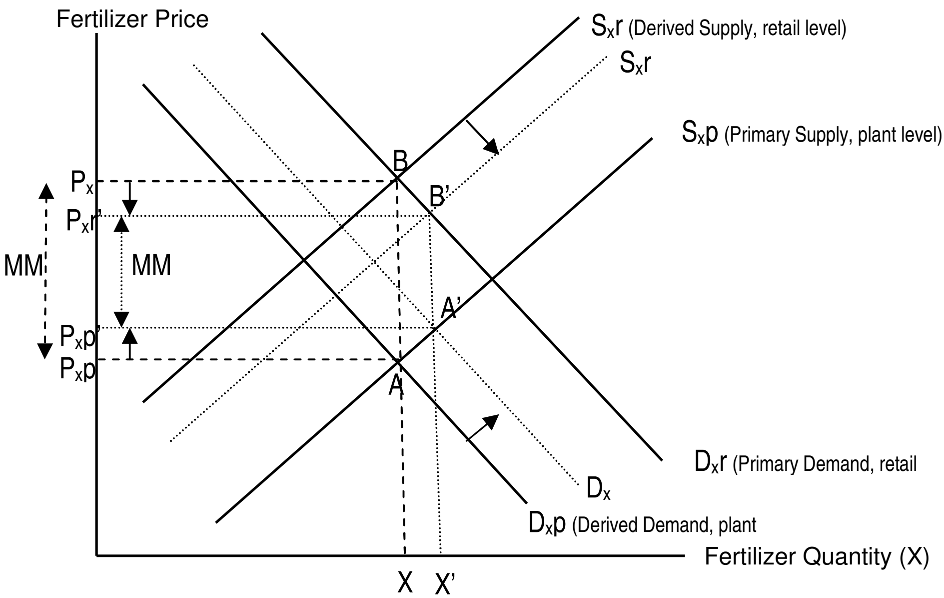


Figure 2. Effect of Good Infrastructure on Fertilizer Prices at Plant and Retail Levels in a Competitive Input Market.

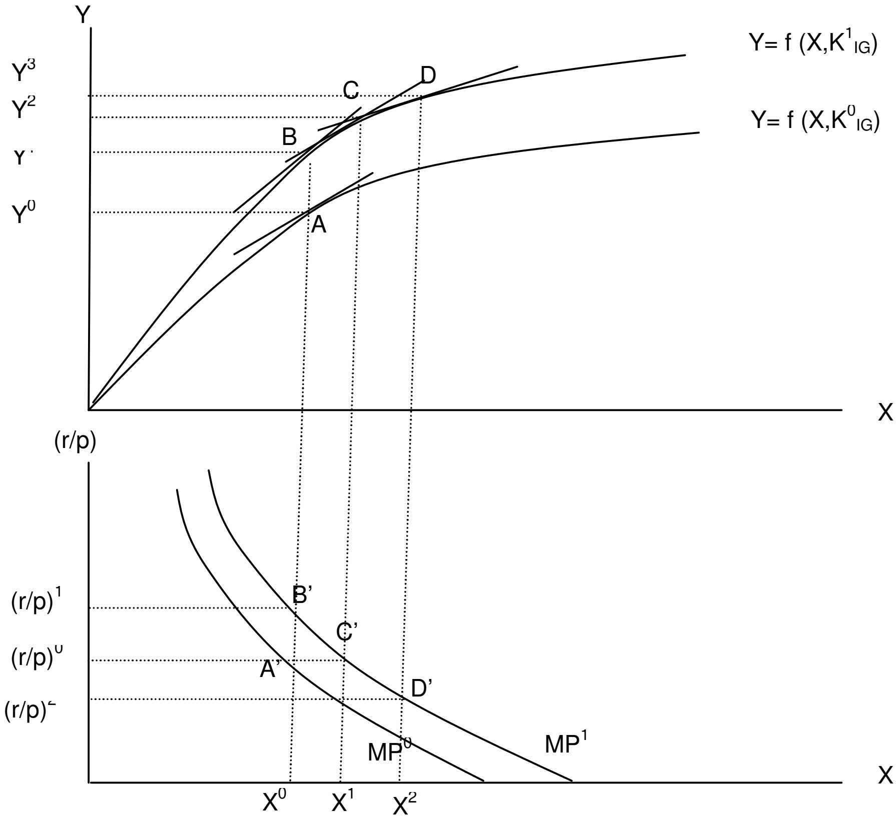
Since the improved infrastructure and market information causes a more efficient transportation system, with the same amount of money, reduction in transport cost enables the fertilizer dealer to buy more fertilizer from plant, thus shifting D_xp to D_xp'. This in turn causes retail supply to shift from S_xr to S_xr'. At new equilibrium at plant level (point A') and retail level (point B'), the fertilizer price at retail level is lower, from $P_x r$ to $P_x r'$; and fertilizer price at plant/factory level is higher, from $P_x p$ to $P_x p'$. This leads to lower marketing margin, from MM to MM'.

This shows that the presence of good infrastructure (road) and market information leads to decrease in marketing margin (MM' < MM). This could bring about higher output price ($P_y f' > P_y f$) and lower input price ($P_x r' < P_x r$). This yields more favorable input-output price ratio, that is, $P_x r'/P_y f' < P_x r/Pyf$.

The Effect of Infrastructure and Government Support on Productivity

Available infrastructure and government support influence productivity level. Yoshino and Nakajima (2000) stated that the productivity effect of infrastructure can be divided into direct and indirect effects. The direct effect is an additional output due to an increase in marginal productivity which occurs as a result of an increase in available infrastructure and government support. The indirect effect is an additional output due to an increase in input use based on an increase in available infrastructure and government support as presented in Figure 3.

Given input-output price ratio and the level of available infrastructure and government support, K^0_{IG}, point A, is the optimal output (Y^0) and input use (X^0) under profit maximization. Now, suppose available infrastructure and government support are increased from K^0_{IG} to K^1_{IG}. This will have a positive effect on productivity. Production in the top panel will shift upward, and so will the marginal productivity curve, from MP^0 to MP^1 (from A' to B') in the bottom panel. The corresponding point on the new curve above point A is indicated by point B. The direct effect is the difference between output Y^0 and Y^1. It is noted that the input-output price ratio $(r/p)^0$ (r is the price of input and p is the price of output) is given. The available infrastructure and government support caused cheaper input prices. Output prices become more favorable due to more efficient transportation. Good infrastructure and government support lead to a competitive output market wherein the farmers can have better bargaining power. This is indicated by the higher output price at farm level. As presented, input-output price ratio is flatter and moves from $(r/p)^0$ to $(r/p)^2$. Since marginal productivity at point B is higher than the input-output price ratio, the farmers can increase profit by increasing more input, from X^0 to X^2, thus, producing more output. This move is shown by a shift from point B to point D. Accordingly, output is increased from Y^1 to Y^3, the difference between them being the indirect effect. At point C, the slope of input-output price ratio is the same at point A when the available infrastructure and government is K^0_{IG}. Therefore, point C does not represent the optimal input use of the farmers.



Source: Yoshino and Nakajima (2000), modified

Figure 3. Direct and Indirect Effects of Infrastructure and Government Support on Productivity

Studies on impact of infrastructure on productivity and economic development were conducted. A study was conducted by Li and Liau (2009), for instance, found that transportation infrastructure plays the most substantial positive role on technical efficiency, followed by vocational/technical education infrastructure, electricity facilities, and water supply systems. Another study conducted by Fabrizio, Wahl, Wandschneider, and Gilbert (20030 found that the density of roads and the availability of electricity are significant predictors of production and productivity in agricultural sector. Their study suggests that access to transportation infrastructure and electricity will be crucial the modernization of China agriculture.

Llanto (2007) also did study on impact of infrastructure on a region's economic growth prospect in Philippines. The result of his study showed that recent causality tests indicate that the direction of causation runs from infrastructure to economic growth and that regional imbalance in infrastructure availability has a negative impact on a region's economic growth prospects. Differences in availability of infrastructure have led to differences in regional growth in the Philippines. His study, furthermore, found evidence that infrastructure could be a key variable in regional convergence. Aside from those study above, A study that conducted by Manalili, and Gonzales (2009) also found that the availability of good infrastructure led to better on profitability and global competitiveness of rice production in the Philippines.

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METHODOLOGY

Selection of the Study Areas

This research was conducted for two months (January to February, 2011) in two provinces; namely, East Java and West Nusa Tenggara Provinces, Indonesia. Selections were done purposively. East Java Province was selected to represent provinces with good infrastructure and government support while West Nusa Tenggara Province was selected to represent provinces with poor infrastructure and government support. Good infrastructure and high government support are characterized by good road conditions, good market infrastructure, and sufficient number of extension workers and pest and disease observers. Based on these characteristics, it could be assumed that East Java has better infrastructure and government support than West Nusa Tenggara

Sampling Procedure

In choosing the farm samples, a random sampling was employed. In the first step, the selection was done only for corn farmers under ICM-FFS program in two provinces (East Java and West Nusa Tenggara). The following step is one hundred twenty (120) farmers, 60 farmer-respondents from locations with good infrastructure and government support (ICM-FFS_{GIGS}) and 60 farmer-respondents from locations with poor infrastructure and government support (ICM-FFS_{PIGS}), were interviewed using random sampling approach. Meanwhile for extension workers, pest and disease observers, input producers, and key informants were purposively selected.

Analytical Tools

In order to satisfy the objectives of this study, a number of analytical tools were employed. The comparative mean analysis, response function analysis, productivity decomposition analysis, production decomposition analysis, income decomposition analysis were employed to evaluate the effect of infrastructure available and government support on the performance of Integrated Crop Management Farmer Field School on corn production in Indonesia.

Comparative Mean Analysis

Under the comparative mean analysis, significant difference in the mean yields, area, production, seed, labor, fertilizer application, chemical utilization, and revenue in corn production between ICM-FFS in locations with good infrastructure and high government support (ICM-FFS_{GIGS}) and ICM-FFS farms in locations with poor infrastructure and low government support (ICM-FFS_{PIGS}) were investigated.

These were conducted by employing the t test statistic as defined below:

$$t_c = \frac{\bar{X}_a - \bar{X}_b}{\sqrt{\frac{S_a^2}{n_a} + \frac{S_b^2}{n_b}}} \qquad \text{...(1)}$$

Where:

$\bar{X}_a$ = the sample mean of the variables being tested for ICM-FFS_{GIGS} farms

$\bar{X}_b$ = the sample mean of the variables being tested forICM-FFS_{PIGS} farms

S_a^2 = variance of ICM-FFS_{GIGS} farms

S_b^2 = variance of ICM-FFS_{PIGS} farms

n_a = sample size of ICM-FFS_{GIGS} farms

n_b = sample size of ICM-FFS_{PIGS} farms

The t-computed value was compared with the t-tabulated. If $t_c > t_t$, the null hypothesis was rejected and it was concluded that the difference in the means of the two groups is statistically significant.

Response Function Analysis

In the response function approach, the yield response of corn to various factors such as seed, labor, fertilizer, and chemical was investigated. Out of the several agricultural production functions discussed by a handful of economists like Heady and Dillon (1961), the Cobb Douglas production was chosen for this particular study.

Generally, in the analysis, the Cobb-Douglas production fitted to the data is of the form:

$$Y = a_o N^{a1} S^{a2} C^{a3} F^{a4} e \quad (2)$$

Where: Y = Total production in kg per hectare; N = Labor in man-days per hectare; S = Seed in kg per hectare; C = Chemical in liter per hectare; F = Fertilizer in kg per hectare; a_0 = intercept or scale of the regression function; a_j (j=1,2,3, 4) = slope parameters of the regression function; and e = disturbance or error term

When transformed into logarithm, the equation is reduced to:

$$\ln Y = \ln a_0 + a_1 \ln N + a_2 \ln S + a_3 \ln C + a_4 \ln F + e \quad (3)$$

The simple equation Cobb-Douglas production function was estimated separately for ICM-FFS_{GIGS} and ICM-FFS_{PIGS} samples. To test the hypothesis of no significant differences in the resource productivities between ICM-FFS_{GIGS} and ICM-FFS_{PIGS} farms the F-statistics by Chow (1960) was performed.

Decomposition Analysis

Decomposition method is a mathematical technique for partitioning an aggregate into its component elements (Solow, 1957). This model enables researchers to allocate differences in productivity, production, and income resulting from a variety of factors such as technological change, input use, area, yield, and price differences (Catelo, 1984).

Income decomposition model. The objective of income decomposition analysis is to decompose the observed income difference between ICM-FFS_{GIGS} and ICM-FFS_{PIGS} farms into yield, harvested area, and price components and the interaction of these components. Therefore, the income model used is as follows:

$$I = A_i . Y_i . P_i \quad (4)$$

Where : I = Gross farm income in rupiah per farm; A_i = Farm area in hectare(s); Y_i = Yield in kg per hectare; P_i = Price in rupiah per kg

In decomposition of the individual contribution to output difference, let:

for ICM-FFS_{GIGS} farms:

$$I^a = A_i^a . Y_i^a . P_i^a \quad (5)$$

and for ICM-FFS$_{PIGS}$ farms:

$$I^{b} = A_i^{b}.Y_i^{b}.P_i^{b} \quad \text{.......} \quad (6)$$

The value of ΔI can be derived from the equation below. Taking equation (4), this can be rewritten by subtracting equation (6) from equation (5), that is

$$\Delta I = I^{a} - I^{b} \quad \text{.......} \quad (7)$$

$$I^{a} = I^{b} - \Delta I \quad \text{.......} \quad (8)$$

By expanding equation (8) and re-arrangement of some terms, the following income decomposition model was arrived at:

$$I^{a} = A_i^{b}.Y_i^{b}.P_i^{b} + \Delta I \quad \text{.......} \quad (9)$$

Where : $\Delta I = A_i^{b}.Y_i^{b}.\Delta P_i$ .... pure price effect

$+A_i^{b}.\Delta Y_i.P_i^{b}$ .... pure yield effect

$+\Delta A_i.Y_i^{b}.P_i^{b}$ .... pure area effect

$$\left.\begin{array}{l} +\Delta A_i.\Delta Y_i.P_i^{b} \\ +\Delta A_i.Y_i^{b}.\Delta P_i \\ +\Delta A_i^{b}.\Delta Y_i.\Delta P_i \end{array}\right\} \text{first-order interaction terms}$$

$+\Delta A_i.\Delta Y_i.\Delta P_i$ .... second-order interaction term

Production decomposition model. The production decomposition model derived from production is equal to harvested area times yield. The production, then, can be decomposed into two sources: harvested area and yield. The production model used is as follows:

$$Q = A_i.Y_i \quad \text{.......} \quad (10)$$

In partitioning the individual contribution to production difference, let:

Q^{a} = Corn production of ICM-FFS$_{GIGS}$ farms , $Q^{a} = A_i^{a}.Y_i^{a}$ .... (11)

Q^b = Corn production of ICM-FFS$_{PIGS}$ farms, $Q^b = A_i^b.Y_i^b$ .... (12)

Similar to processes and steps in deriving the income decomposition model, equation (11) leads to:

$$Q^a = A_i^b.Y_i^b + \Delta Q \text{ .... (13)}$$

Where : $\Delta Q = A_i^b.\Delta Y_i$ .... pure yield effect

$+\Delta A_i.Y_i^b$ .... pure area effect

$+\Delta A_i.\Delta Y_i$ .... first-order interaction term

Productivity decomposition model. With the help of the functional form specified in equation (3), the Cobb-Douglas production function on per hectare basis, as specified below in log-linear form was estimated.

ICM-FFS$_{GIGS}$ farms:

$$\ln Y_a = \ln a_0 + a_1 \ln N_a + a_2 \ln S_a + a_3 \ln C_a + a_4 \ln F_a + e_a \text{ .. (14)}$$

ICM-FFS$_{PIGS}$ farms:

$$\ln Y_b = \ln b_0 + b_1 \ln N_b + b_2 \ln S_b + b_3 \ln C_b + b_4 \ln F_b + e_b \text{ ...... (15)}$$

To decompose the differences in the yield per hectare between the ICM-FFS$_{GIGS}$ and the ICM-FFS$_{PIGS}$ farms, the difference of the predicted linearized production function of two groups using mean values of each variable was computed as follows:

$$\Delta Y = \ln Y_a - \ln Y_b \text{ .... (16)}$$

$$\ln Y_a - \ln Y_b = \left(\ln a_0 + a_1 \ln N_a + a_2 \ln S_a + a_3 \ln C_a + a_4 \ln F_a + e_a\right) -$$

$$\left(\ln b_0 + b_1 \ln N_b + b_2 \ln S_b + b_3 \ln C_b + b_4 \ln F_b + e_b\right) \text{ .. (17)}$$

By adding and subtracting some terms to equation (16) and re-arrangement of some terms, the following productivity decomposition model was arrived at:

$$\ln Y_a - \ln Y_b = \left[\ln a_0 - \ln b_0\right] + \ldots\ldots\ldots\ldots$$

measures the change in productivity due to the shift in the intercept of the production function

$$\left[(a_1 - b_1)\ln b_b + (a_2 - b_2)\ln S_b + (a_3 - b_3)\ln C_b + (a_4 - b_4)\ln F_b)\right] +$$

measures the change in productivity due to the shift in the slope of parameters of the production function

Direct Effect

$$\left[a_1\left(\ln N_a - \ln N_b\right) + a_2\left(\ln S_a - \ln S_b\right) + a_3\left(\ln C_a - \ln C_b\right) + a_4\left(\ln F_a - \ln F_b\right)\right] +$$

measures the change in productivity due to changes in the quantity of inputs used

Indirect Effect

$$\left[e_a - e_b\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

measures the difference in error terms............................ (18)

RESULTS AND DISCUSSION

Condition of Infrastructure and Government Support in Study Areas

Infrastructure and government support have pivotal roles in influencing the performance of ICM-FFS program. In this study, the infrastructure available are market infrastructure and road condition while government support included the ability of the government to provide the required number of extension workers and pest and disease observers. The assessment focused on the differences in market infrastructure, road condition, and input and output prices in locations with differences in infrastructure and government support.

Extension workers, pest and disease observers, and market infrastructure. The number of extension workers in East Java Province that represents locations with good infrastructure available and government support was higher than in West Nusa Tenggara Province that represents locations with poor infrastructure available and government support (Table 1). The number of extension workers in East Java was relatively higher than in West Nusa Tenggara based on the number of villages. Eighty percent of the villages in East Java had one extension worker while the remaining 20% had one extension worker to service two villages. In contrast, most of the villages (75%) in West

Nusa Tenggara had one extension worker to serve two villages and only 35% villages had one extension worker. Moreover, in East Java Province only one person was assigned as pest and disease observer at every subdistrict level. However, in West Nusa Tenggara, one pest and disease observer had to cover two subdistricts.

Table 1. Number of Extension Workers, Pest and Disease Observers, and Input Producers, East Java and West Nusa Tenggara Provinces, Indonesia, 2010.

Item	East Java	West Nusa Tenggara
1. Number of extension worker		
a. One per village	80%	35%
b. One per two villages	20%	75%
2. Number of pest and disease observer at subdistrict level	1	0.5-1
3. Location of fertilizer kiosk	Village	Subdistrict
4. Availability of seed producers		
a. Multinational level	Yes	No
b. State-owned enterprises	Yes	No
c. Local	Yes	Yes
5. Number of corn buyers at subdistrict level	7	3

Source: Interview of key informants

There is one fertilizer kiosk located in almost every village in East Java whereas there was only one located in West Nusa Tenggara at the subdistrict level. Significant differences also existed in the number and type of seed producer. There were some multinational corn seed producers in East Java such as PT. A, PT. B, PT. C, etc but there was none in West Nusa Tenggara. There was no corn seed producer from state-owned enterprises in the latter province while the former province had two seed producers; namely, PT. D and PT. E. Nevertheless, there were few producers of corn seed in West Nusa Tenggara to fulfill the demand of farmers in the area. A large number of this type of producers can be found in West Java. Aside from producing for local farmers' demand, corn seeds were also produced for farmers outside East Java Provinces.

East Java had a higher number of buyers for corn than West Nusa Tenggara. There were seven buyers in every subdistrict in East Java but only three buyers in West Nusa Tenggara.

Road condition. The availability of infrastructure such as roads plays an important role in promoting agricultural development, including corn production. Good roads can narrow the marketing margin by reducing transport cost, hence, lessening the price gap between farm level and retail level. Coupled with a relatively competitive output market, the lower transport cost could be translated into higher output price. On the other hand, lower transport cost could also mean that farmers pay lower input price. Thus, farmers could buy inputs at lower prices and sell their produce at higher prices. This creates a favorable condition for farmers and thus motivating them to manage their farms more intensively.

The infrastructure available in terms of road condition in the two locations of ICM-FFS development is presented in Table 2. In general, the roads in East Java (representing the location with good infrastructure and government support, GIGS) were much better than in West Nusa Tenggara (representing locations with poor infrastructure and government support, PIGS). There are about 1,258.2 kilometers of state road in East Java in which all are in good condition. In contrast, only 69.1% of 631 km state roads in West Nusa Tenggara are in good condition; 15.6% and 15.3% are lightly damaged and seriously damaged, respectively.

Table 2. Comparative Road Conditions, East Java and West Nusa Tenggara Provinces, Indonesia, 2010.

Road Condition	East Java	West Nusa Tenggara
1. State Road (km)[1)]	1,258.2	631
a. Good (%)	100.0	69.1
b. Lightly damaged (%)	0.0	15.6
c. Seriously damaged (%)	0	15.3
2. Provincial Road (km)[1)]	2,001	1,842
a. Good (%)	80.1	51.9
b. Lightly damaged (%)	18.6	12.8
c. Seriously damaged (%)	1.3	25.3
3. District to village road[2)]		
a. Good (%)	85	40
b. Damaged (%)	15	60

Sources: [1)] Public Work Service of East Java and West Nusa Tenggara Provinces
[2)] Interview of key informants

Besides state roads, there are about 2,001 km provincial roads in East Java, in which 80.1% is good condition, 18.6% is lightly damaged, with only 1.3% seriously damaged. In West Nusa Tenggara, this type of road measures

1,842 km with 51.9% in good condition and the rest are poor ones (lightly damaged and seriously damaged). At district to village levels, most of the roads are poor in West Nusa Tenggara with 60% of its total roads damaged, and only 40% is in good condition. In some places, only earth road is available. But in East Java, most (85%) of the district to village roads are good and only 15% is in damaged condition. Earth road is no longer found in East Java.

Input and output prices. The infrastructure available such as roads and markets, and government support such as number of extension workers and pest and disease observers, influence the input and output prices. In general, the input prices in East Java were lower than in West Nusa Tenggara, except for labor input (Table 3). The input producers in East Java can sell their products at lower prices due to more efficient transport system thus lowering costs. In contrast, the labor wage in East Java was higher than in West Nusa Tenggara because of the much stronger competition in labor use with other sectors, particularly with industrial and services sectors. In other words, young people have more chances to get job beyond the agricultural sector which caused the wage in East Java to be higher than in West Nusa Tenggara.

Table 3. Comparative Output and Input Prices and Price Ratios, East Java and West Nusa Tenggara Provinces, Indonesia, 2010.

Item	East Java	West Nusa Tenggara
1. Corn price (Rp/kg)	2,871	2,679
2. Input prices		
a. Seed (Rp/kg)	40,000	42,500
b. Fertilizer (Rp/kg)		
- Nitrogen	1,600	1,610
- Potassium Chloride	2,300	2,320
c. Chemical (Rp/liter)	150,000	155,000
d. Labor (Rp/man day)	39,000	37,500
3. Input-output price ratio		
a. Seed-corn ratio	13.932	15.864
b. Nitrogen-corn ratio	0.557	0.601
c. Potassium Chloride -corn ratio	0.801	0.866
d. Chemical-corn ratio	52.247	57.857
e. Labor-corn ratio	13.584	13.998

The price of corn at Rp2,871 per kg in East Java was higher than in Nusa Tenggara (Rp2,679 per kg). Data also show that input-output price ratios in East Java were generally lower than in West Nusa Tenggara. Seed-corn price ratio, for instance, in East Java was 13.93 and 15.86 in West Nusa Tenggara. Another example is Nitrogen (Urea)-corn price ratio of 0.56 in East Java and 0.60 in West Nusa Tenggara.

The situation where inputs can be bought at lower prices and the produce could be sold at higher price will encourage the farmers to use more inputs. This is consistent with the production function curve shown earlier where farmers could achieve an optimal condition at a higher level involving higher input use and output level with more favorable price ratio (that is, smaller slope or flatter price line).

Comparative Mean Analysis for Input Use, Yield, Production, Price and Income

Using all data of farmer-respondents (not aggregate provinces) and employing t-test statistic, the availability of infrastructure and government support affected the input use, corn productivity, production, price, and farmer's income (Table 4). Farmers under ICM-FFS$_{GIGS}$ (locations with good infrastructure and government support) used significantly higher inputs such as fertilizer and labor than farmers under ICM-FFS$_{PIGS}$ (locations with poor infrastructure and poor government support). However, it was found that there was no significant difference at 10% probability level in seed and chemical use between the two groups of farmers.

Table 4. Differences in Yield, Input Use, Production, Land Area, Price and Income Between ICM-FFS$_{GIGS}$ and ICM-FFS$_{PIGS}$ farms, Indonesia, 2010

Item	ICM-FFS$_{GIGS}$	ICM-FFS$_{PIGS}$	Difference
a. Seed (kg/ha)	15.700	15.767	-0.067 ^{ns}
b. Fertilizer (kg/ha)	434.21	410.16	24.06***
c. Chemical (liter/ha)	0.985	0.999	-0.014 ^{ns}
d. Labor (Man day/ha)	98.19	94.04	4.14***
e. Productivity (kg/ha)	5,141	4,659	481.54***
f. Land area (ha)	0.463	0.428	0.036 ^{ns}
g. Production (kg/farm)	2,396	2,026	370**
h. Price (Rp/kg)	2,871	2,679	191.31***
i. Gross income (Rp000/farm)	6,885	5,418	1,467***

Notes: ***and ** Significant at 1% and 5% probability levels, respectively
^{ns} Not significant at 10% probability level

On the other hand, corn productivity, price, and farmers' income were higher for the farmers under ICM-FFS$_{GIGS}$ than for farmers under ICM-FFS$_{PIGS}$, with the differences being statistically significant at 1% probability level. Similarly, corn production in ICM-FFS$_{GIGS}$ farms was significantly higher than in ICM-FFS$_{PIGS}$ farms at 5% probability level. It is important to note that good infrastructure and government support can lessen transport cost (marketing margin) and can lead to higher output price at farm gate. More efficient transport cost not only increases the output price in farm level, but at the same time it also lessens input price, encouraging farmers to use more inputs properly (quantity, quality, and time application). These conditions can bring about more corn productivity and production as well as farmers' income.

Response Production Function

The results of estimation for ICM-FFS farms in locations with and without/poor infrastructure and government support are summarized in Table 5. The values of the multiple coefficient of determination (adjusted R^2) of ICM-FFS_{GIGS}, ICM-FFS_{PIGS}, and pooled farms were 56.5%, 67.5%, and 63.3%, respectively. These values indicate that the independent variables in each model consisting of seed, fertilizer, chemical, and labor were good enough to explain the variations of corn productivity in these locations. All models were also found to be significant at 1% probability level. This means that as a whole, the data fitted in the model strongly influenced corn productivity in both locations.

Table 5. Estimated Regression Coefficients of Cobb-Douglas Production Function (per ha) for ICM-FFS_{GIGS}, ICM-FFS_{PIGS}, and all farms, Indonesia, 2010.

Item	Regression Coefficient		
	ICM-FFS_{GIGS}	FFS-ICM_{PIGS}	Pooled (ICM-FFS)
Dependent variable			
Yield (Y)			
Independent variables			
Intercept	5.723***	5.763***	5.381***
	(0.867)	(0.633)	(0.578)
Seed (S)	-0.511**	-0.442**	-0.495***
	(0.228)	(0.173)	(0.156)
Fertilizer (F)	0.308***	0.263***	0.310***
	(0.082)	(0.075)	(0.060)
Chemical (C)	0.000^{ns}	-0.027^{ns}	-0.030^{ns}
	(0.069)	(0.052)	(0.047)
Labor (N)	0.513***	0.509***	0.569***
	(0.132)	(0.106)	(0.091)
Sample size (n)	60	60	120
Adj R^2	0.565	0.675	0.633
F-computed value	20.17***	31.64***	52.21***

Notes: Figures in parentheses are the standard errors
*** and ** Significant at 1% and 5% probability levels, respectively
^{ns} Not significant at 10% probability level

The coefficients of all inputs were significant at 1% probability level in all models, except for chemical. The intercepts of the two models, ICM-FFS_{GIGS} and ICM-FFS_{PIGS}, were almost the same. It means that infrastructure and government support had no significant impact on the technological component. Meanwhile, the use of production inputs such as fertilizer and labor was more productive in locations with good infrastructure and government support compared to those with none. This is shown by the regression coefficients of fertilizer and labor being higher in ICM-FFS$_{GIGS}$ higher than in ICM-FFS$_{PIGS}$ farms. In other words, good infrastructure and government support can promote input productivity. Aside from being more productive, ICM-FFS$_{GIGS}$ farms were able to use more of these inputs because of lower prices. It was noted earlier that transportation cost was lower and there were more choices of input suppliers (kiosks) in locations with good infrastructure and government support.

In both areas, the farmers under ICM-FFS program were not effective in using seed and tended to use more than the recommended technology. This is indicated by the negative coefficients of seed input in the two locations. The recommended technology for seed is 15 kg/ha, in fact most famers applied this input more than 15 kg/ha. The use of chemical in ICM-FFS$_{GIGS}$ farms was effective. It means that the farmers used chemical only if urgently needed and with proper application in terms of time and dose. In addition, most famers implemented Integrated Pest Management (IPM) approach, and it was in line with recommended technology. ICM-FFS farmers in locations with poor infrastructure and government support (ICM-FFS$_{PIGS}$) tended to use slightly more of this input and sometimes with a tendency of improper applications. This could happen because of the lack of extension workers and pest and disease observers in those areas.

Productivity Decomposition Analysis

Based on observations (using all data of farmer-respondents), ICM-FFS farms with good infrastructure and government support (ICM-FFS$_{GIGS}$) performed better than farms with poor infrastructure and government support (ICM-FFS$_{PIGS}$). This is indicated by the higher (9.84%) corn productivity in ICM-FFS$_{GIGS}$ compared to ICM-FFS$_{PIGS}$ farms (Table 6). On the other hand, based on estimation, the productivity of ICM-FFS farms with good infrastructure and government support was 9.81% higher than in other locations. There was slight discrepancy between the observed and the estimated productivity decomposition. This discrepancy was attributed to the random term which, among others, accounts for variables that could not be included in the model such as management input. Such discrepancies of varying degrees in decomposition analysis were also noted in several earlier studies such as those of Kiresur, *et al.* (1995) and Lalwani (1990). In majority of these studies, such discrepancies were attributed to random errors and exclusion of management input which is one of the important variables excluded from the model. However, in this study, the results of the decomposition analysis were found to be satisfactory since the discrepancy in the analysis was of a very low order.

Table 6. Decomposition of Productivity Difference Between ICM-FFS$_{GIGS}$ and ICM-FFS$_{PIGS}$ farms, Indonesia, 2010.

Source of Productivity Difference	Percentage Contribution	
	Sub-total	Total
A. Total observed difference in productivity		9.84
B. Direct Impact		5.62
1. Change in Intercept	-4.0088	
2. Change in productivity	9.6241	
a. Seed (S)	-19.1079	
b. Fertilizer (F)	26.8617	
c. Chemical (C)	-0.0024	
d. Labor (N)	1.8727	
C. Indirect Impact		4.19
a. Seed (S)	0.2166	
b. Fertilizer (F)	1.7575	
c. Chemical (C)	-0.0001	
d. Labor (N)	2.2155	
D. Total estimated difference in productivity		9.81

From the total productivity difference of 9.81%, 5.62% was the direct impact of good infrastructure and government support and the rest (4.19%) was indirect impact. Direct impact of good infrastructure and government support involved the upward shift of the production function of ICM-FFS farms. Indirect impact of good infrastructure and government support, on the other hand, gave farmers the chance to use more inputs due to lower transport cost. The good infrastructure also resulted to more attractive corn price for farmers.

It can be concluded that good infrastructure and government support increased corn productivity of ICM-FFS farms by 9.81%, of which 5.62% came from its direct impact and the rest (4.19%) from its indirect impact. Therefore, the availability of good infrastructure and government support is essential to ensure success of ICM-FFS program.

Production Decomposition Analysis

In line with the productivity analysis, by using all data of farmer-respondents, ICM-FFS farms with good infrastructure available and government support performed relatively better. This was indicated by the contribution of pure yield effect of 52.85% in the incremental corn production (Table 7). The good infrastructure also encouraged farmers to expand their corn area as proven by the contribution of pure area effect on corn production difference of 42.73%, which was almost close to pure yield effect contribution. Meanwhile, interaction between yield and area gave a contribution of 4.42%.

Table 7. Decomposition Analysis of Production Difference Between ICM-FFS$_{GIGS}$ and ICM-FFS$_{PIGS}$ farms, Indonesia, 2010

Source of Production Difference	Absolute Change	Percentage Change
A. Individual (pure) effects		
Yield	206.0	52.85
Area	166.5	42.73
B. First-order interaction effect		
Yield and area	17.2	4.42
Total	389.7	100.00

Farm Income Decomposition Analysis

Using all data of farmer-respondents, the income of the ICM-FFS farms with good infrastructure and government support was about Rp1.50 million higher than their counterpart farms with poor infrastructure and government support (Table 8). Yield in ICM-FFS farms was higher than in non ICM-FFS farms. This was proven by the 36.79% pure yield effect contribution to income difference which was also the largest contributor. The second largest contribution came from pure area effect, followed by pure price effect with contributions of 29.75% and 25.42%, respectively. The significant contribution of pure price effect could be attributed to the favorable corn price received by the farmers in areas with good infrastructure.

Table 8. Decomposition Analysis of Income Difference Between ICM-FFS$_{GIGS}$ and ICM-FFS$_{PIGS}$ farms, Indonesia, 2010.

Source of Income Difference	Absolute Change	Percentage Change
A. Individual (pure) effects		
Yield	551,829.0	36.79
Area	446,129.2	29.75
Price	381,232.8	25.42
B. First-order interaction effects		
Yield and area	46,107.3	3.07
Yield and price	39,400.3	2.63
Area and price	31,853.4	2.12
C. Second-order interaction effect		
Yield, area, and price	3,292.0	0.22
Total	1,499,844.0	100.00

Among the first-order interaction effects, yield and area interaction was the biggest contributor (3.07%), followed by yield and price interaction with contribution of 2.63%, and area and price interaction with contribution of 2.12%.

Interactions of all components in second-order contributed only about 0.22% to income difference.

Thus, it can be concluded that good infrastructure and government support brought about favorable corn price which had an important role on increasing farmer's income. Infrastructure development and government support should be an essential component of the ICM-FFS program.

CONCLUSIONS AND POLICY RECOMMENDATIONS

Productivity decomposition analysis showed that good infrastructure and government support could increase corn productivity in ICM-FFS farms by 9.81%, with 5.62% as direct impact and 4.19% as indirect impact. Corn production in ICM-FFS farms with good infrastructure and government support was higher than in ICM-FFS farms with poor ones. Of the production difference, 52.85% came from the contribution of pure yield effect while the contribution of pure area effect was 42.73%.

The income differential of Rp1.50 million arising from good infrastructure and government support was attributed to pure yield effect (36.79%), pure area effect (29.75%) and pure price effect (25.42%). The pure price effect was related to the fact farmers in areas with good infrastructure and government support received higher price for corn.

The road and market infrastructure as well as government support have important roles to support ICM-FFS program and corn production. Both had positive impacts on the performance of ICM-FFS and had significantly increased yield, production, and farmers' income. This implies the need to prioritize the improvement of road and market infrastructure and strengthen government support particularly in locations with poor road and market infrastructure.

The government should provide competitive input market to ensure that farmers could buy production inputs at lower prices and then able to use inputs according to the recommended technology. On the other hand, prices of agricultural products including corn are fluctuating and tend to discourage farmers from increasing their produce. Through a competitive output market, corn price at the farm level could remain favorable for growers to increase production.

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