Increasing the efficiency of rice agribusiness through the recommendations of balanced fertilizers and price policies

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Abstract. The efforts in increasing national rice production through production efficiency and price efficiency more important alternative than having extensification through the extension of the area. This study was purposed in leveling the national rice agribusiness economic efficiency by comparing between before and after the subsidy price was calculated based on the conditions of irrigated rice farming technology in Java in 2010 and in 2014. The results of the analysis rice farming nation efficiency 85% was increased to be 88% on fertilizer subsidies had been taken into account. The rice farming efficiency in year 2014 was 71% to be 84% at the subsidies price calculated. National technical efficiency of lowland rice production can still be increased in improving production technology through the application of balanced in use of NPK, KCl, and organic fertilizer recommendation. In 2014 conditionally shown the economic efficiency on farm level 38%, was smaller than national level 65%, the grain was sold by the government purchase price, using technology, and only looks up to 48% efficiency after fertilizer subsidy prices had been taken into account. Overall the agribusiness efficiency of wetland rice trends to increase above 50% at milling has the price as the retail price at the farm level. It was suggested that technical efficiency on production should increased technology in application of fertilizer on rice farming in Java.

Keywords: Efficiency, balanced fertilizer, subsidized fertilizer, basic price of grain

1. Introduction
Indonesia in which population 248 million people in average increase 1.36% each year in time periods 2010–2015, it requires sufficient rice availability to guarantee the people whose was depend on rice for food [1]. National program to increasing rice production by Guidance of Farmer Communities through Bimas and Inmas, Special Intensification such INSUS, SUPRA INSUS, Integrated Pest Management abbreviated IPM, Direct Seed Planting, Integrated Business Systems called SUTPA, IP 300. Development of hybrid rice, Integrated Crop Management known as PTT, Planting Intensity on IP 400, and others [2,3]. Rice production since 2010 has increased almost four times compared to 1970s of rice production development. The extensive enlarging of harvested area and increasing productivity in that period of time did not appear to have changed much. Productivity development was slightly faster than the development of the area, although the development of productivity trends to be flat. The development of total production was mainly due to the development of agro-technology. In the few years later, the productivity of rice farming was unstable and stagnates (leveling off) [4,5].
It was caused, among others, by the slow growth of new planting areas (extensification) as a result of limited budgets for the construction of new rice fields and rehabilitation of irrigation networks, and the symptoms of slowing productivity growth have not been successfully solved [6]. The slowing development of rice productivity per hectare indicated that marginal productivity of rice fields was almost the maximum approaching leveling off. These productivity conditions can be increased through the efforts to intensify by improvement technology. This effort was more likely considerable to increase production through extensification or expansion of rice fields that was increasingly inefficient. The limitations of the government budget for the establishment of irrigated land and the high competition for land use of non-agricultural activities has an impact on increasing rice production through the expansion of rice fields to become more expensive. The alternative was needs be considered in increasing land productivity through efficiency [7]. If the community continues to take rice as a staple food that was difficult to diversify, it will have implications on the demand. High demand at least the government to implement a policy of cheap rice prices. National rice prices are controlled to protect rice consumers, especially for low-income people [8]. The policy of cheap rice prices was indeed beneficial to consumers, but detrimental to rice-producing farmers. In turn, cheap rice prices will suppress even eliminate economic incentives for farmers who produce rice and do not rule out the possibility for farmers to switch of non-rice. On the other hand, national rice consumption still early in high, and even trends to increase. From BPS data, in 2010-2015 the average national rice consumption was 86.9 kilograms per capita per year, and based on per capita consumption per week was calculated as much as 1.67 kilograms. National rice consumption was considered very high compared to other countries in Asia such as Japan which has an average consumption of 60 kilograms of rice per capita per year and Malaysia 80 kilograms per capita per year.

Through the growing of population of 1.36 percent per year [9-11]. National rice needs will increase continuously. Based on the description above, increasing productivity accompanied by price policies will improve efficiency in the national rice agribusiness. The benefits of farming were determined by the achievement of economic efficiency, namely the multiplication of technical efficiency and price efficiency. Efficiency value of 1 was the profit condition expected by each farmer, but in practice efficiency still below 1. The efficiency concept used in this study refers to the efficiency stated by [12]. Efficiency was classified into three, namely technical efficiency, allocative efficiency, and economic efficiency. Technical efficiency showed the relative ability of a company (farming) to obtain certain outputs by using a certain amount of input at a certain level of technology. Allocative efficiency showed the relative ability of farming to use inputs and to produce output in conditions of minimal costs or maximum benefits at a particular technological level. Allocative efficiency could be obtained in technically efficient farming conditions. If allocative efficiency was obtained in technically efficient conditions, the farm was in the condition of economic efficiency. The value of the technical efficiency index results of the analysis was categorized efficient because it produced a value of more than 0.70 of efficient limit [13]. The results showed that the productivity of lowland rice with a combination of inputs per ha of urea 560.1 kg, ZA 117.7 kg, TSP 63.8 kg, SP-36 39.5 kg, KCl 35.7 kg, organic 20.1 kg with the implication of farming costs of IDR 4,335,300 per hectare resulted in productivity of 56.5 quintals of dry grain and efficiency of agribusiness 0.28 [14]. Rice productivity with a combination of inputs per ha of 50 kg seed, urea 278 kg, ZA 51 kg, SP-36 97 kg, 96 kg NPK and 8 kg KCl, without TSP and organic with the implications of farming costs of Rp 10,445,132 per hectare were resulting in productivity of 56.7 quintal of dry grain and efficiency of agribusiness 0.58 [15]. Other studies described a combination of inputs per ha, 187.2 kg urea, 163.1 kg SP-36, 12.3 kg NPK and 7.8 kg KCl, and 43.2 kg fertilizer without ZA and TSP implicating the cost of farming was IDR 10,445,132 per hectare resulting in productivity of 61.7 quintal of dry grain and efficiency of agribusiness 0.71. Rice farming efficiency was correlated with reduced production. Land use had not been optimal and there was an excess in the outpouring of labor. The optimization process can increase farmers' income by 54.6% from the previous conditions [16].

IOP Conf. Series: Earth and Environmental Science 205 (2018) 012007 doi:10.1088/1755-1315/205/1/012007
Rice production was determined by the use of inputs both of land, seed, fertilizer, and labor [17]. Frontier production elasticity of the variables of seed, N fertilizer, P fertilizer, and labor were found to have a significant effect on rice production with production elasticity values of 0.0350 for seeds, 0.0153 for N fertilizer, 0.0045 for P fertilizer, and 0.0678 for labor. These indicated that the addition of seedlings, N fertilizer, P fertilizer, and labor in each by 1 percent (assuming other inputs remain), could still increase rice production with additional production of 0.0350, 0.0153, 0.0045 and 0.0678 percent. For the variable K fertilizer, it was found no significant effect on rice production. Technical efficiency was analyzed by using the frontier production function model with an average efficiency level of 91.86 percent. The technical efficiency of rice farming in Indonesia should be improved because the level of technical efficiency of rice farming based on the previous research was in the range of 50-90 percent. The level of technical efficiency of rice farming was varying in each of regions, with a range of 0.64 to 0.80 [18,19]. That research supported the research [20-22]. Changes in irrigated rice technology from 1980 to 1988 were 42.72 percent [23]. From the study of the Sumatra Agricultural Technology Assessment Institute, there were six hope lines for wetland rice that had higher yields than the comparative varieties Fahmawati and Ciharang [24]. The yield potential of the variety has between 7-8 tons per ha compared to Fatmawati and Ciharang varieties of 6.7 and 7.0 tons per ha, respectively [25]. The results of the farm business analysis of the six varieties studied were able to increase farmers' income as much as 43.3%.

Technology changes trend to be biased towards reducing seeds and labor and increasing in use of fertilizers, pesticides and tractors. The introduction of new superior varieties in rice farming was very important to increase productivity and boost the efficiency of agribusiness in the future. Price efficiency was determined by input prices and output prices. Some inputs were subsidized with prices set by Permentan No. 130/2014, while the purchase price of grain was set by INPRES No. 3/2012 [26]. The method of purchasing grain prices was calculated by using the ratio of revenue costs (R/C). Rice production costs were calculated no longer based on the cost of urea fertilizer, but includes all input components, such as seeds, fertilizers, pesticides, and labor. The size of the ratio was set above 2.0, with the reason to provide adequate production incentives for farmers. In line with the increasing attention of the government to food security and poverty alleviation, the effect of rising rice prices on increasing the number of poor people was an important variable in determining the amount of rice and rice price increases. Previous research on poverty which concluded that every 10% increase in rice prices would increase around 1% of the proportion of the poor in Indonesia, and it became an important argument in the discussion of rice price policy, the purchase of grain and rice by the government was always discussed in relation to maintaining economic stability, rice price stability, influence on inflation, and incentives for rice farmers. Various calculation methods were used, ranging from analysis of rice farming by using econometric models [27].

2. Research Methods
This study compared the agribusiness efficiency of wetland rice at the national level between before and after fertilizer subsidy prices that were calculated based on farming conditions and technology used in irrigated rice farming in Java in 2010 and 2014. The analyzed data were taken from 2010-2015 and it sourced from BPS. As a comparison, secondary data from farm efficiency research in irrigated rice fields in Java in 2010 and 2014, with consideration because as long as two years the use of balanced fertilizer and organic fertilizer was very dominant. Production costs were calculated based on market prices and subsidized prices for subsidized production inputs, namely Urea, SP-36 and NPK fertilizers. Other inputs were all calculated at market prices. Farming costs at the national level were the average costs over a period of six years, was calculated on the basis of subsidized prices and market prices. The production price (grain) was the average price of milled dry grain (MDG), harvested dry grain (HDG), and lowly grain quality (LGG) calculated at the market milling price, and government purchase price (GPP). Agribusiness efficiency was calculated by the method of revenue cost ratio (R/C) ratio and Benefit Cost Ratio (B/C) ratio.
3. Results and Discussion

The results of the research on agribusiness efficiency at the national level with the interval of observation 2010-2015 were obtained an illustration that productivity reached an average of 5.135 tons. This efficiency was smaller than the productivity of agriculture in 2010 amounted to 5.76 tons and smaller than productivity in 2014 of 6.170 tons. Some fertilizers were subsidized by the government, while other production facilities such as subsidized seeds and pesticides. During 2010-2015, the types of government subsidized fertilizers were determined, including: Urea, NPK and SP-36, with the same relative prices of Rp 1.600-1.800/kg, IDR 2.300/kg, and IDR 2.000/kg. Meanwhile, the basic price of unhulled rice at the farm level during the same time period was determined according to the quality of milled dry grain (MDG), harvested dry grain (HDG), and unhulled grain quality (UGQ), with an average price variation of IDR 4.453.27 / kg, IDR 3.901.59/kg, IDR 3.399.55/kg. This price was different at the level of the rice mill and at the government purchase price (GPP). The price of production facilities in farming affects the cost of farming. The increasing productivity can not be separated from the development of production technologies such as the use of SP-36 balanced NPK fertilizer and organic fertilizer. Productivity and technology used in irrigation rice farming in java, can be seen at Table 1.

Table 1. Productivity and technology used in irrigation rice farming in java 2010 and 2014

| Description                | In 2010 National | In 2010 Farming | In 2014 National | In 2014 Farming |
|----------------------------|------------------|-----------------|------------------|-----------------|
| Productivity (ton gkp)     | 5.760            | 5.698           | 5.135            | 6.170           |
| Input:                     |                  |                 |                  |                 |
| Seed (kg)                  | 50.00            | 48              |                  |                 |
| Inorganic Fertilizer (kg): |                  |                 |                  |                 |
| Urea                       |                  | 273.2           |                  | 187.2           |
| Za                         | 278              | -               |                  | -               |
| TSP                        | 51               | -               |                  | -               |
| SP36                       | 97               | 50.8            | 163.1            |                 |
| NPK                        | 96               | 103.4           | 169.6            |                 |
| KCl                        | 8                | 7.6             | 107.3            |                 |
| Organic                    |                  |                 | 593.6            |                 |
| The others                 |                  |                 |                  |                 |
| Cost of Pesticides (IDR.000) | 541             | 553.0           | 14.829.590       | 14.255.020*     |
| (Daily kindergarten, borongan, bawon) | 3.111       | 3.187           | 12.445.000*      | 14.804.200      |

Note *) Some of the costs were calculated based on fertilizer subsidy prices while other costs were calculated based on market prices.

The results of a study of farm production costs with / and without fertilizer subsidy prices calculated at the national level as well as at irrigated rice farming levels in Java produce different average costs per hectare. National average production costs per hectare for six years whether before and after the subsidy price was calculated at IDR. 13.907.660 and IDR 13.350.015 respectively. This cost was smaller than the cost of irrigated rice farming in Java technological conditions in 2010 and 2014 before and after the subsidy price was taken into account, but generally the cost of farming was relatively lower after the subsidy price was calculated. Production efficiency and price efficiency reflected in input prices and production prices affected the size of the efficiency of agribusiness (farming). The results of the research showed that there was a difference between the basic prices of grain related to the quality of grain.
At the farmer level, the price of unhusked unhulled rice was IDR. 4,453.26, harvested unhulled rice was IDR. 3,901.59, and low quality unhulled rice was IDR. 3,399.55, on average the grain was IDR. 2,763.33 / kg. Based on the price, it can be calculated the acceptance and efficiency of rice farming at the national level and the level of irrigated rice farming at the market price and the price of government purchases. Average agribusiness needs of rice per hectare before and after the price of fertilizer subsidies is calculated can be seen at Table 2.

**Table 2.** Average agribusiness needs of rice per hectare before and after the price of fertilizer subsidies is calculated

| Description                              | Farming Fee (IDR) |
|------------------------------------------|-------------------|
|                                          | Technology        | Technology       | National         |
|                                          | Conditions 2010   | Conditions 2014  |                 |
| Before Subsidized Prices were Calculated | 14.829,593.2*     | 14.804,200*      | 13.907,660      |
| After Subsidized Prices were Calculated  | 14.724,960        |                 | 13.350,015      |
|                                          | 13.785,080        |                 |                 |

Description: *) Calculated based on the technology irrigated rice farming in Java in 2010 and 2014

National average rice agribusiness acceptance and efficiency during 2010-2015 and irrigation rice farming in Java in 2010 and 2014 based on market prices (idr./ha) before prices for fertilizer subsidies were calculated can be seen at Table 3.

**Table 3.** National average rice agribusiness acceptance and efficiency during 2010-2015 and irrigation rice farming in Java in 2010 and 2014 based on market prices (idr./ha) before prices for fertilizer subsidies were calculated

| Year | Acceptance of MDG | Acceptance of HDG | Acceptance of LGQ | Acceptance of Average | Efficiency (R/C) | Efficiency (B/C) |
|------|-------------------|-------------------|-------------------|-----------------------|-----------------|-----------------|
| National (2010-2015) | 11.795,750 | 10.278,070 | 11.845,790 | 1.85 | 0.85 |
| 2010 | 17.643,971 | 15.254,686 | 17.704,921 | 1.19 | 0.19 |
| 2014 | 22.789,142 | 26.177,603 | 26.177,603 | 1.77 | 0.77 |

Both of Table 3. and Table 4. be explained that nationally agribusiness efficiency before the subsidy price was calculated at 0.85 and it was greater than the efficiency of the farm level of only 0.19 in 2010 and 0.77 in 2014. This efficiency means that 1 percent increase in costs will provide agribusiness benefits of 0.85% and 0.19% and 0.77%, respectively. Likewise national efficiency comparisons between before and after fertilizer subsidy prices were taken into account and basic grain prices received at the farm level showed efficiency of 0.85 and 0.88. This efficiency figure means that by increasing the cost of 1%, it will give an agribusiness profit of 0.85% and 0.88%. Furthermore, the comparison of the efficiency of farming level between before and after the subsidy price was calculated and the selling price of grain at the market level showed the efficiency of 0.19 and 0.77 respectively (before the subsidy price), while the efficiency of fertilizer subsidy was 0.20 and 0.90 respectively (after subsidy price). Both of these efficiency figures mean that increasing of 1% cost could increase agribusiness profits 0.19% and 0.77% respectively (before the subsidy price was taken into account), while after the subsidy the meaning of the figure was an increasing in 1% cost could provide the benefits of each agribusiness by 0.20% and 0.90%, respectively. National average rice agribusiness acceptance and efficiency during 2010-2015 and irrigation rice farming in Java in 2010 and 2014 based on market prices (idr./ha) after fertilizer subsidy prices were calculated can be seen at Table 4.
Table 4. National average rice agribusiness acceptance and efficiency during 2010-2015 and irrigation rice farming in Java in 2010 and 2014 based on market prices (idr/ha) after fertilizer subsidy prices were calculated

| Year   | Market Prices | Acceptance of MDG* | Acceptance of HDG* | Acceptance of LGQ | Acceptance of Average | Efficiency (R/C) | Efficiency (B/C) |
|--------|---------------|--------------------|--------------------|-------------------|-----------------------|-----------------|-----------------|
| National (2010-2015) | 13.463.560 | 11.795.750 | 10.278.070 | 11.845.790 | 1.88 | 0.88 |
| 2010   | 20.216.110 | 17.643.970 | 17.704.920 | 26.177.600 | 1.20 | 0.20 |
| 2014   | 29.409.800 | 26.333.870 | 15.254.690 | 22.789.140 | 1.90 | 0.90 |

Note: * MDG = Milled Dry Grain, HDG = Harvested Dry Grain, LGQ = Low Quality Grain

The price of grain at the market level was different from the level of Government Purchase Prices (GPP), respectively IDR. 2.640/kg before subsidy prices lower than IDR. 3.300 per kg after the subsidy price had calculated. This has implications for the difference in the amount of revenue and efficiency of agribusiness as in Table 5.

Table 5. National average rice agribusiness acceptance and efficiency during 2010-2015 and irrigation rice farming in Java in 2010 and 2014 based on hpp (idr/ha) before and after the price of fertilizer subsidies were calculated

| Year   | GPP* | Acceptance of MDG | Acceptance of HDG | Acceptance of LGQ | Acceptance of Average | Efficiency (R/C) | Efficiency (B/C) |
|--------|------|-------------------|-------------------|-------------------|-----------------------|-----------------|-----------------|
| National (2010-2015) | 17.083.200 | 17.083.200 | 17.083.200 | 17.083.200 | 1.65 | 0.65 |
| Before Subsidies: 2014 | 15.042.720 | 15.042.720 | 15.042.720 | 15.042.720 | 1.01 | 0.01 |
| After subsidies: 2014 | 20.361.000 | 20.361.000 | 20.361.000 | 20.361.000 | 1.38 | 0.38 |

Note: *) GPP = Government Purchase Prices, Note: National efficiency before subsidies calculated at 1.55 and 1.72 after subsidies

It can be explained that nationally the agribusiness efficiency before the subsidy price was calculated and the price of grain sold at the Government Purchase Price (GPP) of 0.65 far exceeds the efficiency of the farm level of only 0.01 (2010) and 0.38 in 2014. This efficiency means that by increasing the cost of 1 percent it would provide national agribusiness benefits of 0.65% and at the farm level of 0.01% and 0.38%. Likewise, the comparison of national efficiency with the farm level after the price of fertilizer subsidies is calculated and the basic price of grain calculated on the GPP showed the national efficiency rate of 0.65 while at the farm level of 0.02 (in 2010) and 0.48 in 2014. Each of these efficiency figures means that with an increase in the cost of 1% will give agribusiness benefits at the national level of 0.65%, while at the farm level of 0.02% and 0.48% respectively. In rice field agribusiness, an alternative market for farming was the rice milling industry. Both mean that if the cost increases by 1%, the profit of agribusiness increases by 1.86% and 2.01% at the level of the rice mill.
This figure exceeds the efficiency level at the farm level, each of which had an efficiency of 0.58 and 0.71 (before subsidies are taken into account) and increases after fertilizer subsidies were calculated to be 0.84 (in 2010) and 0.59 in 2014. This last efficiency figure was interpreted if the farm cost increases by 1% can increase the profit of 0.58% and 0.71% (before the subsidy price) and 84% and 59% after the fertilizer subsidy price was calculated and the price of grain applies at the level of rice mill. The government is also obliged to buy grain from farmers with the standard of grain in milling. Government purchase price (GPP) at the level of the rice milling industry as in Table 6.

Table 6. National average rice agribusiness acceptance and efficiency during 2010-2015 and irrigation rice farming in Java in 2010 and 2014 based on the price mill (idr / ha) before and after the price of fertilizer subsidies was calculated.

| Year               | Acceptance of MDG | Acceptance of HDG | Acceptance of LDQ | Acceptance of Average | Efficiency (R/C) | Efficiency (B/C) |
|--------------------|-------------------|-------------------|-------------------|----------------------|-----------------|-----------------|
| Before subsidies:  |                   |                   |                   |                      |                 |                 |
| National           | 13.703.145        | 12.015.089        | 10.503.801        | 12.074.012           | 2.05            | 1.05            |
| After subsidies:   |                   |                   |                   |                      |                 |                 |
| National           | 12.015.089        | 12.015.089        | 10.503.801        | 11.511.326           | 1.31            |                 |
| Before subsidies:  |                   |                   |                   |                      |                 |                 |
| 2010               | 26.664.475        | 23.203.567        | 20.280.322        | 23.382.788           | 1.58            | 0.58            |
| 2014               | 28.873.255        | 25.125.659        | 21.960.264        | 25.319.726           | 1.71            | 0.71            |
| After subsidies:2010| 26.664.475        | 23.203.567        | 20.280.322        | 23.382.788           | 1.84            |                 |
| 2014               | 28.873.255        | 25.125.659        | 21.960.264        | 25.319.726           | 1.59            | 0.59            |

From the Table 7, it can be explained that nationally the efficiency of agribusiness before and after the subsidy price was calculated and the price of grain sold at GPP at the milling rate is 1.72 and 1.95, respectively.

Table 7. National average rice agribusiness acceptance during 2010-2015 and irrigation rice farming in Java in 2010 and 2014 based on gpp at the grinding level (idr / ha) before and after the subsidy prices fertilizer calculated:

| Year               | Acceptance of MDG | Acceptance of HDG | Acceptance of Average | Efficiency (R/C) | Efficiency (B/C) |
|--------------------|-------------------|-------------------|----------------------|-----------------|-----------------|
| Before subsidies:  |                   |                   |                      |                 |                 |
| National (2010-2015)| 19.556.075        | 15.854.175        | 19.556.075           | 2.72            |                 |
| After subsidies:   |                   |                   |                      |                 |                 |
| National (2010-2015)| 19.556.075        | 15.854.175        | 17.705.125           | 2.95            |                 |
| Before subsidies:  |                   |                   |                      |                 |                 |
| 2010               | 18.803.400        | 15.299.130        | 23.137.500           | 5.79            | 4.79            |
| 2014               | 25.605.500        | 20.669.500        | 85.897.350           | 1.56            | 0.56            |
| After subsidies:   |                   |                   |                      |                 |                 |
| 2010               | 18.803.400        | 15.299.130        | 85.897.350           | 4.83            | 3.83            |
| 2014               | 25.605.500        | 20.669.500        | 23.137.500           | 2.36            | 1.36            |
Both mean that if the cost increases by 1% then the profit of agribusiness increases by 1.72% and 1.95% at the level of the rice mill. Condition in 2010, efficiency at level national 2.72 was lower than efficiency of farming 4.83, and decreased at efficiency farming in 2014 was 1.56. Both of the last efficiency means, if the farm was increase 1% could be increasing the profit 4.79% and 0.56% respectively (before the subsidy price) also 3.83% dan 1.36% after the subsidy price of fertilizer was accounted and the price at GPP applied at the level of rice mills.

4. Conclusion
Improving technology with balanced fertilizer recommendations in using NPK, KCl and organic fertilizers were important solutions in increasing the efficiency of rice production in Indonesia. The economic efficiency was very small at 38% at the farm level compared to national efficiency of 65% if the grain was sold by the government purchase price (GPP), and increases to 48% after fertilizer subsidy prices were taken into account. The government purchase price grain policy on fertilizer subsidies was very effective in boosting agribusiness efficiency.

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Acknowledgement
The author expressed his gratitude to the Rector of Universitas Katolik Santo Thomas