IMPACTS OF UPSUS PROGRAM ON THE COST EFFICIENCY AND COMPETITIVENESS OF RICE PRODUCTION IN INDONESIA

Dampak Program Upsus terhadap Efisiensi Biaya dan Daya Saing Produksi Padi di Indonesia

Adi Setiyanto[1*], Isabelita M. Pabuayon[2]

[1]Indonesian Center for Agricultural Socio Economic and Policy Studies
Jln. Tentara Pelajar No. 3B, Bogor 16111, West Java, Indonesia
[2]University of the Philippines Los Baños
Pedro R. Sandoval Ave, Los Baños, Laguna, Philippines
**Corresponding author. E-mail: amihardjo@yahoo.com*

Naskah diterima: 5 Juni 2020 Direvisi: 1 Agustus 2020 Disetujui terbit: 29 Oktober 2020

ABSTRAK

Program Upsus adalah program nasional yang dirintis pada tahun 2014 dan mulai diterapkan secara besar-besaran pada tahun 2015. Dalam program ini, padi mendapatkan porsi terbesar dari anggaran pemerintah, dan diharapkan dapat meningkatkan produksi beras melalui peningkatan luas areal panen dan produktivitas. Target yang ditetapkan adalah bahwa Indonesia akan mencapai swasembada beras lagi dalam tiga tahun. Setelah itu, targetnya adalah Indonesia dapat memelihara keberlanjutan swasembada beras, mencapai surplus untuk ekspor setelah 2017, dan dalam jangka panjang Indonesia akan menjadi lumbung pangan dunia pada tahun 2045. Saat ini, program tersebut telah dilaksanakan selama lima tahun dan analisis dampak dari penerapan program Upsus terhadap sisi efisiensi biaya dan daya saing produksi beras Indonesia ini penting untuk dikaji. Makalah ini bertujuan untuk membahas kerangka teoritis dan konseptual pengaruh program Upsus terhadap peningkatan efisiensi biaya dan daya saing produksi padi pada tingkat usaha tani. Alat analisis yang dapat digunakan untuk ini adalah perbandingan antara sebelum dan sesudah implementasi program Upsus yang terdiri dari regresi fungsi *stochastic frontier cost* (SFC), *policy analysis matrix* (PAM), analisis distribusi kepadatan kernel, dan model regresi berganda pengaruh peningkatan efisiensi biaya terhadap perubahan daya saing. Beberapa rekomendasi kebijakan yang dihasilkan dari pembahasan makalah ini berguna untuk lebih membantu meningkatkan strategi implementasi selanjutnya dari program Upsus pada padi.

Kata kunci: *daya saing, efisiensi biaya, kerangka analisis, padi, program*

ABSTRACT

The Upsus *(Special Effort)* program is nationwide and massive. This program was initiated in 2014 and started to be massively implemented in 2015 and prioritized rice in term of government spending and was expected to increase rice production by enhancing harvested area and yield. It was targeted that Indonesia would achieve rice self-sufficiency again within three years, aim for sustainability, accomplish a surplus for export after 2017, and the country will become the world food barn in 2045. This program has been carried out for five years, and an analysis of the effects of the implementation of this program on the cost efficiency and competitiveness of Indonesian rice production is urgent. This paper aims to discuss the theoretical and conceptual framework of the Upsus program's effects on rice farm cost-efficiency and competitiveness. Analysis tools used for this purpose were before and after implementing the Upsus program such as stochastic frontier cost function regression, policy analysis matrix (PAM) analysis, kernel density distribution analysis, and multiple regression models. Some policy recommendations are useful for further improving the next Upsus program implementation strategies on rice production enhancement.

Keywords: *competitiveness, cost efficiency, framework of analysis, rice, Upsus program*

INTRODUCTION

The Upsus program is a response to the instruction of the President of Indonesia of the 2014–2019 period to achieve sustainable rice, corn, and soybean self-sufficiency in three years. In this program, rice got the most considerable portion of government spending and was expected to increase rice production by increasing the harvested area and productivity. All strategies are meant to increase the planting activities, harvested areas, and productivity by providing favorable conditions for paddy growing and input use efficiency. These are expected to increase cost efficiency and farmers' income. As incentives are provided to farmers, sustainable rice self-sufficiency is expected. In the medium term, rice is expected to be an export commodity, and in the long term, Indonesia will be a world food barn in 2045 (MoA 2017). This means that attention to issues affecting the rice cost efficiency and competitiveness become very important.

There is still no study about the Upsus program's effects on the competitiveness and cost efficiency of rice production in Indonesia. Past studies (before implementing the Upsus program) have mixed results. Several studies showed that East Java and Central Java Provinces have no marginal comparative and competitive advantage (Gonzales et al. 1993; Antriyandarti 2015). However, the studies of Agustian et al. (2014) and Antriyandarti (2015) revealed that West Java Province has both comparative and competitive advantages. Nevertheless, based on the study of Gonzales et al. (1993), West Java does not have comparative and competitive advantages. It has lower cost efficiency than East Java and Central Java, although higher than those of North Sumatra and South Sulawesi (Antriyandarti 2015). The study of Bordey et al. (2016) found that Indonesia (West Java) does not have cost competitiveness compared to Vietnam, Thailand, and India as rice exporting countries.

Some studies analyzed the socio-economic effect and performance of the implementation of the Upsus program on rice. Saptana et al. (2016) evaluated the implementation of the Upsus program in Klaten Regency of Central Java and found that it has shown good performance in terms of planting area, productivity, and production. Using a participatory research approach in the Wonosobo Regency of Central Java Province, Nugroho et al. (2017) reported that farmers' knowledge about the program assistance component is still not maximized. Sari and Sjah (2016) studied the Upsus program implementation in East Lombok Regency of West Nusa Tenggara Province using a descriptive method analysis. The result reveals that there was an improvement in the production of rice. However, there were problems at the level of both farmers and extensions workers. Using the Cobb-Douglas production function method, Wijaya et al. (2016) analyzed rice farm input allocation's effectiveness under the Upsus program at the Tabanan Regency of Bali Province. They found that all inputs significantly affect the output, but the allocation of inputs has not reached the expected efficiency level. Using structural econometric modeling, Busyra (2017) concluded that the Upsus program on rice has a positive effect on the GDP of Tanjung Jabung Timur Regency of Jambi Province. Using the ethnographic study approach, Hamyana (2017) evaluated the Upsus program's implementation on rice in the Bondowoso Regency of East Java Province has a positive effect but had little impact on the marginalized people and communities. Using a path-method of analysis, Krisnawati et al. (2018) indicated the direct positive impact of the program on poverty in the Eastern Region of Indonesia. The indirect effect on rural poverty is through rice production and the GDP of the food crops sub-sector in Indonesia's western and eastern regions.

However, these studies cannot serve as bases for answering whether or not the Upsus program has contributed to making rice production in Indonesia more competitive and cost-efficient. This aspect is crucial because after rice self-sufficiency was achieved again in 2017, the GOI will focus the Upsus program to maintain sustainable self-sufficiency and promote rice export. For this reason, improvement of the cost efficiency and competitiveness of rice production is very important. As a nationwide and massive program, no study has measured and investigated the Upsus program's effect on rice production cost efficiency and competitiveness in Indonesia comprehensively.

This paper aims to discuss the theoretical and conceptual framework of the Upsus program's effects on increasing rice farms' cost-efficiency. This paper discusses a comparison between before and after implementing the Upsus program to determine its effects. This information can serve as a method for the next study to improve the next implementation strategies and program for Indonesia to achieve sustainable self-sufficiency and rice export.

This paper is organized to explain the Upsus program on rice, including the components and implementation performance based on some studies in the second section after the introduction. The third section shows the theoretical framework for analysis, which includes mathematical and econometric models that can be used to analyze the effect of the implementation of the Upsus program on cost efficiency and competitiveness of rice production. The next section shows the direction of the next implementation of the Upsus program. The final section is concluding remarks.

THE UPSUS PROGRAM ON RICE AND ITS PERFORMANCE OF IMPLEMENTATION

The Upsus Program on Rice

The Upsus program is an integrated approach with coordination and integration among the central government institutions down to the lowest institutions at the local level. Included are the Bulog, universities, and the military. The Ministry of Agriculture (MoA) of Indonesia initiated the Upsus program or “Special Program” for increasing rice, corn, and soybean production in 2014. This program started to be implemented in 16 provinces in 2015 and massively implemented in all or 34 provinces of Indonesia in 2016. This program is nationwide and massive and is expected to increase rice production by increasing harvested area and productivity. It has been targeted that Indonesia would achieve rice self-sufficiency again within three years, then aim for sustainability, be able to achieve a surplus for export after 2017, and in long-term Indonesia will be a world food barn in 2045. The Upsus program is targeted to address some problems identified as the causes of Indonesia not meeting the rice consumption needs of the population (Table 1). There is a need to address these problems as soon as possible.

The Upsus program on rice has ten components (Table 2). Out of these, seven are national in scope and massive. There are some program components implemented in specific locations, namely (1) development of new big and small dams including irrigation networks and introduction of deep well and pump irrigation networks; (2) land optimization program which only covers locations that have paddy field with cropping index (CI) equal to or less than 1, temporarily or previously never cultivated, and peatland and swamp areas; (3) development of System of Rice Intensification (SRI) program which only covers the locations with favorable conditions for SRI implementation; and (4) agricultural insurance which is only for locations identified as pilot project areas. The Upsus program also links to other programs to address farmers' problems on capital, transportation, distribution, and marketing in all areas, including strengthening farmers' group institutions and farmers' participation, specifically developing irrigation networks and land optimization. Thus, the Upsus program has complete components and is defined as a new technology innovation approach to increase rice planting areas and productivity. Increasing planting area, having two components, namely (i) irrigation network development; and (ii) land optimization and increasing productivity through the application of technology, has three components, namely (i) development of the system of rice intensification (SRI); (ii) massive implementation of the integrated crop management (ICM); and (iii) control of plant pests and diseases and the effects of climate change.

Table 1. Factors causing rice production and productivity problems in Indonesia

No.	Item
1.	Fifty two percent of irrigation networks have been damaged.
2.	Utilization of superior seeds at the farm level was only about 47% of the total acreage.
3.	Farmers do not use fertilizer correctly according to time of application and they sometimes use it over the recommended dosage with unbalanced components.
4.	Farmers give lack of attention to the importance of proper crop management and input usage due to the lack of knowledge and education of farmers.
5.	Technology innovation and dissemination were weak because of the lack of extension staffs and farmer assistance.
6.	High cost of labor was due to scarcity.
7.	High losses before harvest time were due to the lack of pest control management and climate change adaptation problems.
8.	High losses at harvest and post-harvest handling problems were due to the lack of mechanization and technology.
9.	Lack of coordination and integration among stakeholders and weak capability of farmers were due to inadequate capital, and access to transportation, distribution, and marketing facilities.

Source: MoA (2015)

Table 2. Components of the Upsus program on rice in Indonesia

No.	Item	Note
1.	Development of irrigation networks	Develop new big and small dam and new irrigation networks in some specific areas, rehabilitate primary and secondary irrigation networks in all existing areas, and introduce the deep well and pump irrigation system in some specific areas.
2.	Land optimization	Cover locations which have paddy field with cropping index (CI) ≤ 1 with paddy field rehabilitation in the specific areas, tertiary irrigation network rehabilitation in all areas, and introduce deep well and pump irrigation system for the specific areas
3.	Development of System of Rice Intensification (SRI)	Only in the specific and favorable areas
4.	Implementation of Integrated Crop Management (ICM)	All locations using Farmers Field School (FFS) and demo farms were assisted and tested by University and IAARD.
5.	Provision of seed and assistance	All areas
6.	Provision of fertilizer and assistance	All areas
7.	Provision of agricultural equipment and machinery and assistance	All areas
8.	Pest control and the impacts of climate change	All areas
9.	Agricultural insurance	Specific and pilot project areas
10.	Guidance and extension	All areas and links to the other programs in order to address farmers' problems on capital, and access to transportation, distribution, and marketing which is carried out through farmer group development capacities.

Source: MoA (2015)

Five other components of the Upsus program are provided to support the increase in planting areas and productivity by providing production facilities and infrastructure and providing farm support. Providing production facilities and infrastructures has three components: (i) providing seed assistance; (ii) providing fertilizer assistance; and (iii) providing agricultural machinery assistance; while providing farm supports has two components: (i) the development of agricultural insurance; and (ii) guidance and assistance. In terms of program outcome, the Upsus program has increasing planting areas and productivity through technology application as the main target focus in its implementation. Provision of production facilities and infrastructures and farm support is a supporter of achieving the target of the increase in planting areas and productivity. These two aspects are also set as performance indicators to measure the level of success in their implementation.

Table 3 showed that as a national and massive program, the GOI provided significant support for rice in the Upsus program. Based on the Directorate General of Food Crops (DGFC) and Directorate General of Agriculture Infrastructure and Facilities (DGAIF) of MoA (2019) data, expenditure support for the Upsus program on Rice amounted to around IDR 24 trillion in 2016 and increasing to more than IDR 32 trillion in 2018. This amount does not yet include the fertilizer subsidy, new big dam development fund, credit interest subsidy, and transportation access and networks. Almost all the program components were implemented and carried out through farmer group development capacities.

The performance indicators or outcomes of the Upsus program implementation were stipulated in the Minister of Agriculture Regulation No. 03/2015. The performance indicators or outcomes of the Upsus program implementation on rice were an increase in rice cropping intensity (CI) of at least 0.5 and rice productivity of at least 0.30 tons/ha of dry-harvested grain (*gabah kering panen*/GKP). It is equal to 0.25 tons/ha of dry grain ready for milling (*gabah kering giling*/GKG). GKG is a standard quality accounted for in the statistical data. In the five years of implementing the Upsus program, the Regulation of the Minister of Agriculture No. 03/2015 was issued in 2015, and this was the only released guideline during this period. This guideline was used as a reference in implementing the Upsus program until 2019. The problem is for the following years because there were no performance indicators that have

Table 3. Number of locations and volume of the Upsus program on rice activities by component in Indonesia, 2016–2018

No.	Item	Location (province)	Scope		
			Unit	Cumulative	Average per year
1.	Development of irrigation networks	32	ha	3,141,153.57	1,047,051.19
2.	Land optimization	31	ha	1,386,176.20	462,058.73
3.	Development of System of Rice Intensification (SRI) [a]	24	ha	365,280.00	91,320.00
4.	Implementation of Integrated Crop Management (ICM) [b]	31	ha	3,676,504.36	919,126.09
5.	Provision of seed	34	tons	58,052.70	19,350.90
6.	Provision of fertilizer	34	tons	20,457,614.06	5,114,403.52
7.	Provision of agricultural equipment and machinery	34	unit	280,092.00	93,364.00
8.	Pest control and the impacts of climate change	34	ha	2,924,553.00	974,851.00
9.	Agricultural insurance	26	ha	2,304,160.11	768,053.37
10.	Person for guidance and extension	34	person	172,542	57,514

Sources: DGFC (2019, 2017) and DGAIF (2019, 2018)

Note: [a] Only one-year implementation amounted to 161,705 ha. In 2017–2018, the program transformed into other program and terms named Organic Rice Development and Specific Rice Development. The cumulative of each program in 2017–2018 is 179,500 ha and 24,075 ha, respectively.

[b] Only one-year implementation amounted to 1,524,412.36 ha. In 2017-2018, the program transformed into other program and terms named "*Jajar Legowo (Jarwo)* Farming System", "*Jarwo Super* Farming System", Hazton Farming System", "Salibu Farming System" and others. Total cumulative of the program in 2016–2018 is 2,152,092.00 ha.

been set. Hence, the 2015 performance indicators were used for the next four years.

Performance of the Upsus Program Implementation

Table 4 shows the target achievement of the Upsus program on implementation change in cropping intensity and productivity indicator performance. Considering the changes from 2015 to 2018, rice CI showed only a slight increase. It was less than 2. There is still a possibility of an increase. However, based on ICASEPS (2019) report, the rice planting area's extension to increase CI is difficult for some provinces. In the 2015–2018 period, CI at the national level reached 56% of the target, and this result shows that the Upsus program failed in achieving the target of CI increase.

Table 4. Target achievement of the Upsus program on implementation change in cropping intensity and productivity indicator performance in Indonesia, 2016–2018

Year	Indicator performance	
	Cropping intensity (time per year)	Productivity (tons/ha)
2015	1.65	5.34
2016	1.74	5.24
2017	1.78	5.17
2018	1.93	5.19
	Change cropping intensity (times per year)	Change in productivity (tons/ha)
2015–2016	0.09	-0.10
2016–2017	0.04	-0.07
2017–2018	0.15	0.02
2015–2018	0.28	-0.15
	Comparison of change to the target (%)	Comparison of change to the target (%)
2015–2016	18.00	-40.00
2016–2017	8.00	-28.00
2017–2018	30.00	8.00
2015–2018	56.00	-60.00

Source: ICASEPS (2019) and recalculated by author based on CADIS (2018, 2019, 2020) data for extension

Table 5. Summary of problems regarding the six components of the Upsus program implementation in Indonesia

Component	Problem summary
1. Development of irrigation networks	(1) Problems in selecting of location and farmers group based on the selection criteria; (2) project administration reporting problems; (3) tertiary integration channels built were not integrated with improvements in the secondary or primary irrigation networks and dams (still in a damaged condition and sedimentation accident), and other tertiary networks; (4) relatively short preparation time negatively affected construction, and cost standards set by the government for tertiary channel repairs do not meet the needs and the rehabilitation activities carried out by consultants and contractors resulting in poor quality facilities.
2. Land optimization	(1) Problems in selecting of location and farmers group based on the selection criteria; (2) project administration reporting problems; (3) socialization activities and planning for implementation of Design and Investigation Survey (DIS) activities were not carried out properly; and (4) water sources and land are not available for facilities construction.
3. Provision of seed	The seed provided did not match the farmers' preference (the varieties are not the same as those proposed by farmers, have poor quality, mixed with other varieties, and deliveries were late). Different prices among the varieties caused farmers to be less sure about their quality.
4. Provision of fertilizer	(1) Distributors are often not timely in distributing fertilizers; (2) some distributor's warehouse capacity is lacking (3) farmers groups proposed chemical fertilizers more than they needed but absorbed by farmers less than distributed and did not enthusiastic in using organic fertilizer; and (4) frequent revisions to the proposed needs due to changes in the target planting area have caused the delay in distribution.
5. Provision of agricultural equipment and machinery	(1) Agricultural equipment and machinery distributed far away from farmers group location; (2) specification did not fit into local agroecosystem and other local characteristics (availability of warehouse, workshop and spare parts, skilled operator, and existing providers).
6. Guidance and extension	The insufficient number and expertise of agricultural extension worker, agricultural extension worker did not get additional salaries, overloading workload of implementation and supervisor teams, change in organizational structure in the regency level, some key institutions are not in the planning or implementation organization, and difficulties in coordination and integration among the parties.

Source: ICASEPS (2017, 2019)

Based on the performance indicator of productivity improvement, where the target is to increase productivity by 0.25 tons/ha of GKG, it shows that the target was also not achieved. The rice productivity in the 2016–2018 period was stagnant and tended to decline. When compared to that of 2015, productivity in 2018 showed a more significant decline. Aside from not achieving the target increase, productivity showed a tendency to level off or a continuous decline at the national level while the Upsus program was being implemented. Analysis at the provincial and district levels is expected to produce different performance. It will be possible to find provinces and regencies that achieve targets and those that cannot reach the targets set. It is important to know the performance of each province and regency because the target set should be different according to the characteristics of each province and regency.

The study of ICASEPS (2017, 2019) showed problems in the organization/management and delivery of six Upsus program components. In organization/management, since the middle of 2016, the implementation of the Upsus program is more focused on increasing the planting area. Increased productivity is no longer a focus, and the attention of it is diminishing. The parties responsible for implementing Upsus program at the provincial and regency levels are required to report the achievement of an increase in the planting area, which was initially only once a week to every day. This change causes the agricultural officers in the field, especially agricultural extension workers, to be very inconvenient. The workload of agricultural extension workers and Babinsa increased.

Guidance and assistance focused on recording the increase in a planting area that must be reported every day. The participation of tertiary institutions (university) and the students in providing technical assistance to increase productivity was stopped at the end of 2016. Guidance and assistance to increase productivity are reduced and more focused on increasing the rice planting area. The problems of delivery of six components of the Upsus program problems are summarized in Table 5. There are the same problems in ICASEPS (2019) report compared to ICASEPS (2017) report, indicating that there was no significant improvement in implementing the Upsus program from 2016 to 2018.

Based on DGFC (2017), the SRI development component and the ICM movement were ended in 2016 and replaced by other technology packages that were relatively new introduced and implemented in early 2017 (see note in Table 3). Increasing the rice CI from twice to three times a year increases the risk of rice plants' pests and diseases. Statistical data shows that national rice pests and diseases increased by 15.77% in 2016, and increased by 16.50% in 2017 compared to 2015. The increased area of rice plants that are attacked by pests and diseases, aside from decreasing productivity, also increases the value of budget expenditures to deal with its effects. For the agricultural insurance, the problem is very little socialization and promotion, lack of farmers' perception due to less guidance and extension, and a one-time pilot project considered not enough. The insured rice planting area did not have a significant increase in 2015–2018. Like the six components in Table 5, neither of these four components showed any improvement in implementation in 2017 and 2018.

Some studies analyzed the socio-economic effect of the implementation of the Upsus program. The implementation of the Upsus program on rice in Klaten Regency of Central Java Province has shown good performance. Still, it has weaknesses in farmer empowerment and challenges on the technical, economic, and institutional aspects (Saptana et al. 2016). There are technical, economic, and institutional problems in program implementation, program support and promotion, and less attention to farmers' empowerment. The policy strategy should be focused on farmer empowerment to strengthen the farmers' technical skills and managerial capability.

During the Upsus program implementation in Wonosobo Regency of Central Java Province, there were problems with the extension workers' and farmers' knowledge about applying the components of the Upsus program, especially regarding the new technical terms of agricultural innovation (Nugroho et al. 2017). The knowledge of farmers about the program assistance component is still not maximized due to the short period of implementation and program target being too high. The provision of agricultural machinery equipment and seeds is not enough. Many extension workers and farmers do not understand the terms of some new technology and innovation components. However, the activities of providing subsidized seed, a balanced fertilizer, and rehabilitation of tertiary irrigation have been running well. This study recommended that to improve the Upsus program, the government should prioritize the bottom-up planning principle and adequately provide the needs of all program components. Also, the new technology system should be fully understood by the extension workers and farmers.

The implementation of the Upsus program in East Lombok Regency of West Nusa Tenggara Province has succeeded in improving rice production. However, there was a problem with the time of preparation, the start of implementation, and supervisors' motivation (Sari and Sjah 2016). This study recommended that supervision is needed at the start of the planting season, and the supervisors' salary needs to be increased to improve their motivation. The Upsus program did not affect farmers' input allocation, although farm productivity increased in the Tabanan Regency of Bali Province (Wijaya et al. 2016). The ratio of the value of marginal products of seed and fertilizer inputs compared to seed and fertilizer prices is greater than 1, and less than 1 for pesticides. The use of seeds and fertilizers still needs to be added, while pesticides must be reduced to achieve a efficiency higher level. The Upsus program implementation has increased rice productivity by 0.93 tons/ha, which is higher than the target of increasing productivity by 0.30 tons/ha.

The Upsus program implementation has a positive direct effect on rural poverty in the eastern region of Indonesia and an indirect effect on food-crops subsector GDP in eastern and western regions of Indonesia (Krisnawati et al. 2018). The direct positive impact of the program on poverty in the eastern region of Indonesia. The indirect effect on rural poverty is through rice production and GDP of the food crops sub-sector in the western and eastern regions of Indonesia. Busyra (2017) showed that the factors that affected the rice harvested area in East Tanjung Jabung Regency of Jambi Province were the price of paddy and fertilizer and the rice harvested area in the previous period. Rice productivity is affected by rice harvested area, seeds, fertilizers, machinery, labor, and rice productivity in the previous period. The Upsus program on rice can at least develop farming patterns through the provision and assistance of machines and equipment, and agricultural inputs in Bondowoso Regency of East Java Province (Hamyana 2017).

It has been noted that the Upsus program on rice has increased production and farm efficiency, but that impact only occurs at the elite farmer groups and farmers who are financially well off. The assistance and provision of agricultural machinery and equipment and also funds are provided through farmer groups. However, the management of farmer organizations and internal mechanisms are still generally weak. As a result, there is a tendency for leaders, administrators, and members who are rich, have extensive land, and have an influence in the community to dominate the use of the aids of the Upsus program. On the other hand, seeds, fertilizers, and other simple agricultural tools are only given to landed farmers. Those who do not own lands, such as farm laborers and other agricultural workers who are marginalized groups in the community, do not accept and cannot take advantage of this aid. They lost their jobs because their roles were replaced by the use of agricultural equipment and machinery.

As has been explained, various studies have investigated the socio-economic aspects of the Upsus program. However, it has not examined the cost efficiency and competitiveness of farming in producing rice at the household level of rice farmers due to the implementation of the Upsus program. The Upsus program is expected to increase rice production by increasing harvested area and productivity. Therefore, all strategies are meant to increase the planting activities, harvested areas, and productivity by providing favorable conditions for paddy growing and input use efficiency. These are expected to increase cost efficiency and farmers' income. By providing incentives to farmers, sustainable rice self-sufficiency is expected. Exports will be possible if domestic production is more profitable, and rice produced by Indonesian farmers can compete globally. Measuring the impact of the Upsus program on cost efficiency and competitiveness of rice farming is very important considering the sustainability of self-sufficiency and rice exports to be the ultimate goal of program implementation.

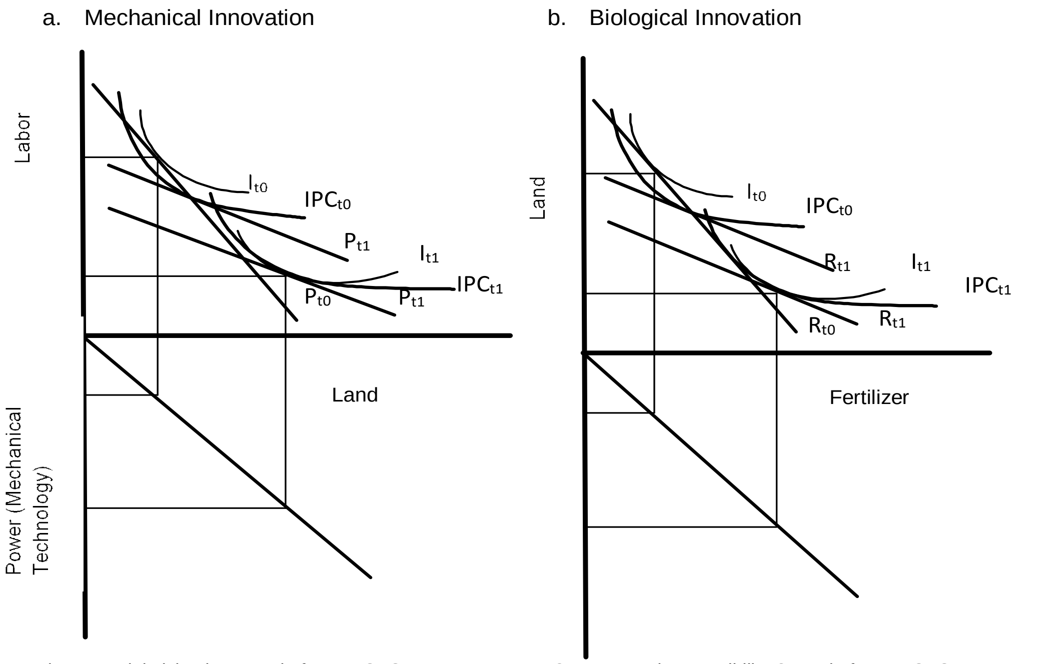
THEORETICAL FRAMEWORK

After 2017, the GOI has encouraged rice production by implementing the Upsus program to achieve sustainable rice self-sufficiency and rice export. The Upsus program on rice is a full package of strategies and efforts intended to increase rice production through increasing planting area and harvest area or increasing cropping index, and increasing yield (productivity) by improving irrigation and input use, crop management and technology, and reducing risk and yield losses in pre-harvest, harvest, and postharvest activities. The Upsus program has complete components and is defined as a new technology innovation approach to increase rice production by expanding the harvested area and increasing rice productivity in Indonesia.

Induced Innovation and Effect of New Technology on Production

Technological change or innovation can lead to productivity growth by increasing the application of relatively cheap inputs. Efforts to increase productivity can be made by trimming the use of inputs that are more or less expensive. Hayami and Ruttan (1971) demonstrated that depending on the inputs and product price relations, diverse kinds of technical change, technologies, and institutions must efficiently achieve agricultural growth. They stated that input prices induce technological change. When the relative factor prices change, a cost-minimizing producer will adopt a new technology that saves relatively more expensive inputs.

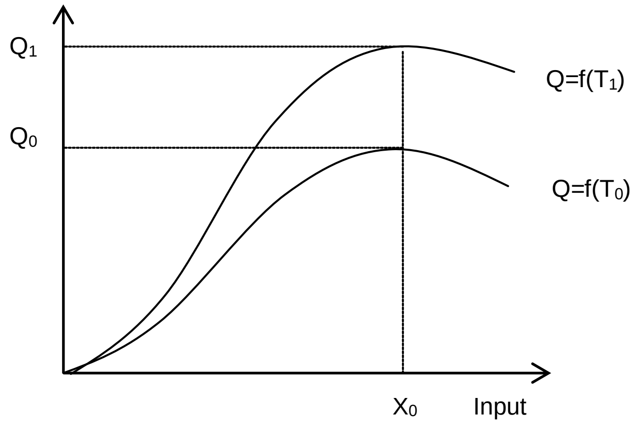
Hayami and Ruttan (1971) classified agricultural innovations into two categories: mechanical innovation and biological innovation. They also stated that the dominant factor leading to labor productivity growth has been progressing in mechanization. The dominant factor leading to growth in land productivity has been progressing in biological technology. Figure 1 depicts the application of the induced innovation model in the Upsus program, which refers to Hayami and Ruttan.



I_{t0} = The cost minimizing isoquant before UPSUS Program
I_{t1} = The cost minimizing isoquant after UPSUS Program
P_{t0} = Labor and Power price ratio before UPSUS Program
P_{t1} = Labor and Power price ratio after UPSUS Program

IPC_{t0} = Innovation Possibility Curve before UPSUS Program
IPC_{t1} = Innovation Possibility Curve after UPSUS Program
R_{t0} = Fertilizer and Land price ratio before UPSUS Program
R_{t1} = Fertilizer and Land price ratio after UPSUS Program

Figure 1. Induced innovation of Upsus program (adapted from Hayami and Ruttan 1971)



Q_1 = Production level after program implementation
Q_0 = Production level before program implementation

Figure 2. The effect of the technology on output level (adapted from Kariyasa 2011)

Figure 1.a refers to the mechanical innovation, representing the switch from technology before the Upsus program (I_{t0}) to the technology under the Upsus program (I_{t1}), which uses relatively less labor and more machine in responding to an increase in the relative price of labor. The mechanization program or application of mechanical technology in the Upsus program is labor-saving. The substitution of machinery and equipment for labor in the relatively labor scarce rice farming has been made possible primarily by mechanization progress. Figure 1.b refers to the use of biological technology and represents the switch from technology I_{t0} to a technology I_{t1}. Compared to technology I_{t0} (before the Upsus program), the technology of I_{t1} uses relatively less land and more fertilizer and land infrastructure as a response to a decrease in the relative price of fertilizer. The introduction of a new package of technology in the Upsus program is land saving. Implementing a new package of technology for the land-scarce rice areas has been made possible primarily by the development of high yielding varieties, which

required improved fertilizer application, irrigation, and farm management technique.

The implementation of new package technology of the Upsus program (irrigation, equipment and machinery, seeds, fertilizers, pesticides, and farm management, and technique) and farmers' adoption are expected to have positive impacts on increasing production. Figure 2 represents the effect of new technology on the output level. The implementation of the Upsus program will shift the production function from $Q = f(T_0)$ to $Q = f(T_1)$. At input level X_0, the application of the Upsus-Rice program components as a new package of technology produces output at Q_1, Q_0 is output before application. Thus, $Q_1 > Q_0$.

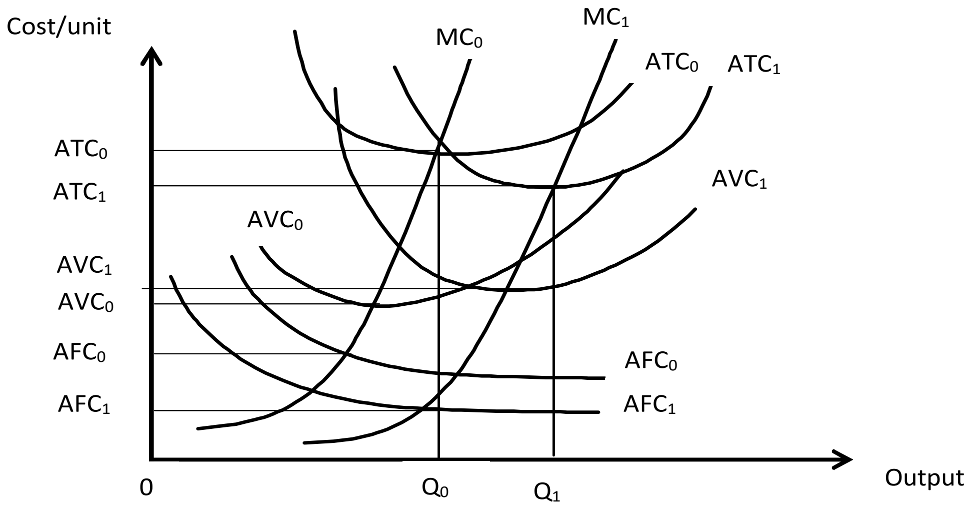
The application of the Upsus program components as a new package of technology produces output at Q_1 while before application only produces an output of Q_0, in which $Q_1 > Q_0$. Increasing the AVC may happen because of improved input use, but the AFC and ATC will decrease. Figure 3 represents the effect of new technology on the cost structure.

The implementation of the Upsus program will shift the production from Q_0 to Q_1. At output level Q0, the cost structure is given as AFC_0, AVC_0, and ATC_0. Then the application of the Upsus program as a new package of technology produces output at Q_1. At this level of output, the cost structure is shown as AFC_1, AVC_1, and ATC_1. Increasing the AVC happens because of improved input use, but the AFC will decrease more than increasing in the AVC. Therefore, the effect of the Upsus program is lowering the ATC compared to before the Upsus program.

Effect New Technology on Cost Efficiency

Studies to measure the efficiency of rice farming have been very widely carried out in Indonesia, some of which are Rachmina and Maryono (2008), Kusnadi et al. (2011), Saptana (2012), Tinaprilla et al. (2013), Murniati et al. (2014), Rivanda et al. (2015), Rifiana and Ikhsan (2017), Abas et al. (2018), Kartiasih and Setiawan (2019), and Nainggolan et al. (2019). Overall, these studies use the production function model for estimating stochastic frontier function and focus on the determinants of efficiency. Studies to measure the cost efficiency of Indonesian rice farming by applying a stochastic frontier approach using a cost function model still are very limited. As of this writing, only two studies have been found using the stochastic cost function (Hidayah et al. 2013; Antriyantarti 2015; Antriyandarti, 2016). No studies that measure the impact of the Upsus program in increasing the cost efficiency of rice farming in Indonesia have been found.

As in Hidayah et al. (2013) and Andriyantarti (2015), the measurement of cost-efficiency can be done by estimating the stochastic frontier cost function. Using the



MC_0 = marginal cost before Upsus program
ATC_0 = average total cost before Upsus program
AVC_0 = average variable cost before Upsus program
AFC_0 = average fixed cost before Upsus program
Q_0 = output before Upsus program

MC_1 = marginal cost after Upsus program
ATC_1 = average total cost after Upsus program
AVC_1 = average variable cost after Upsus program
AFC_1 = average fixed cost after Upsus program
Q_1 = output after Upsus program

Figure 3. Effect of new technology on cost structure (adapted from Zugarramurdi et al. 1995; FAO 2003)

estimation result, the comparison of the actual and the frontier function will represent the farmer's efficiency. The stochastic frontier cost function can be developed from the stochastic production frontier. The stochastic production frontier was introduced by Aigner et al. (1977) and further by others such as Kumbhakar et al. (1991), Battese and Coelli (1992, 1995), Coelli et al. (1999), Kumbhakar and Lovell (2003), Greene (2005), and Coelli et al. (2005). As a starting point to develop stochastic frontier cost function, from stochastic production frontier Equation (1) represents the stochastic production frontier function.

$$Y_i = X_i\beta + (V_i - U_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

where Y_i is the production of the i-th firm; X_i refers to input quantities of the i-th firm; and β is a set of parameters. Equation (2) represents the transformation of equation (1) into the natural logarithm function.

$$LnY_i = \beta_0 + \beta_i LnX_i + (V_i - U_i) \quad \ldots\ldots\ldots\ldots\ (2)$$

Then equation (3) represents the form of stochastic cost frontier function. Coelli (1996) stated that to specify a stochastic frontier cost function, the error term specification needs to be changed from (V_i - U_i) to (V_i + U_i).

$$C_i = C(Y_i, P_i, \beta)+(V_i+U_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

where C_i is cost of production of the i-th firm; P_i refers to input prices and output of the i-th firm; and β is a set of parameters. Equation (4) represents the transformation of equation (3) into the natural logarithm function.

$$LnC_i = LnC(Y_i, P_i, \beta) + (V_i + U_i) \ldots\ldots\ldots\ldots\ (4)$$

From the equations above, the error term consists of two components, V_i and U_i. The first component V_i, is the random shock variable which is identically normally distributed with the value of mean (μ_i) equal to 0 and the variance is constant; or $N(0,\sigma_V)^2$. The second component U_i represents the unmeasured variables such as weather, walkout, epidemic, and other variables which are undefined in the production or cost function, and there is no U_i intervention. U_i is a non-negative variable and assumed normally distributed which could have distribution pattern such as exponential, truncated normal and half-normal. For the frontier cost function, U_i also defines how far the farms operate above the frontier. From equation (4), the cost efficiency can be measured by equation (5).

$$CE_i = \frac{C(Y_i, P_i, \beta)\exp(U_i)}{C_i} \quad \ldots\ldots\ldots\ldots\ (5)$$

where CE_i is the possibility of a minimum cost ratio with a specific level of inefficiency toward the total actual cost. The rice farming system is in the full efficiency condition in time i, if CE_i = 1, and the CE_i will be equal to 1 when the actual cost is equal to the minimum estimated cost or $C_i = C(Y_i, P_i, \beta)\exp(U_i)$. On the other hand, when the value of actual cost is bigger than the value of minimum estimated cost ($0 \leq CE_i < 1$), the rice farming system is inefficient.

The parameters β_0, β_i, μ_i, and the two variances of V_i and U_i, can be estimated using the Maximum Likelihood Estimation (MLE) approach. The value of variances can be used to measure the value of γ, which is the contribution of the technical (for stochastic frontier production function) and cost (for stochastic frontier cost function) efficiency of the total residual effect. Therefore, the value of γ is between zero and one ($0 \leq \gamma \geq 1$).

The cost efficiency is the possible minimum cost ratio with specific inefficiency levels toward actual total cost (Coelli et al. 2005; Kumbhakar et al. 2000). The cost efficiency index *eU* is calculated from the inverse of *eU* = *q/f(x)*; *q*: actual cost, *f(x)*: cost on the frontier function. Therefore, the cost efficiency is defined as the percentage achievement of production cost by best practice. Two models can be estimated: first is before the Upsus Rice program, and the second is after the Upsus program. Thus, the estimated cost-efficiency indices calculated from the frontier function before the Upsus program can be compared with those after the Upsus program.

The research result of Andriyantarti (2015) shown that that average cost efficiency was 0.4846 for North Sumatra, 0.5881 for West Java, 0.6557 for Central Java, 0.6142 for East Java), and 0.4382 for South Sulawesi. These results indicate that the rice farming system in Central Java has the highest cost-efficiency. Another study that also used the same model to measure the cost efficiency was conducted by Hidayah et al. (2013) in Buru Regency, Maluku Province. The study found that average technical efficiency was 0.86, and 75.83% of the respondents already operated in this efficiency level. The average cost efficiency was 0.86, and 80% of respondents already achieved this cost-efficiency level. With the Integrated Plant and Resources Management (IPRM) approach in the research area, the rice farming system was found to be efficient and profitable.

In 2016, the Phil-Rice conducted a study on the competitiveness of Philippine rice in Asia by comparing the rice cost structure in the Philippines with those in China, India, Indonesia, Thailand, and Vietnam. The results show that producing a kilogram of rice is more expensive in intensively cultivated and irrigated areas in importing countries such as the Philippines, Indonesia, and China than in exporting countries such as Thailand, Vietnam, and India. This indicates that exporting countries have an advantage in cost competitiveness at the farm level than importing countries (Bordey et al. 2016). Based on this study, substantial differences occur in major cost items such as labor, not because of major differences in prices but because of varying mechanization levels. Low-cost countries such as Thailand and Vietnam are highly mechanized, resulting in low labor costs compared with those in labor-intensive countries such as the Philippines and Indonesia. Deviations in other cost items also occur but at a smaller magnitude.

The study of the Phil-Rice suggests the need to look for solutions to reduce the costs of producing rice in the Philippines and other high-cost rice-producing countries in Asia. There were two options to reduce the cost: the first, as shown in Thailand and Vietnam, involves full mechanization of harvesting and threshing activities. The second relates to the method of crop establishment (Bordey et al. 2016). This suggestion is relevant to rice development in Indonesia, and in the Upsus program, specifically on the component of mechanization and crop management and establishment. The question is whether the Upsus program has lowered the unit cost of producing rice and increased rice competitiveness.

New Technology and Rice Competitiveness

Competitiveness requires a business environment where successful firms operate inefficient markets under effective national and regional regulations (ADBI 2014). Competitiveness is "the ability to face competition and to be successful when facing competition" or "the ability to sell products that meet demand requirements (price, quality, and quantity), and at the same time, ensure profits over time that enable the firm to thrive" (Latruffe 2010). Farmers and processors must be able to produce rice with the same or superior quality at costs lower than those of international competitors to be competitive. Competitiveness is affected by technological capacity, market conditions, and existing domestic and trade policies of participating countries in the world market and natural endowments (Bordey et al. 2016).

There are many indicators of competitiveness that have been developed and applied by economists. Among them are Revealed Comparative Advantage (RCA) and Domestic Resource Cost (DRC) commonly used for agricultural products. Balassa (1965) developed the RCA based on the idea that a country's actual trade performance will reveal competitiveness compared with other countries or regions or the world. However, for the Indonesian case, the rice trade is not fully liberalized. Also, according to Balance et al. (1987), there is a high degree of inconsistency among RCA indices. He strongly suggested that empirical work incorporating comparative advantage measures should rigorously base the specification of such measures on theoretical constructs rather than adopting heuristic measures that have appeared in the literature. In particular, statistical criteria should not be the basis for choosing among alternative seemingly reasonable RCA indices. For this reason, this paper did not employ RCA as a method for calculating rice production competitiveness.

Instead, the DRC calculated using the Policy Analysis Matrix (PAM) framework developed by Monke and Pearson (1989) was used. The PAM content has two accounting measurements. One is measuring profitability as the difference between revenues and costs. The second is measuring the effects of divergences or distorting policies and market failures as the difference between observed (the private values) and the social values that would prevail if the divergences were removed. The DRC is the ratio of the cost in domestic resources and non-traded inputs (valued at their shadow prices) of producing the commodity domestically to the net foreign exchange earned or saved by producing the good domestically (Sadoulet and de Janvry 1995; Pearson et al. 2005). DRC as an indicator is used to measure whether a commodity is more profitable when produced domestically or imported, and it reflects social profitability or comparative advantage. DRC < 1 indicates that the commodity is more profitable when produced domestically. Meanwhile, DRC > 1 indicates that it is less profitable to produce domestically, and a neutral condition exists if it is equal to 1.

The other indicator that can be calculated using the PAM is a Private Cost Ratio (PCR) to provide a measure of private profitability. PCR shows the competitiveness of the rice production system, given current technologies, output values, input costs, and policy transfers. The term private refers to observed revenues and costs reflecting actual market prices received or paid by farmers, merchants, or processors in the rice production system. Thus, the actual market prices incorporate the underlying economic costs and valuations plus the effects of all policies and market failures. PCR < 1 indicates that the commodity has a competitive advantage when produced domestically. Meanwhile, DRC > 1 indicates that the commodity has a competitive disadvantage when produced domestically, and a neutral condition exists if it is equal to 1.

The impact of the Upsus program on competitiveness was measured from the DRC and PCR using the data before and after Upsus program implementation. If, after program implementation, the DRC and PCR values are less than before the program, then it has a positive effect. Otherwise, it has a negative effect. If the values are similar before and after the program, then it has no effect.

Several studies on rice have been conducted before the Upsus program was implemented and showed that rice production in Indonesia had a comparative advantage between 0.50 and more than 1.00. Some of the studies also showed a decrease in competitiveness in several study locations. Gonzales et al. (1993), covering all provinces in Indonesia using comparative advantages analysis, found that Indonesian rice has a comparative advantage as an import substitute but not as an export crop because of poor quality and a thin world rice market. Except for Central and East Java, which have only marginal competitiveness, Indonesia appears to have no comparative advantage as a rice exporter considering long-term world prices. Due to the local currency devaluation in 1986, increased input and marketing and transport costs rapidly reduced competitiveness gains. Relatively slow projected productivity growth tends to weaken competitiveness. The other study by Rusastra and Ilham (2009) found that in 1986–2001 period, the competitiveness of paddy (rice) declined because of the government’s protectionist policy.

Romdhon and Cahyadinata (2004) used the Policy Analysis Matrix (PAM) analysis with domestic resource cost (DRC) as an indicator of competitiveness. They found that the rice farming systems in North Bengkulu Regency, Bengkulu Province, were highly competitive in both the wet and dry seasons. However, they said that this competitiveness would be reduced in the future if Indonesia complies with its AFTA commitments in 2010 and eliminates protection on rice. Mantau et al. (2014) found that rice farming in the Bolaang Mongodow Regency, Gorontalo Province, has DRCs of 0.61 in 1999 and 0.68 in 2009. This means that the competitiveness of rice in this location declined.

Agustian et al. (2014) found that rice farming in some rice production center provinces is efficient and has DRCs of about 0.50 to 0.77. In Sumatra, Lampung, West Sumatra, North Sumatra, and Nangroe Aceh Darussalam (NAD), the DRC ratios were 0.50, 0.62, 0.73, and 0.77, respectively. In Java, East Java and West Java had DRC ratios of 0.60 and 0.62, respectively, while South Sulawesi Province had a DRC ratio of 0.62. This indicates that rice farming in these regions has a comparative advantage, and some provinces outside Java could have a comparative advantage or competitiveness better than Java. The study of Antriyandarti (2015) found that the DRCs of rice farming in North Sumatra, West Java, and South Sulawesi were less than 1.

In contrast, the DRCs of rice farming in Central Java and East Java are larger than 1, indicating that rice farming in these regions does not have a comparative advantage. In addition, she noted that even if the cost efficiency of rice farming in Central Java and East Java increases to 1, rice sectors in these areas will not achieve global competitiveness. In line with Antiyandarti (2015), Saptana (2010) stated in terms of the comparative and competitive advantages of rice competitiveness which showed quite alarming conditions due to the DRC and PCR values of rice are close to one (0.80–1.00) and in some cases show values greater than 1. So far, the studies carried out only measure competitiveness by the average of the research respondents. This will provide an incomplete picture of sectoral competitiveness since results based on average data may conceal important variations in competitiveness among heterogeneous producers (von Cramon-Taubadel and Nivyevskyi 2008; von Cramon-Taubadel and Nivyevskyi 2010; Nivievskyi et al. 2010).

Following von Cramon-Taubadel and Nivyevskyi (2008), the probability analysis using kernel density distribution was used to estimate the proportion of rice farms and that of total rice production that was produced competitively. The effects of an intervention can be captured from the measurement results before and after the intervention. If the proportion of rice farms and the total rice production produced competitively after program implementation are higher than before, it means that the intervention has a positive effect. Otherwise, it has a negative effect. It has no effect if the values are the same before and after the intervention.

Von Cramon-Taubadel and Nivyevskyi (2008) characterized DRCs into three categories, namely, DRCs less than 0 (very competitive), DRCs between 0 and 1 (competitive), and DRCs greater than 1 (uncompetitive). The proportions of farms and those of total production on the farms in each category were estimated. Detailed farm-level data were used to calculate DRC distributions. An estimate of the resulting univariate density function of DRCs across all relevant farms was calculated using the kernel-based estimate proposed by Rosenblatt (1956).

The kernel density estimation is a technique used to estimate the unknown probability distribution of a random variable, based on a sample of points taken from that distribution. The kernel density estimation is a non-parametric way to estimate the probability density function of a random variable, which involves smoothing the data but retaining the overall structure. Each data point of xi, i = 1, ..., n is replaced by a specified distribution, which is typically normal, centered on the point x and with a standard deviation designated by h (bandwidth). In the kernel density estimation, the normal distributions are added together, and the resulting distribution scaled to have a unit area, and a smooth curve, given by Rosenblatt (1956) is as follows:

$$\hat{f}(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x-x_i}{h}\right) \text{........................} (6)$$

where $\hat{f}(x)$ is the height of the curve at x, a point on the x-axis (value of data), K(.) is the standard normal density, n is the number of samples, and h is the bandwidth (value of smoothing parameter). The appearance of the kernel density depends critically on the value of the smoothing parameter *h*; selecting an appropriate bandwidth for a kernel density estimator is of crucial importance.

Many authors have explored the problem of selecting the smoothing parameter for kernel estimation. Rather than using a single smoothing parameter h, some authors have considered the possibility of using a bandwidth h(x) that varies according to the point x at which it is estimated. Bandwidth will vary depending upon the location of either the estimate (balloon estimator) proposed by Loftsgaarden and Quesenberry (1965) or the samples (pointwise estimator) proposed by Breiman et al. (1977). This technique is termed as a variable or adaptive bandwidth kernel density estimation approach. The variable bandwidth approach can be found in Hall (1992), Burkhauser et al. (1999), Taron et al. (2005), Wu et al. (2007), and Gine and Sang (2010), while the adaptive approach can be found in Van Kerm (2003). Adaptive kernel density estimation is referred to as akdensity in the STATA program. This study used the STATA program for data processing. The adaptive kernel density estimation is given by Van Kerm (2003):

$$\hat{f}(x) = \frac{1}{\sum_{i=1}^{n} w_i}\sum_{i=1}^{n} \frac{w_i}{h_i} K\left(\frac{x-x_i}{h_i}\right) \text{...............} (7)$$

Using this method, the DRC and PCR values can be grouped respectively from those who are able to reach the highest competitiveness to the lowest and have no competitiveness. The difference in the value of the DRC and PCR of each household between before and after the Upsus program has two benefits, namely identifying farmer households that have the ability to compete and the magnitude of their changes, and identifying production produced from rice farmer households that have the ability to compete and the level of yield quality its production. The analysis results will provide to determine what guidance is being done to improve the competitiveness of individual farmers.

Cost Efficiency and Competitiveness Improvement

Starting from the target set that the implementation of the Upsus program, Indonesia will be able to export rice. The competitiveness of rice production has the meaning of farmers' ability to produce rice that can be marketed in the international market. Therefore, the international competitiveness of rice is the ability of rice farmers to supply rice to the world market at prices that provide adequate returns on the resources of inputs used to produce rice. Thus, the cost-efficiency of rice farming which measures how close a rice farmer is to produce the maximum output possible given its size, the inputs it employs, and the technology at its disposal. Improving cost efficiency will lead to increased global competitiveness.

Global or international competitiveness is a product of many factors and the interactions among them. Sudaryanto and Agustian (2003) stated that the comparative and competitive advantage of rice farming is greatly influenced by technical, economic, and social institutional factors. This statement also showed by

Rachman et al. (2001, 2004). Some technical factors that influence are as follows: (a) climate, which greatly affects the availability and access of farmers to water resources; (b) irrigation infrastructure, which affects the availability, access, and control of water resources; (c) location accessibility to infrastructure and economic infrastructure; and (d) the level of technology adoption such as the use of balanced fertilizers and labeled seeds that will affect the level of productivity and quality of yields. Some very influential economic factors are input prices, output prices, labor availability, wage rates, and interest rates. They are closely related to the mechanism of the input market, labor market, and capital market in rural areas.

The other factors that can affect the competitiveness of rice production in Indonesia are non-land assets value. Irawan et al. (2007) stated that the contribution of farmer household income from outside rice farming activities showed an increase in 2007 compared to 2003. Rice farm households used this income to augment their farming capital and finance the rice farm. Households that have higher non-land assets tend to adopt a higher level of technology or innovation. This is also indicated in the 1998–2003 and 2007–2010 periods in the research results by Hadi et al. (2003) and Susilowati et al. (2010), respectively.

Liese et al. (2014) discussed the factors that influenced rice competitiveness in ASEAN countries: Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam. They state that farming management and technique and level of technology adoption and cropping patterns have influenced rice competitiveness in those countries. Thailand and Vietnam have higher direct costs and land rent than in other countries. However, Thailand and Vietnam are more advanced in farm technology and mechanization levels, have lower operational costs and produce higher rice quality. The total cost per ton is lowest in Myanmar and Laos, followed by Vietnam. This advantage in production cost implies a competitive edge in international rice markets and coincides with low farm gate prices in Myanmar and Laos. However, the low production cost is not an immediate advantage in the international market since this is related to return to land and quality issues. Rice farmers in Thailand and Vietnam have to pay significant land rents (or respective opportunity costs when they are on their own land). In contrast, farmers in Myanmar, Laos, and Cambodia can use the land almost for free.

In the case of Thailand, USITC (2015) found that despite low yields and high farm costs, Thailand rice exporters competitively supply high-quality rice to the global market. Thailand produces a reliable surplus of high-quality rice each year. Thailand is home to an efficient rice supply chain, including a modern milling sector, infrastructure to support exports, and a private sector able to provide good customer service to global purchasers. For Vietnam, USITC (2015) found that Vietnam's natural resource endowments greatly enhance its competitiveness. Vietnam is competitive in rice production because of its rich natural resource endowments, including plentiful water and natural flooding. Success in adopting better seed varieties and improved crop management has helped Vietnam increase yields and improve the overall quality of its rice.

Besides Thailand and Vietnam, USITC (2015) study covered the factors that affect rice competitiveness in other countries, namely, the USA, China, India, Pakistan, Myanmar, Cambodia, Indonesia, the Philippines, Brazil, and Uruguay. Specifically, for Indonesia, USITC (2015) found that Indonesia's climate gives a competitive advantage through an extended growing season. Its competitiveness is also enhanced by the use of high-yielding varieties, new investment in modern mills, and the increased use of fertilizers, pesticides, and irrigation. However, the growth in yields has slowed in recent years, and relatively high production costs, pressure on land and water resources, postharvest losses, and unpredictable weather patterns have undermined the competitiveness of the sector. Competitiveness has also been limited by inadequate logistics infrastructure.

The change in international rice competitiveness from one period to the next as a result from the changes in productivity, production costs, and the implementation of government policies that encourage increased productivity, reduction of costs and increased farm income, which serve as incentives for farmers to continue producing such as seeds, fertilizers, fuel, and interest rate subsidy, and government purchasing or procurement prices. Changes in productivity affected the rice competitiveness is stated by Rachman et al. (2001), Sudaryanto and Agustian (2003), and Rachman et al. (2004). The changes in rice production costs affected the rice competitiveness is concluded by USITC (2015), Antriyantarti (2015), Antriyandarti (2016), and Bordey et al. (2016). The change in international rice competitiveness is affected by the changes in the implementation of government policies that encourage increased productivity, reduction of costs and increased farm income, which serve as incentives for farmers to continue producing such as seeds, fertilizers, fuel, and interest rate subsidy, and government purchasing or procurement prices is resulted from the studies of Suryana and Hermanto (2004), IAARD (2010), Tamba and Pastini (2012), Suryana et al. (2014), and Abidin (2015). The DRC as an indicator of international competitiveness of rice is the ratio of the cost of domestic resources and non-tradable inputs (valued at their shadow prices) to the net foreign exchange earned or saved by producing rice domestically. Increasing cost efficiency will have the effect of increasing competitiveness. Antriyandarti (2015) stated that some other factors like farm-scale, exchange rate, and consumer price might also affect competitiveness. She proposed using a multiple regression model to estimate the relationship between the competitiveness of rice and the cost efficiency of rice farming as follows:

$$lnDRC_i = a + b_1 ln\ CE_i + b_2 ln\ CPI_t + b_3 ln\ ER_t + b_4 ln\ FS_i + e_i \quad \text{…………………} \quad (8)$$

where: DRC_i = domestic resource cost of farmer i
CE_i = cost efficiency of farmer i
CPI_t = consumer price index in year t
ER_t = exchange rate of the USD to IDR in year t
FS_i = farm size of farmer i (ha)
e_i = error term

Using this model, Andriyantarti (2015) found that farm size has a positive effect on competitiveness, and the competitiveness of rice is positively influenced by rice farming's cost efficiency. If the cost efficiency increases by 10%, DRC will decrease by 6.35% in North Sumatra, 10.50% in West Java, 5.52% in Central Java, 6.95% in East Java, and 9.47% in South Sulawesi. Other studies have shown that changes in international prices of rice and fertilizer, exchange rate (ER) value of the United States Dollar (USD) to Indonesian Rupiah (IDR), and import tariffs also influence the comparative and competitive advantages of rice production in Indonesia (Rachman et al. 2004; Tamba and Pastini 2012; Nurayati 2015; Bowo et al. 2016). The Consumer Price Index (CPI) and ER value of the USD to IDR, two variables in equation (8), import tariff, and international rice and fertilizer prices have the same value for every farm household sample and become irrelevant when using cross-section data. Improvements are needed to apply the model (8) to determine whether the improvements in the cost efficiency of the Upsus program affect the increase in competitiveness using farm household-level data. New variables can also be added based on the reliability and eligibility of data collected at the farm household level. The addition of variables must consider the presence of variables that have been used in the measurement of DRC and PCR on PAM analysis as factors influencing rice competitive and comparative advantages. The other is the regression variables to estimate the level of cost efficiency and inefficiency determinants in the equations (4) and (5). Thus, the results will provide additional information on understanding competitiveness and how cost efficiency and competitiveness are related and applied more comprehensively.

Based on the studies above, the factors that might affect the global competitiveness of rice production in Indonesia are as follows: (1) cost efficiency (CE) obtained from the estimation of the stochastic frontier cost function analysis; (2) farm size (FS) that represents the scale of rice farming in hectares, including self-owned land that is cultivated on its own and form tenancy system; (3) non-land asset value (NLA) in IDR million and constant prices, representing the capacity of farmer households in financing technological change and innovation; (4) productivity of rice farm (PYF) measured by labor productivity, since there is FS as one variable; (5) cropping intensity (CI) in a year, representing climate favorable conditions, infrastructures of location, land and irrigation, and farm management technique; (6) share of production sold (SY), representing farming orientation (commercial/subsistence) and access to market and marketing institutions; (7) ratio of farm price (RFP), that is the farm gate ratio price to government procurement or purchasing price (GPP), representing the government policy in providing output price incentives; (8) share of farming capital from outside and loan or credit (SCL), representing the access of farmer households to capital sources from outside the household, banks, and government credit program; (9) the ratio of mechanical cost per kg to farm gate price (RMC), representing the ability of farmers to overcome labor scarcity, save time, and reduce the rate of loss of yields and government intervention program on pre and postharvest mechanization; (10) land rent to farm gate price (RLC) ratio, representing fixed costs and opportunity cost of land for other commodities; and (11) ratio of subsidy value per kg to farm gate price (RSC), representing the government policy in providing input price incentives.

In order to capture the effects of cost efficiency on the global competitiveness of the Upsus program, a dummy variable representing conditions before and after implementing the Upsus program will be added into the equation. Then, to evaluate the effect improvement of cost efficiency on competitiveness as the impact of the Upsus program, we can propose the model shows in equation (9) for DRC and equation (10) for PCR, which is the difference after and before the Upsus program implementation will be captured by dummy variable as follows:

$$LnDRC_i = a + b_1 LnCE_i + b_2 LnFS_i + b_3 LnNLA_i + b_4 LnRCI_i + b_5 Ln PYF_i + b_6 LnSY_i + b_7 LnSCL_i + b_8 LnRFP_i + b_9 LnRMC_i + b_{10} LnRLC_i + b_{11} LnRSC_i + b_{12} D_i + e_i \quad \text{...(9)}$$

$$LnPCR_i = a + b_1 LnCE_i + b_2 LnFS_i + b_3 LnNLA_i + b_4 LnRCI_i + b_5 Ln PYF_i + b_6 LnSY_i + b_7 LnSCL_i + b_8 LnRFP_i + b_9 LnRMC_i + b_{10} LnRLC_i + b_{11} LnRSC_i + b_{12} D_i + e_i \quad (10)$$

where:

DRC_i = domestic resources cost ratio value of farm household i
PCR_i = private cost ratio value of farm household i
CE_i = cost efficiency value of farm household i
FS_i = farm size of household i (ha)
NLA_i = non-land assets value of farm household i (Rp million in constant price)
RCI_i = rice cropping intensity in a year of farm household i
PYF_i = ratio production to total labor of farm household i (kg/person)
SY_i = share of production sold of farm household i
RFP_i = ratio of government purchase price to farm gate price of farm house hold i
SCL_i = share of cost from outside or loan of farm household i
RMC_i = ratio of mechanical cost per kg to farm gate price of farm household i
RLR_i = ratio of land rent per kg cost to farm gate price of farm house hold i
RSC_i = ratio of subsidy value per kg to farm gate price of farm house hold i
D_i = dummy program (after Upsus program = 1, before Upsus program = 0)
e_i = error term

The analysis results of equation models (9) and (10) will show the difference in the influence of the model variables on comparative and competitive advantages. Considering the ultimate goal of the Upsus program is to increase surpluses for the sustainability of rice self-sufficiency and exports, it will be beneficial for decision-making in coaching rice farmers in the subsequent implementation of the Upsus program. Of course, the variables in equations (9) and (10) can be added or subtracted as long as it is relevant to the components of the Upsus program and other factors associated with it, the use of econometric modeling, and the availability of data at the household level of rice farmers.

AN IMPLEMENTATION DIRECTION OF THE UPSUS PROGRAM

The Upsus program is all over the country and involves all the wetland paddy field areas. With an increase in cropping index and yield (productivity), national rice production will increase. Since irrigation and agricultural equipment and machinery are already developed and provided, farmers' knowledge and skills in farm management and technology will increase. If sustained, national rice production will increase and possibly generate surplus production for export. However, there were problems, as reported by ICASEPS (2017). Since the middle of 2016, the Upsus program implementation has been more focused on increasing the planting area; thus, increasing productivity is no longer a focus. The attention of it is diminishing. The first is monitoring and evaluation of the implementation of Upsus program activities continues to be conducted every month, recording and reporting of additional planting must be reported every day, as a basis for monthly target revision. The second is the addition of the planting area target revised every month and impacted the amount of seed and fertilizer procurement.

Recording and reporting additional planting areas every day provides positive benefits for the province and the Ministry of Agriculture to monitor the progress in achieving the planting area target and estimated harvest area that can be achieved every month. Nevertheless, this also raises operational problems because (1) the evaluation of planted area added is done monthly by comparing the achievements of the same month in the previous year, and (2) based on the results of the monthly evaluation, the MoA then sets changes in the target size of the area added to the province for the following months (ICASEPS 2017). To support the change, the MoA also prepares reserve funds for the procurement of agricultural equipment and machinery. The reserve fund is prepared to purchase agricultural equipment and machinery at any time if needed to increase the planting area so that the additional planting area target can be achieved (DGAIF 2018). However, operational constraints in the implementation of activities that occur at this time, compared to the same month in the previous year, are not used as the main consideration for decision making. These include the availability of areas for increasing planting area, the level of attainment of cropping intensity, and the presence of differences in rainfall.

A team of agricultural equipment and machinery brigades was formed under the Regency Agriculture Office and Military Regency Command Headquarters (MoA 2015). Each brigade team is provided with at least four units of tractor, rice trans-planter, and combine harvester. This team was formed with the aim of providing and managing agricultural equipment and machinery to assist farmer groups who need additional agricultural equipment and machinery in the context of acceleration of tillage and rice planting. Farmer groups can borrow equipment and agricultural machinery and must be returned after using it. Farmer groups must provide mobilization funds because the government does not allocate funds for this. In addition to the mobilization fund, the farmer group must incur fuel, operator costs, and care and maintenance costs for the agricultural equipment and machinery. However, according to ICASEPS (2017), the following problems occur. (1) There are already many groups or businesses renting out agricultural equipment and machinery. This has caused social conflict due to existing agricultural equipment and machinery service providers in several regions. On the other side, it has shifted the use of agricultural and rural labor in areas that do not yet exist, and there are quite a lot of agricultural workers available. (2) Agricultural equipment and machinery received are too large and do not fit into the local agroecosystem. (3) The recipient farmer groups with no storage warehouse might result in engine theft. (4) Lack of capacity and capability of farmer groups in financial and management. (5) In common, there are no workshops and spare-parts providers that are relatively close for the damaged machine and no skilled personnel to operate the machine and equipment (ICASEPS 2017). Agricultural equipment and machinery deliveries were placed at the Agriculture Service Office and the MDC Headquarters and not used by farmers.

The addition of planting area targets at the provincial level also has an impact on changing targets at the regency level. Many regencies objected to the addition of these targets and impacted the amount of seed and fertilizer procurement. Besides, the revision must be made because the amount that must be added follows the increase in the planting area to achieve. This change or revision has an impact on delays in procurement and distribution to farmers. Particularly for seeds other than revisions causing delays, the additional amount of sudden procurement affects the distributed seeds quality, causing it not entirely high. Besides, the varieties do not meet the farmers' needs. Production of quality and certified seeds requires certain processes and standard operating procedures that are difficult to do in a short time. If there is a revision, the changes cannot be made suddenly monthly, but annually because the Upsus program components are related to one another. It is not easy for the implementing organization and operational management to make adjustments.

Referring to the Regulation of the Minister of Agriculture No. 50/2012 on Guidelines for the Development of Agricultural Areas (MoA 2012), the increase in rice production can be divided into three areas: (1) areas for opening new agricultural paddy fields and undeveloped areas; (2) developing and moderately developed areas; and (3) developed areas. The faithful development plan of the area and its implementation are prepared in a minimum of five years with stages, targets to be achieved, and components of the program package for farmers tailored to each area's needs. A comprehensive evaluation to increase the effectiveness of the Upsus program implementation is critical to carry out as a basis for planning the implementation of the program in the following years. ICASEPS (2019) reported variations among provinces of five rice producing centers and five non-producing centers evaluated in achieving the target set. This indicates that the target setting and implementation focus of the given program must be adjusted to the agroecosystem characteristics, socio-economy, potential, and rice farming development levels in each region. Consequently, the planning and implementation of the Upsus program must be adapted to the characteristics of each development region, could not be revised every month, and focuses on increasing rice productivity in every possible way could not be diminished.

In the Upsus program approach, the government provides a complete technological package (irrigation, equipment and machinery, seeds, fertilizers, pesticides and agricultural management, improved techniques) and farmers' guidance through extension agents and program implementation assistants. Farmers can learn how to use new production technologies and how much inputs should be used to achieve optimal results. They can adopt better farm management techniques to improve their technical skills and allocate inputs properly, bringing about higher yield and a more efficient cost structure.

ICASEPS (2017) study identified that (1) there is around 3 million ha of damaged irrigation, which could potentially result in a rice production loss of around 4.5 million tons; (2) delivery of fertilizers to the farmer often experiences a delay of about 1–2 weeks and potentially causes loss of rice production of around 3.0 million tons; (3) the number of agricultural extension workers is decreasing, which can lead to loss of rice production of 3.0 million tons; (4) the use of seeds whose quality is not good and certified causes loss of rice productivity potential of 1.0 ton/ha, meaning that potentially from 6.0 million hectares of paddy fields can lose potential rice production of about 6.0 million tons; and (5) limited supply and use of machinery can cause pre-harvest and harvest losses of around 3.5 million tons. This study indicated that the target achievement of the Upsus program would not be achieved if the performance of all components of the Upsus program and the management and organization of the program implementation is inadequate and ineffective.

Even though the damaged irrigation network has been successfully repaired and rice farmers have received assistance in the form of equipment and agricultural machinery, the Upsus program implementation remains inadequate and ineffective if other components were problematic. Rice farmers cannot adopt better farm management to improve their technical skills, nor can they allocate inputs ultimately and adequately cannot achieve higher yields and more efficient cost structures. The next implementation of the Upsus program must consider the level of adequacy and effectiveness of all program components in each rice farmer receiving the program assistance package. The adequacy of provision refers to how adequate each component of the Upsus program is provided. The effectiveness refers to how effective the program is increasing yield and reducing cost or making rice farming competitive.

CONCLUDING REMARK

At the national level, the Upsus program implementation did not succeed in achieving the target of rice cropping intensity, and productivity increases. Rice productivity was tending to levelling off or continuously declining at the national level, while the Upsus program was implemented. Due to the management and organization's problems and delivery provisions of all components of the Upsus program implementation, there was no significant improvement in 2016 to 2018. The Upsus program implementation has encouraged an increase in rice harvested area but did not encourage rice productivity growth.

Analysis at the provincial and district levels is expected to produce different performances. In the next implementation of the Upsus program, the target set should be different according to the characteristics of each province and regency. As a consequence, the planning and implementation of the Upsus program must be adapted to the characteristics of each development region, could not be revised in every month, and focuses on increasing rice productivity in every possible way (through improvement in the application of rice farming technology package, and reducing the level of yield loss during harvest and post-harvest handling) could not be diminished.

The next implementation of the Upsus program must consider the level of adequacy and effectiveness of all program components in each rice farmer receiving the program assistance package. Adequacy refers to how adequate each component of the Upsus program is provided. Effectiveness refers to how effective the program is in increasing yield and reducing cost or making rice farming more competitive. The level of adequacy and effectiveness of the Upsus program requires reliable management and organization at both the central and regional levels, which are able to manage the implementation of each component of the Upsus program at their best. The Upsus program implementation remains inadequate and ineffective if management and organization implementation and some Upsus program components were problematic.

Measuring the Upsus program's impact on cost efficiency and competitiveness of rice farming is very important considering the sustainability of self-sufficiency and rice exports to be the ultimate program implementation goal. The competitiveness of rice production will be affected by higher yield and a more efficient cost structure. Increasing yield and lowering costs will increase competitiveness. Thus, rice production becomes more competitive after the Upsus program is implemented than before. The application of the stochastic cost frontier function model will obtain the cost-efficient distribution of each rice farmer from the highest to the lowest level. The application of the kernel density distribution model to the competitiveness analysis results with DCR and PCR indicators for each rice farmer will obtain the distribution of rice farmers who can reach the highest to lowest competitiveness level. Referring to these, in the next Upsus program implementation, rice farmers who are at the highest level of cost efficiency and competitiveness can be used as a model for fostering rice farmers who are at a lower level of cost efficiency and competitiveness. The use of the stochastic cost function frontier analysis model will produce a determinant cost efficiency and the influence of the variables in it. Likewise, the use of PAM analysis will produce a determinant of the comparative and competitive advantage of rice production. At the same time, the use of the link between cost efficiency and competitiveness provides additional information on understanding competitiveness and how cost efficiency and other factors can affect competitiveness more comprehensively.

The followings are some policy recommendations to help further improve the next implementation strategies of the Upsus program on rice. (1) Serious consideration of the problems encountered and other factors that contributed to difficulties in the Upsus program implementation. (2) Maintain the area of rice planting and more focus on higher productivity target through every possible way adapted and adjusted to the characteristics of each development region (agroecosystem, socio-economy, potential, and level of development of rice farming of province, regency, and sub-district). (3) Conduct study to measure cost efficiency and competitiveness levels of farm households and use the farming system application of farms with the highest range of cost efficiency and competitiveness as models for less cost-efficient and competitiveness farms, followed by determining what guidance should be done to improve the competitiveness of individual farmers. (4) Conduct a specific, comprehensive, and detailed evaluation to increase the adequacy and effectiveness of the Upsus program's implementation and develop systematic and detailed planning and implementation for better results.

ACKNOWLEDGMENT

Acknowledgments were conveyed to Dr. Cesar B. Quicoy, Dr. Dinah Pura T. Depositario, and Dr. Jose DV. Camacho, Jr. for the comments and inputs provided in the process of writing of this paper.

REFERENCES

Abas H, Murtisari A, Boekoesoe Y. 2018. Analisis efisiensi usahatani padi sawah dengan penerapan sistem tanam jajar legowo di Desa Iloheluma, Kecamatan Tilongkabila, Kabupaten Bone Bolango. Agrinesia. 2(2):121-131.

Abidin MZ. 2015. Dampak kebijakan impor beras dan ketahanan pangan dalam perspektif kesejahteraan sosial. Sosio Informa. 1(3):213-230.

Agustian A, Hermanto, Friyatno S, Ar-Rozi AM, Suryana A. 2014. Daya saing beberapa komoditas pangan strategis. Policy Analysis Research Report. Bogor (ID): Center for Agro Socio Economic and Policy Studies.

Aigner DJ, Lovell CAK, Schmidt P. 1977. Formulation and estimation of stochastic frontier production function models. J Econom. 6:21-37.

Antriyandarti E. 2015. Competitiveness and cost efficiency of rice farming in Indonesia. J Rural Probl. 51(2):74-85.

Antriyandarti E. 2016. An economic study of the Indonesian rice sector: toward harmonization of structural adjustment and food security [Doctoral dissertation]. [Kyoto (JP)]: Kyoto University.

[ADBI] Asian Development Bank Institute. 2014. ASEAN 2030: toward a borderless economic community. Tokyo (JP): Asian Development Bank Institute.

Balassa B. 1965. Trade liberalisation and ‘revealed’ comparative advantage. The Manchester School. 33:99-123.

Ballance R, Forstner H, Murray T. 1987. Consistency tests of alternative measures of comparative advantage. Rev Econ Stat. 69:157-161.

Battese GE, Coelli TJ. 1992. Frontier production functions, technical efficiency and panel data: with application to paddy farmers in India. J Product Anal. 3(1/2):153-169.

Battese GE, Coelli TJ. 1995. A model for technical inefficiency effects in a stochastic frontier production function for panel data. Empir Econ. 20(2):325-332.

Bian F, Xie Y, Cui X, Zeng Y, editors. 2013. Geo-informatics in resource management and sustainable ecosystem. Proceedings of International Symposium GRMSE 2013; 2013 Nov 8-10; Wuhan, China. Part 2. New York (US): Springer.

Bordey FH, Moya PF, Beltran JC, Dawe DC, editors. 2016. Competitiveness of Philippine rice in Asia. Science City of Muñoz (PH): Philippine Rice Research Institute and International Rice Research Institute.

Bowo PA, Nurayati A, Muhammad R, Imleesh M. 2016. Analysis of competitiveness and government policy on rice, corn and soybean farming. Jejak. 9(2):59-169.

Breiman L, Meisel W, and Purcell E. 1977. Variable kernel estimates of multivariate densities. Technometrics. 19:135-144.

Burkhauser RV, Crews AD, Daly MC, Jenkins SP. 1999. Testing the significance of income distribution changes over the 1980s business cycle: a cross-national comparison. J Appl Econ. 14(3): 253-272.

Busyra RG. 2016. Dampak program Upaya Khusus (Upsus) Padi Jagung Kedelai (Pajale) pada komoditas padi terhadap perekonomian Kabupaten Tanjung Jabung Timur. J Agribusiness Media. 1(1):12-27.

[CADIS] Center for Agriculture Data and Information System. 2018. Statistik pertanian 2017. Jakarta (ID): Center for Agriculture Data and Information System.

[CADIS] Center for Agriculture Data and Information System. 2019. Statistik pertanian 2018. Jakarta (ID): Center for Agriculture Data and Information System.

[CADIS] Center for Agriculture Data and Information System. 2020. Statistik pertanian 2019. Jakarta (ID): Center for Agriculture Data and Information System.

Coelli TJ. 1996. A guide to frontier version 4.1: a computer program for stochastic frontier production and cost function estimation. Armidale (AU): Center for Efficiency and Productivity Analysis, University of New England

Coelli TJ, Perelman S, Romano E. 1999. Accounting for environmental influences in stochastic frontier: with application to international airlines. J Product Anal. 11(3):251-273.

Coelli TJ, Rao DSP, O'Donnell CJ, Battese GE. 2005. An introduction to efficiency and productivity analysis. 2nd ed. New York (US): Springer.

[DGAIF] Directorate General of Agriculture Infrastructure and Facilities. 2018. Statistik prasarana dan sarana pertanian 2013–2017. Jakarta (ID): Directorate General of Agriculture Infrastructure and Facilities.

[DGAIF] Directorate General of Agriculture Infrastructure and Facilities. 2019. Statistik prasarana dan sarana pertanian 2018. Jakarta (ID): Directorate General of Agriculture Infrastructure and Facilities.

[DGFC] Directorate General of Food Crops. 2017. Laporan pelaksanaan program Upsus Padi, Jagung dan Kedele tahun anggaran 2017. Jakarta (ID): Directorate General of Food Crops.

[DGFC] Directorate General of Food Crops. 2019. Database statistik pertanian tanaman pangan 2006–2019. Jakarta (ID): Directorate General of Food Crops.

[FAO] Food and Agricultural Organization. 2003. Consultation on agricultural commodity price problems; 2002 Mar 25-26; Rome, Italy. Rome (IT): Food and Agriculture Organization of the United Nations.

Gine E, Sang H. 2010. Uniform asymptotics for kernel density estimators with variable bandwidths. J Nonparametr Stat. 22:773-795.

Gonzales LA, Kasryno F, Perez ND, Rosegrant MW. 1993. Economic incentives and comparative advantage in Indonesian food crop production. Research Report 93. Washington, DC (US): International Food Policy Research Institute.

Greene W. 2005. Efficiency of public spending in developing countries: a stochastic frontier approach. New York (US): Stern School of Business, New York University.

Hadi PU, Suhaeti RN, Djulin A, Purwantini TB. 2003. Analisis dinamika struktur sosial ekonomi pedesaan: Patanas data analysis. Final Research Report. Bogor (ID): Indonesian Center for Agricultural Socio Economic and Policy Studies.

Hall P. 1992. On global properties of variable bandwidth density estimators. Ann Stat. 20:762-778.

Hamyana UR. 2017. Pembangunan dan konflik sosial (Studi etnografi implementasi program Upaya Khusus Peningkatan Produksi Padi, Jagung, dan Kedelai di Kabupaten Bondowoso-Jawa Timur)**.** Agriekonomika. 6(2):108-119.

Hayami Y, Ruttan VW. 1971. Induced innovation in agricultural development. Discussion Paper No. 3, May 1971. Minnesota (US): Center for Economics Research, Department of Economics, University of Minnesota.

Hidayah I, Hanani N, Anindita R, Setiawan B. 2013. Production and cost efficiency analysis using frontier stochastic approach, a case on paddy farming system with Integrated Plant and Resource Management (IPRM) approach in Buru District Maluku Province Indonesia. J Econ Sustain Dev. 4(1):78–84.

[ICASEPS] Indonesian Center for Agricultural Socio Economic and Policy Studies (ICASEPS). 2017. Kebijakan pelaksanaan program Peningkatan Produksi Pangan Pokok. Policy Analysis Report.

Bogor (ID): Indonesian Center for Agricultural Socio Economic and Policy Studies.

[ICASEPS] Indonesian Center for Agricultural Socio Economic and Policy Studies. 2019. Evaluasi independen program Upsus Pajale. Policy Analysis Report. Bogor (ID): Indonesian Center for Agricultural Socio Economic and Policy Studies.

Irawan B, Simatupang P, Kustiari R, Sugiarto, Supadi, Sinuraya JF, Iqbal M, Ariani M, Darwis V, Elizabeth R, Sunarsih, Muslim C, Purwantini TB, Nurasa T. 2007. Panel Petani Nasional (Patanas). Analisis indikator pembangunan pertanian dan pedesaan: karakteristik sosial ekonomi petani dan usahatani padi. Research Report. Bogor (ID): Indonesian Center for Agricultural Socio Economic and Policy Studies.

Kariyasa IK. 2011. Economic impact of integrated crop management farmer field school on corn production in Indonesia [PhD Thesis]. [Los Baños (PH)]: University of the Philippines at Los Baños.

Kartiasih F, Setiawan A. 2019. Efisiensi teknis usaha tani padi di Provinsi Kepulauan Bangka Belitung. Anal Kebijak Pertan. 17(2):139-148.

Krisnawati E, Suman A, Mahardika P, Saputra A. 2018. Kajian pengaruh program nasional Upaya Khusus Peningkatan Produksi Padi terhadap kemiskinan perdesaan di wilayah barat dan timur Indonesia. J Ilmu Ekon Pembang. 18(1):14-34.

Kumbhakar SC, Ghosh KS, McGuckin JT. 1991. A generalized production frontier approach for estimating determinants of inefficiency in US dairy farms. J Bus Econ Stat. 9(3):279-286.

Kumbhakar SC, Lovell CAK. 2003. Stochastic frontier analysis. New York (US): Cambridge University Press.

Kusnadi N, Tinaprilla N, Purwoto A. 2011. Analisis efisiensi usahatani padi di beberapa sentra produksi padi di Indonesia. J Agro Ekon, 29(1):25-48.

Latruffe L. 2010. Competitiveness, productivity and efficiency in the agricultural and agri-food sectors. OECD Food, Agriculture and Fisheries Working Papers No. 30. Paris (FR): Organization for Economic Cooperation and Development.

Liese B, Isvilanonda S, Tri KN, Ngoc LN, Pananurak P, Pech R, Shwe TM, Sombounkhanh K, Möllmann T, Zimmer Y. 2014. Economics of Southeast Asian rice production [Internet]. Agri Benchmark Report. [cited 2019 Jun 13]. Available from: http://www.agribenchmark.org/fileadmin/Dateiablage/B-Cash-Crop/Reports/Report-2014-1-rice-FAO.pdf

Loftsgaarden DO, Quesenberry CP. 1965. A nonparametric estimate of a multi-variate density function. Ann Math Stat. 36:1049-1051.

Mantau Z, Harianto, Nuryartono N. 2014. Analysis of competitiveness of lowland rice farming in Indonesia: case study of Bolaang Mongondow District, North Sulawesi Province. J Econ Int Financ. 6(4):85-90.

[MoA] Ministry of Agriculture. 2012. Peraturan Menteri Pertanian nomor 50/Permentan/OT.140/8/2012 tentang pedoman pengembangan kawasan pertanian. Jakarta (ID): Secretariat General of the Ministry of Agriculture.

[MoA] Ministry of Agriculture. 2015. Peraturan Menteri Pertanian Republik Indonesia Nomor 03/2015 tentang Pedoman Upaya Khusus (Upsus) Peningkatan Produksi Padi, Jagung dan Kedelai melalui program Perbaikan Jaringan Irigasi dan Sarana Pendukungnya. Jakarta (ID): General Secretariat of the Ministry of Agriculture.

[MoA] Ministry of Agriculture. 2017. Success self-sufficiency: Indonesia becomes a world food barn 2045. Jakarta (ID): General Secretariat of the Ministry of Agriculture.

Monke EA, Pearson SR. 1989. The policy analysis matrix for agricultural development [Internet]. Outreach Program. [cited 2018 Jun 12]: Available from: https://www.cepal.org/sites/default/files/courses/files/03_3_pambook.pdf

Murniati K, Mulyo JH, Irham, Hartono S. 2014. Efisiensi teknis usaha tani padi organik lahan sawah tadah hujan di Kabupaten Tanggamus Provinsi Lampung. J Penelit Pertan Terap. 14(1):31-38

Nainggolan S, Fitri Y, Kurniasih S. 2019. Kajian efisiensi teknis dan preferensi risiko produksi petani dalam rangka peningkatan produktivitas usahatani padi sawah di Kabupaten Bungo Provinsi Jambi - Indonesia. J Agribus Local Wisdom. 2(1):2621-1300.

Nivievskyi O, von Cramon-Taubadel S, Brummer B. 2010. A note on technical efficiency, productivity growth and competitiveness [Internet]. [cited 2019 Jan 8]. Available from: http://ageconsearch.umn.edu/bitstream/ 61759/2/11234 AAEA 2010.pdf

Nugroho AD, Hidayah-Utami SN, Yuslianti Y, Nurrokhmah L, Al Huda MA, Suryani L, Riyadi I, Ulfaizah, Septijono T, Adhini HAN. 2017. Pelaksanaan program Upaya Khusus (Upsus) Swasembada Pangan di Kabupaten Wonosobo Provinsi Jawa Tengah. J Pengabdi Masy. 3(1):1-17.

Nurayati A. 2015. Analisis daya saing dan kebijakan pemerintah terhadap usahatani padi, jagung dan kedelai Provinsi Jawa Tengah [Undergraduate thesis]. [Semarang (ID)]: Universitas Negeri Semarang.

Pearson S, Gotsch C, Bahri DS. 2005. Aplikasi policy analysis matrix pada pertanian Indonesia. Jakarta (ID): Penerbit Yayasan Obor Indonesia.

Rachman B, Saptana, Friyatno S, Rusastra IW. 2001. Dampak penyesuaian kebijakan terhadap pasar input pertanian dan pendapatan petani padi. Lokakarya Kebijakan Pangan Makro dan

Keuangan Pedesaan. Malang (ID): Brawijaya University.

Rachman B, Simatupang P, Sudaryanto T. 2004. Efisiensi dan daya saing sistem usahatani padi. In: Saliem HP, Basuno E, Sayaka B, Sejati WK. Prosiding Seminar Nasional Efisiensi dan Daya Saing Sistem Usahatani Beberapa Komoditas Pertanian di Lahan Sawah. Bogor (ID): Indonesian Center for Agricultural Social Economy Research and Development. p. 1-34.

Rachmina D, Maryono. 2008. Analisis efisiensi teknis dan pendapatan usahatani padi program benih bersertifikat: pendekatan stochastic production frontier. J Agribis Ekon Pertan. 2(2):11-20.

Rifiana, Ikhsan S. 2017. Pengukuran Keefisienan Teknis Usaha Tani Padi Sawah di Kabupaten Barito Kuala, Kalimantan Selatan. Prosiding Seminar Nasional Lahan Basah Tahun 2016. Jilid 1. Barjarbaru (ID): Lembaga Penelitian dan Pengabdian kepada Masyarakat, Universitas Lambung Mangkurat. p. 195-199.

Rivanda DR, Nahraeni W, Yusdiarti A. 2015. Analisis efisiensi teknis usahatani padi sawah (pendekatan stohactic frontier) kasus petani SL-PTT di Kecamatan Telagasari Kabupaten Karawang Pronvinsi Jawa Barat. J Agribisnis Sains. 1(1):1-13

Romdhon MM, Cahyadinata. 2004. The competitiveness and efficiency of rice farming system in North Bengkulu District, Bengkulu Province. Bengkulu (ID): University of Bengkulu.

Rosenblatt M. 1956. Remarks on some nonparametric estimates of a density function. Ann Math Stat. 27:832-837.

Rusastra IW, Ilham N. 2009. Daya saing komoditas pertanian: konsep, kinerja dan kebijakan pembangunan. J Agric Innov Dev. 3(1):38-51.

Sadoulet E, de Janvry A. 1995. Quantitative development policy analysis. Baltimore (US): The Johns Hopkins University Press.

Saptana. 2010. Tinjauan mikro-makro daya saing dan strategi pembangunan pertanian. Forum Penelit Agro Ekon. 28(1):1-18.

Saptana. 2012. Konsep efisiensi usahatani pangan dan implikasinya bagi peningkatan produktivitas. Forum Penelit Agro Ekon. 30(2):109-128

Saptana, Supriyo A, Saliem HP. 2016. Evaluasi kinerja program Upsus Padi di Kabupaten Klaten: kinerja, kendala, dan strategi. In: Syahyuti, Susilowati SH, Agustian A, Sayaka B, Ariningsih E, editors. Prosiding Seminar Nasional Perlindungan dan Pemberdayaan Pertanian dalam Rangka Pencapaian Kemandirian Pangan Nasional dan Peningkatan Kesejahteraan Petani; 2015 Nov 10; Bogor, Indonesia. Bogor (ID): Indonesian Center for Agricultural Socio Economic and Policy Studies. p. 257-271.

Sari M, Sjah T. 2016. Implementation of Special Program of PAJALE (Rice, Corn and Soybeans) in Terara District, East Lombok Regency. Int Res J Manag Inf Technol Soc Sci. 3(9):41-50.

Sudaryanto T, Agustian A. 2003. Peningkatan daya saing usaha tani padi: aspek kelembagaan. Anal Kebijak Pertan. 1(3):255-274.

Suryana A, Hermanto. 2004. Kebijakan Ekonomi Perberasan Nasional. In: Kasryno F, Pasandaran E, Fagi AM, editors. Ekonomi Padi dan Beras Indonesia. Jakarta (ID): Indonesian Agency for Agricultural Research and Development. p. 53-72.

Suryana A, Rachman B, Hartono MD. 2014**.** Dinamika kebijakan harga gabah dan beras dalam mendukung ketahanan pangan nasional**.** Pengemb Inov Pertan. 7(4):155-168.

Susilowati SH, Hutabarat B, Rachmat M, Sugiarto, Supriyati, Zakaria AK, Supriyadi H, Purwoto A, Supadi, Winarso B, et al. 2010. Analisis indikator pembangunan pertanian dan pedesaan: karakteristik sosial ekonomi petani dan usahatani padi. Research Report. Bogor (ID): Indonesian Center for Agricultural Socio Economic and Policy Studies.

Tamba IM, Pastini NI. 2012. Dampak kebijakan kredit dan subsidi pupuk terhadap keuntungan usahatani padi. Agrimeta. 2(03):1-11.

Taron M, Paragios N, Jolly MP. 2005. Modeling shapes with uncertainties: higher order polynomials, variable bandwidth kernels and nonparametric density estimation. Proceedings of the 10th IEEE International Conference on Computer Vision; 2005 Oct 17-21; Beijing, China. New York (US): Institute of Electrical and Electronics Engineers. p. 1659-1666.

Tinaprilla N, Kusnadi N, Sanim B, Hakim DB. 2013. Analisis efisiensi teknis usahatani padi di Jawa Barat Indonesia. J Agribis. 7(1):15-34

[USITC] United States International Trade Commission. 2015. Rice: global competitiveness of the U.S. industry. Publication Number: 4530. Investigation Number: 332-549. Washington, DC (US): United States International Trade Commission.

Van Kerm P. 2003. Adaptive kernel density estimation. 9th UK Stata Users meeting paper, Royal Statistical Society, 2003 May 19-20; London, United Kingdom.

von Cramon-Taubadel S, Nivyevskyi O. 2008. Agricultural competitiveness. World Bank Report No. 44843-UA. Washington, DC (US): The World Bank.

von Cramon-Taubadel S, Nivyevskyi O. 2010. Improving the competitiveness of agriculture in Belarus [Internet]. [cited 2019 Jan 9]. Available from: http://www.get-belarus.de/download/Berater papiere/2010/pp2010e05.pdf

Wijaya I, Widyantara IW, Dewi I. 2016. Efektivitas alokasi input usahatani padi dalam program Upsus Pajale di Subak Gadungan Delod Desa,

Desa Gadungan, Kabupaten Tabanan. E-J Agribis Agrowisata. 5(3):527-537.

Wu TJ, Chen CF, Chen HY. 2007. A variable bandwidth selector in multivariate kernel density estimation. Stat Probab Lett. 77(4):462-467.

Zugarramurdi A, Parin MA, Lupin HM. 1995. Economic engineering applied to the fishery industry. FAO Fisheries Technical Paper – 351. Rome (IT): Food and Agriculture Organization of the United Nations.