Research Article

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Study of the impact of increasing the highest retail price of subsidized fertilizer on rice production in Indonesia

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Abstract: Fertilizer plays an important role in agricultural production, and up to now it has always been subsidized through the selling price mechanism. This study aims to analyze three related areas, namely, the subsidized fertilizer policy dynamics, the development of subsidized fertilizer highest retail price (HRP), and the effects of its subsidy price changes on rice production. The study uses both the primary data from research in West Java in 2020 and the data from 2016 national farmer panel and also the secondary data. The data analysis was carried out quantitatively, namely, multiple regression analysis and qualitative descriptive studies. The results of the analysis show that the profit value of lowland rice farming is Indonesian Rupiah (IDR). 13.89 million/ha/season and Revenue per cost ratio (R/C) is 1.85. The proportion of fertilizer input cost to the total lowland rice farming cost reaches 10.25%. The analysis of the nationwide impacts of the HRP increase of the subsidized fertilizers by IDR. 300/kg shows the result that there would be a decrease in national rice productivity by 0.09 tons/ha, a decrease in national rice production by 0.94 million tons milled dry rice (MDR/GKG), and a decrease in the national rice harvest area equivalent to 186,219 ha. It is suggested that in the future, some efforts and measures are needed to make the use of subsidized fertilizers to be more effective and efficient. In order to maintain national rice production, a program to increase the harvested areas is needed.

Keywords: fertilizer, subsidy, HRP, production, rice farming

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1 Introduction

To increase agricultural production, a number of allocations and combinations of production factors are obviously required. In agricultural production process there are a number of necessary production factors to consider, such as land, labor, fertilizers, seeds, pesticides, and others. Fertilizer becomes an important input given to plants to enable them to grow well and give high production as reported by Soekartiwi [1]. A similar highlight was also made in a number of research; Sing et al. [2], Kakar et al. [3], and Wako and Usmane [4] pointed out that the results of balanced fertilization have a significant influence on the resulting grain production, and are economically profitable. Furthermore, it is also stated by Girma et al. [5] that in Ethiopia, to increase the productivity of high agricultural tubers, some inorganic fertilization activities are carried out with a balanced and site-specific composition.

Ensuring the effectiveness and increasing the optimal benefits of fertilizers, it is crucial to have these six basic conditions or principles for fertilizers when reaching farmers. They are the right amount, the right dose, the right type, the right price, the right quality, and the right time. Their availability nationwide and proper distribution to farmers is, therefore, required. The government has taken some measures to improve the distribution process to farmers, two of which are by providing a fertilizer subsidy budget and by distributing subsidized fertilizers through distributors on each line in the distribution stages.

Generally, a subsidy policy is to encourage farmers to increase agricultural production. The subsidy applies to fertilizers used for the main food crop, namely, rice. Considerably, the government's subsidy policy can be seen as one way to ease the burden on rice farmers. Fertilizer subsidies start from the factories; they are given to factories. Then, the fertilizers from those factories are distributed through distributors to farmers at the subsidized price. This selling price is then set as the highest retail price (HRP). So, this HRP for fertilizer is the price of the subsidized fertilizer purchased by the farmers or farmer groups at line IV distributors or fertilizer kiosks as stipulated in the Regulation of the Ministry of Agriculture.

Based on the Regulation of Ministry of Agriculture No. 49 of 2020, it is imperative that the types of fertilizers which are subsidized by the Government are: Urea, SP36, ZA, NPK, Liquid Organic Fertilizer, and Organic Fertilizer. These six types of the subsidized fertilizers are intended for rice farmers who: (a) are members of farmer groups; (b) have registered in the e-Definitive Plan for Farmers' Group Needs; (c) are able to show the identity; and (d) fill in the form of redemption of subsidized fertilizer. The farmer groups receiving subsidized fertilizers consist of: (a) farmers who carry out farming in the food crops, plantation, horticulture, and/or livestock sub-sectors with a maximum area of 2 Ha/season, (b) farmers who carry out farming in the food crop sub-sector, and/or (c) fish cultivators with a maximum cultivation area of 1 Ha/growing season.

The HRP for the subsidized fertilizers from the year 2012 to the end of 2020 remained the same for Urea at IDR 1,800/kg; ZA at IDR 1,400/kg; SP-36 at IDR 2,000/kg; NPK at IDR 2,300/kg, and Organic for IDR 500/kg. However, recently there was a new fertilizer HRP policy effective as of January 1, 2021, determining the new subsidized fertilizer HRP, namely: for Urea at IDR 2,250/kg; ZA at IDR 1,700/kg; SP-36 at IDR 2,400/kg; NPK at IDR 2,300/kg, and Organic for IDR 800/kg.

Regarding any positive effects of price support to fertilizer, research results of Komareka et al. [6] depict that in Malawi, the presence of fertilizer price support affects the marginal benefit cost of farmers to be greater than 1. The same results were also provided by Gilbert and Jayne [7], saying that in Malawi, the existence of a fertilizer subsidy program has encouraged the use of fertilizers and food production. In addition, Theriault and Smale [8] also state that for more than a decade, the Government of Mali launched a fertilizer subsidy program to expand the use of fertilizers and increase the productivity of food crops. Kone et al. [9] describe that the determination of fertilizer subsidies in the State of Mali has encouraged an increase in cereal production, thus preventing the country from a food crisis.

Based on the description above, this study aims to analyze the dynamics of fertilizer subsidy policy, the development of subsidized fertilizer HRP, and analyze the effects of changes in fertilizer HRP on rice farming production in Indonesia.

2 Theoretical framework

According to Pindyck and Rubinfeld [10], subsidies are the opposite of taxes, therefore they are often also called negative taxes. Accordingly, its effect on market equilibrium is inversely proportional to that of taxes, so we can analyze its effects as well when analyzing the effects of taxes. Subsidies can either be specific or proportional. Subsidies given to the production of an item can cause the selling price of the item to be lower. It is thought that with a subsidy, producers feel that their production costs are becoming lesser so they are willing to sell cheaper. As a result, the equilibrium price created in the market is lower than the equilibrium price before or without subsidies, and the balance amount should become relatively more.

The types of subsidies can be grouped based on the target recipient or the subsidy scheme given. Based on the target recipients, there are two types, namely, consumer subsidies and producer subsidies. Meanwhile, based on the scheme of subsidy provided, there are two types, that is, in the form of money (cash transfers) and in the form of goods or in-kind subsidies reported by Hirshileifer [11].

Concerning the scheme of the subsidy, although each can have its own advantages and disadvantages, Hyman [12] stated that subsidies in the form of goods are believed to be more targeted. If it is given in the form of money, it is feared that the transferred funds will not be spent for the intended purpose, but will be used for consumption expenditures, such as buying cigarettes, telephone credits, jewelry, or others, resulting in the subsidies not looking well-targeted. The aid fund is thought to be neither long-term nor sustainable as a poverty alleviation program; it is more temporary and consumptive. On the other hand, when in the form of goods, it is feared that the goods provided may not be in accordance with the expectations of the intended community, considering that the government procurement process is often susceptible to any unhealthy or improper process and sometimes there could also be irregularities. According to

Ellis [13], a policy can be said to be successful if it can be implemented and it can optimize the wishes of the parties involved or affected by the implementation of the policies made.

According to Hermawan [14], subsidies and price supports are short-term policies that can be applied to increase farmers' production and income. However, these policies often have unsustainable results and can also create new injustices, when poorly targeted. Policies that rely solely on prices often experience obstacles in terms of budget provision and timeliness, so their effectiveness is low. The price policy can clash with the interests of producers or with the interests of consumers, if the budget allocated is inadequate. The fertilizer subsidy policy is, therefore, just the first way to promote food security at the micro and macro levels and at the same time to stimulate the development of input markets.

In general, the benefits of the subsidies are enjoyed by the consumers as reported by Pindyck and Rubinfeld [10]. Input subsidies are subsidies given to the input market so that producers seem to experience a decrease in production costs. Because production costs are reduced, producers tend to produce more at a constant level of consumer purchasing power. A decrease in the producer's cost of production is shown as a shift in the supply curve to the lower right so that the price of the good decreases and the quantity supplied increases.

For agricultural subsidies, the user communities are producers of agricultural products and consumers of agricultural products. For producers of agricultural products, subsidies are given for the price of the production facilities, such as fertilizers and seeds. Meanwhile, for consumers of agricultural products, subsidies are given for the price of basic food, especially rice as reported by Bappenas [15]. The formula for the amount of price subsidy per kg of subsidized product can simply be written as: $S_{Hi} = H_{NSi} - H_{Si}$; and in the formula, S_{Hi} is the price subsidy for the i product per kg; H_{NSi} is the price of non-subsidized product for i per kg; and H_{Si} is the product subsidy price for i per kg. S_{Hi} is the price subsidy given by the government, and H_{Si} is the price paid by the subsidy recipient community. Subsidies on the price of production facilities aim to increase the purchasing power of underprivileged farmers in order to be able to purchase production facilities in sufficient quantities to increase or maintain their expected productivity and farm income. From the lower prices for production facilities, agricultural producing communities are also encouraged to apply more advanced technology to help them increase their farming productivity.

The impact of subsidized prices on agricultural production inputs (e.g., fertilizers) on agricultural production is illustrated in Figure 1. Based on the demand function (DF) of fertilizers, if the price of fertilizers (e.g., Urea) is not subsidized, which means that the price of fertilizer is PF1, then the amount of fertilizer used per ha is QF1 and correspondingly with the existing production technology as reflected in the production curve $Y = f(F; Z)$, where F is the fertilizer and Z is other inputs, the production per ha is only Y1. But then, if the price of the fertilizer is subsidized so that the price paid by farmers decreases to PF2, then the use of fertilizer per ha will increase to QF2 and the existing production technology will obtain a production of Y2.

If there is an input price subsidy, this will then encourage farmers to apply more advanced technology. This can be reflected in the production curve $Y' = f(F; Z)$ which is in a higher position than the production curve $Y = f(F; Z)$. Thus, the use of the same fertilizer is QF2 so that the production that can be achieved is Y3, where the value of Y3 > Y1. However, when the condition of technology remains unchanged, and subsidies are increased, then the price of fertilizer paid by farmers becomes very cheap, namely, PF3, so that production will actually fall to Y4. The decline in production is due to the nature of the agricultural production subject to the law of diminishing marginal return, where the excess use of fertilizers will cause poisoning in plants, which then has an impact on reducing production as reported by Bappenas [15].

3 Research methodology

3.1 Scope and novelty of the research

The scope of the research includes: (1) The dynamics of fertilizer subsidy policies in Indonesia since the 1970s to the present; (2) The development of subsidized fertilizer HRP since the early 2000s until now; and (3) analysis of the impact of changes in fertilizer HRP on increasing rice productivity nationally and in West Java.

The novelty of this research is in: (1) presenting the development of subsidized fertilizer HRP with the latest data; (2) presenting the results of a comprehensive analysis with combined micro and macro data; and (3) using combined data from micro data and macro data from research results from 2016 to 2020 national research panel (PATANAS) and national data. Research on fertilizer subsidy policies using panel data is still limited,

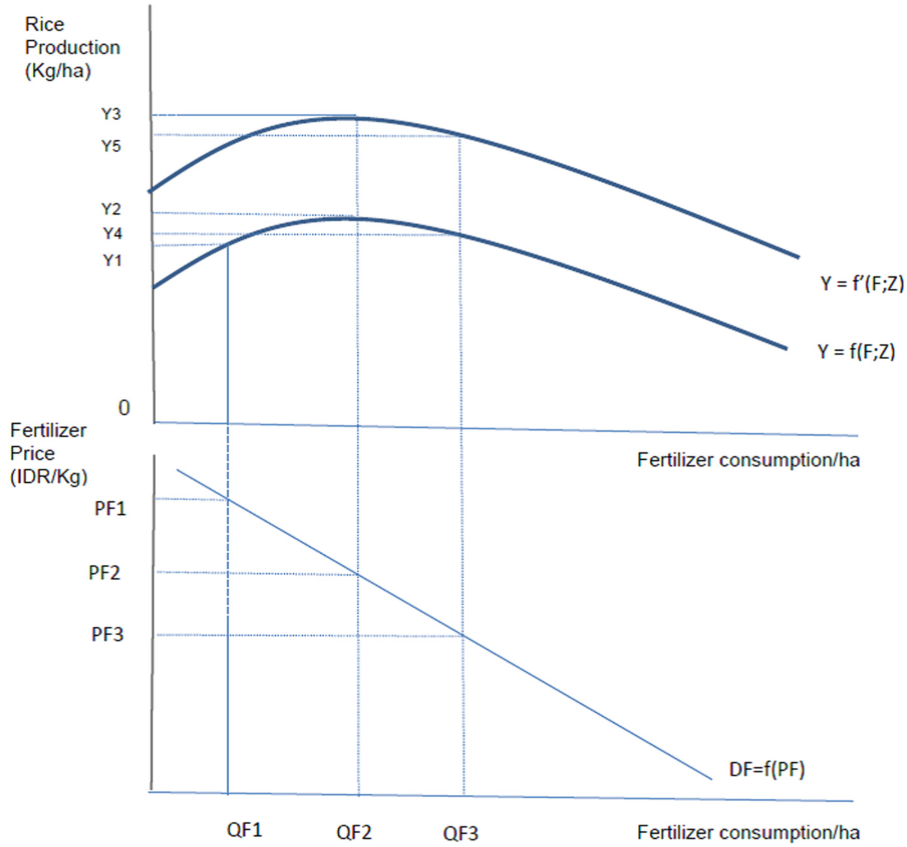

Figure 1: Impact of fertilizer price subsidy on total fertilizer consumption and agricultural productivity in Indonesia, 2021.

studies such as Setiawan et al. [37], Wirakusuma [38], and Adiraputra and Supyandi [39] use time series and cross section data.

This research is expected to be useful and contribute to increasing the knowledge of the community and readers in general, namely, in terms of: (1) how are the dynamics of fertilizer subsidy policy to the current condition, (2) an overview of the development of the HRP of the subsidized fertilizer which is also shown with the development of dry rice prices; (3) provides an analytical description of how if there is a change in the HRP of subsidized fertilizer, it will affect the production of rice farming in Indonesia.

3.2 Study locations and research samples

In this study, the data source is taken from: (1) primary data from the 2019 research in West Java Province with a sample of research respondents: 30 lowland rice farmers, 2 fertilizer distributors, and 3 fertilizer kiosks; (2) secondary data from the Indonesian Central Bureau Statistics (ICBS) for 2020, and (3) data from 2016 to 2020 National Farmers Panel (PATANAS) research data from the Center for Socio-Economic and Agricultural Policy, Ministry of Agriculture in the form of survey results in 14 districts of rice production centers in Java Province West, Central Java, East Java, North Sumatra, and South Sulawesi with a sample of 730 farmer households.

In addition to the primary data, secondary data were also collected from various sources: Directorate General of Agricultural Infrastructure and Facilities-Ministry of Agriculture, National Development Planning Agency, Food Crops Agriculture Service, PT. Indonesian Fertilizer, and secondary data from various other related research institutions.

3.3 Analysis method

The analytical method used is quantitative and descriptive qualitative analysis. To analyze the dynamics of the policy taken and the development of subsidized fertilizer HRP, the qualitative analysis is used in presenting a description of the policy and trends in the development of HRP in a qualitative descriptive manner. Furthermore, to analyze the effect of changes in fertilizer HRP on rice farming production, the study uses a regression model with estimates using the ordinary least square (OLS) method.

To answer the research objective of analyzing the effect of changes in fertilizer HRP on rice farming production, the team used a partial equation. In the productivity equation model (double log), it does not include the price of grain/rice, because it is a production function so that the variable included in the equation is the physical input of production. From the double log equation, the fertilizer parameter coefficient (β_i) is the elasticity of fertilizer to rice productivity. Furthermore, the marginal physical product (MPP) component in the equation is also a component of the value marginal product. In this case, the price of the output of rice and the price of the input of fertilizer are used in the calculation. In detail, the equation modeling is presented as follows.

$$\ln Y_i = \beta_0 + \beta_1 \ln S_i + \beta_2 \ln F_i + \beta_3 \ln P_i + \beta_4 \ln L_i, \quad (1)$$

where Y_i is the farmer's rice productivity for i (kg/ha), S_i is the use of rice seeds per hectare of farmers for i (kg/ha), F_i is the fertilizer use per farmer's hectare for i (kg/ha), P_i is the pesticide use per farmer's hectare for i (kg/ha), L_i is the use of labor per hectare of farmers for i (working people day per hectare), and I is the coefficient of variable parameter for i.

Based on the double log equation above (equation (1)), the fertilizer parameter coefficient (β_2) is the elasticity of fertilizer to rice productivity. In general, the elasticity can be formulated as follows:

$$E_{YF} = \frac{\delta Y_i}{\delta F_i} \cdot \frac{F_i}{Y_i} = \beta_2, \quad (2)$$

until,

$$\frac{\delta Y_i}{\delta F_i} = \beta_2 \cdot \frac{Y_i}{F_i}, \quad (3)$$

where E_{YF} is the elasticity of fertilizer on productivity, $\frac{\delta Y_i}{\delta F_i}$ is the MPP of farmer's fertilizer for i, and β_2 is the fertilizer parameter coefficient.

The MPP component in equation (3) is also a component of the value marginal product, which is generally formulated as:

$$\mathrm{VMP}_i = \frac{\delta Y_i}{\delta F_i} \cdot PY_i = PF_i, \quad (4)$$

where PY_i is the price of farmer's grain output for i, and PF_i is the farmer's fertilizer input price for i.

By substituting equation (3) in equation (4), the marginal product value can be reduced to:

$$\mathrm{VMP}_i = \beta_2 \cdot \frac{\delta Y_i}{\delta F_i} \cdot PY_i = PF_i, \quad (5)$$

$$\frac{PY_i}{PF_i} = \frac{F_i}{F_i i \cdot \beta_2}. \quad (6)$$

Thus, *demand for fertilizer input* can be formulated as:

$$F_i = \frac{PY_i}{PF_i} \cdot Y_i \cdot \beta_2. \quad (7)$$

In the context of efforts to increase the HRP of the subsidized fertilizers, it needs to be done in stages. This effort is one step in increasing the efficiency of the use of subsidized fertilizers. It is important to regulate fertilizer prices with gradual increases in order to maintain national rice production. Increase in the retail price of the subsidized fertilizer should be more balanced with the increase in the national dry rice prices.

4 Results and discussion

4.1 The dynamics of fertilizer subsidy policy in Indonesia

Chronologically, the fertilizer distribution system policy in Indonesia can be divided into several periods: (1) the period before the economic crisis, 1960–1979 and 1979–1993; (2) the 1998 economic crisis period; (3) the period of the free market era, 1998–2003; (3) the post-economic crisis period, 2003–2008; and (4) closed distribution system period, namely, 2008–present.

In the period before the economic crisis (1960–1979 and 1979–1993), where fertilizer distribution was regulated by the government, the fertilizer procurement and distribution were coordinated by PT. Pusri, the subsidies provided by the government were given to participants in the Bimas program and the distribution of fertilizers to distributors/retailers was carried out on consignment. Farmers redeemed fertilizers with coupons from dealers. In this period, there was no provision, so the stable amount of fertilizer was guaranteed at all times. From 1993/1994 to 1997, the subsidies and distribution arrangements were only provided for urea fertilizers, while the non-urea fertilizers were not subsidized and the trade system was not regulated, and this caused a shortage of Urea fertilizers in the market. In 1998, SP36, ZA, and KCl fertilizers were initially re-subsidized but then on December 1, 1998, the subsidies and trading arrangements were lifted, due to the new regulations that were retroactively enforced as of August 6, 1998.

The Free-Market Era period occurred from 1998 to 2003 where the government set a policy of eliminating fertilizer subsidies and releasing fertilizer distribution according to market mechanisms. The government's main considerations for revoking and freeing the fertilizer trade system were: (a) price discrimination of fertilizers for food and non-food farmers' needs causes the flow of fertilizer between the two needs, (b) disparities in the domestic fertilizer prices lead to seepage of fertilizer abroad, (c) the high burden of the government budget in fertilizer subsidies which was increasing, and (d) the international trade environment was increasingly leading to the era of globalization. To ensure the availability of fertilizers in the country, the responsibility for the procurement and distribution of fertilizers in the country were shared (not only PT. Pusri) and were in the hands of a Holding Company.

In the Post-Economic Crisis period, namely, in 2003, the government again provided fertilizer subsidies for the agricultural sector with the aim to assist farmers in the supply and in the use of fertilizers according to the six principles to increase productivity and farm income. Understandably, when it was based on a free market, it then had to be carried out without subsidies and prices would follow the market mechanism. It turned out that the strength of the market demand did not guarantee the availability of fertilizer at the farmer level in the right amount at an affordable price, as a result many farmers seemingly did not fertilize their crops in a balanced way.

During the closed distribution system period, which refers to the Minister of Trade Regulation No. 21 of 2008 which was later changed to Permendag No. 07/M-DAG/Per/2/2009 in which the subsidized fertilizer trade system is regulated through rayonization, so that each fertilizer industry has its own distribution area, and a number of rayonization areas were then designated. PT. Pusri serves Sumatra, Central Java, and western Kalimantan, PT. Pupuk Kujang serves the West Java region, PT. Petrokimia Gresik serves the East Java region, and PT. Pupuk Kaltim serves the East Indonesia. In addition, this rayonization system was strengthened by the policy of determining the HRP for subsidized fertilizers based on the Minister of Agriculture Regulation No. 42/OT.140/09/2008 dated September 23, 2008. It is said that the market is closed because the sale of fertilizers is only in accordance with the needs of the Definitive Plan for Farmers Group Needs for the fertilizer needs. In a further development, the Minister of Trade Regulation No. 15/2013 also regulates the distribution/distribution mechanism of fertilizers for the agricultural sector according to rayonization.

Looking at the development of fertilizer subsidies over the last 5 years, apparently the value of subsidies increased sharply from 2014 to 2015, although the volume of fertilizers remained relatively constant. This sharp increase in subsidies during the year was due to the increase in gas prices as the main component of fertilizer raw materials, while the volume allocation of fertilizers tended to be stable. However, in 2018 to 2019, the volume of subsidized fertilizer actually decreased and this declining trend in fact continued in 2019 and 2020 (Figure 2). Based on the Financial Note and the 2020 RAPBN, the 2020 fertilizer subsidy is allocated at IDR 26,627.38 billion for the provision of 7.95 million tons of subsidized fertilizer. With this allocation, the volume of subsidized fertilizer decreased from 8.88 million tons (2019) to 7.95 million tons (2020) or went down by 0.93 million tons. In its

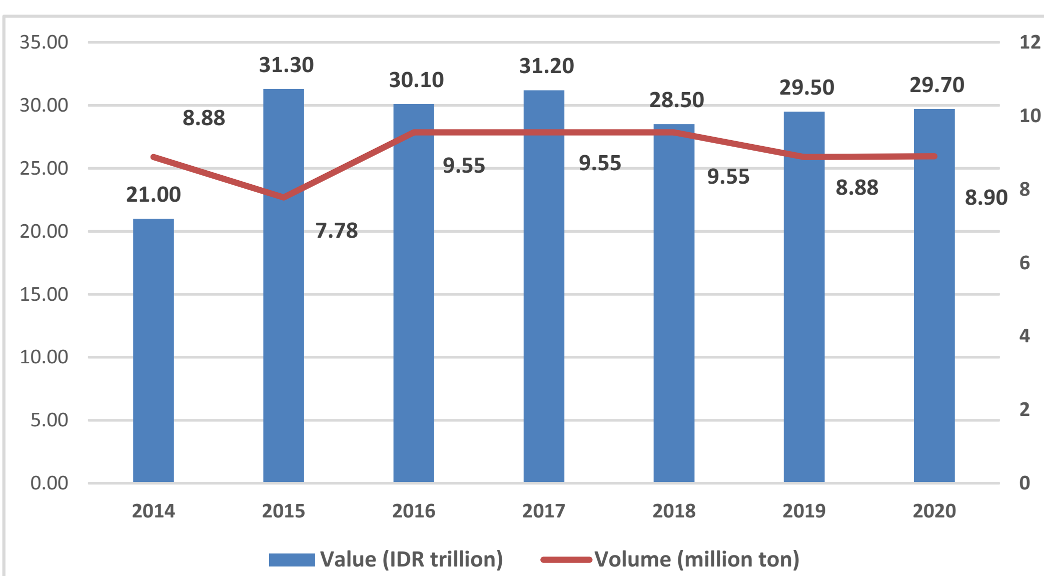

Figure 2: Development of fertilizer subsidies during 2014–2020 (Source: Ministry of Finance, various years of APBN processed).

further development in 2020 along with the additional need for fertilizer, there would be an additional allocation of fertilizer due to the increase in the total area of national rice fields (according to the Decree of the Minister of ATR/BPN No: 686/SK-PG.03/XII/2019 dated December 17, 2019), namely, to 7,463,948 Ha. Therefore, the total volume of subsidized fertilizer in 2020 would be 8.9 million tons with the subsidy budget also experiencing an increase to IDR 29.70 trillion.

4.2 Development of subsidized fertilizer HRP

If we look at the dynamics of the HRP for subsidized fertilizers for the agricultural sector (published annually) there has been no changes, while the government purchase price (GPP) for rice has been adjusted several times. With these developments, the ratio of the price of fertilizer to the price of grain is getting smaller or in other words the real price of fertilizer is getting cheaper. During the introduction of the Bimas/Inmas program, the term "Farmers Formula" was coined as one of the guidelines for the efficient use of production facilities, including fertilizers, namely, the value of 1 kg of Urea fertilizer used is equivalent to 1 kg of rice. With the ratio of the price of fertilizer to the price of grain getting smaller, or the real price of fertilizer getting cheaper, it can encourage inefficiency in the use of inputs.

In addition, the wide difference between subsidized fertilizer prices and non-subsidized fertilizer prices has led to moral hazard actions by unscrupulous market players in the form of fertilizer smuggling, copying subsidized fertilizers, or other fraudulent actions. An alternative policy is to possibly narrow the gap between the subsidized fertilizer prices and non-subsidized prices through an increase in HRP. Furthermore, the increase in the HRP for subsidized fertilizers has been set to start in 2021, with the issuance of Minister of Agriculture Num. 49 of 2020 as of December 30, 2020, concerning the Allocation and HRP of Subsidized Fertilizers for the Agricultural Sector in 2021. In addition, some monitoring efforts in the field must be made consistently as well as some improvements in both the distribution system and distribution of subsidized fertilizers to the farmer level. These efforts have now been executed by the government, and the trend continues to show some improvement and effectiveness.

Furthermore, the Regulation of the Minister of Agriculture 49 of 2020, Article 12 paragraph (2) states, among other things, that the HRP for subsidized Urea fertilizer is IDR . 2,250/kg. An increase of IDR. 450/kg was there from the previously set price, based on Minister of Agriculture Regulation Number 69/2012, which was IDR. 1,800/kg. Thus, it was from the price per bag (fill of 50 kg) of IDR. 90,000–IDR. 112,500 or an increase of IDR. 22,500 per bag. Similarly, there is also an increase for SP-36 fertilizer from IDR. 2,000/kg to IDR. 2,400/kg and ZA fertilizer from IDR. 1,400/kg to IDR. 1,700/kg. Meanwhile, for NPK fertilizer, there is no increase, which is still IDR. 2,300/kg. The special formula NPK increased by IDR. 300/kg, from IDR. 3,000/kg to IDR. 3,300/kg. Granular organic fertilizer went up from IDR. 500/kg to IDR. 800/kg.

Meanwhile, the price of output (grain) increased first, with the release of the HRP amount stipulated in the Minister of Trade Regulation No. 24/2020, namely, for harvested dry un-hulled rice at the farm level is IDR. 4,200/kg and at the milling level is IDR. 4,250/kg. Dry milled un-hulled rice at the milling level is IDR. 5,250/kg and at Indonesian Logistics Agency's warehouse is IDR. 5,300/kg, and rice in the Indonesian Logistics Agency warehouse is IDR. 8,300/kg. The policy of increasing output prices is also deemed important, as stated by Asekunowo [17], because the output price policy is carried out to offset the incomplete implementation of fertilizer subsidy policy reforms related to availability and price. Likewise, a research conducted by Ramli et al. [18] revealed that rice production in Malaysia cannot survive without fertilizer subsidies and farmers themselves are unwilling to buy for their own.

The price of harvested dry rice increased by 7.42% per year, from Rp. 1,230/kg in 2003 to Rp. 3,300/kg in 2012, and increased to Rp. 4,200/kg in 2021. Increase in the price of harvested dry rice tends to occur between 2 and 5 years, while the HRP for subsidized fertilizers has not increased from 2012 to 2020. Since 2021, the HRP for subsidized fertilizers has increased as presented in Table 1.

Correspondingly, along with the increase in fertilizer HRP, there is a decrease in the amount of fertilizer subsidies. This will then significantly have an impact on the performance of food crop production, especially rice. By knowing these conditions, it is necessary to assess what kind of strategy to take in anticipating its negative impacts.

4.3 Farming analysis and various factors that affect rice farming productivity

Based on the results of the financial analysis of lowland rice farming in several production centers in Indonesia, it

Table 1: Development of HRP for subsidized fertilizer and GPP for un-hulled rice in Indonesia, 2003–2021

Year	Urea	ZA	Fertilizer price (IDR/kg) SP-36	NPK	Organic	GPP of harvested dry rice (IDR**/kg)
2003	1,150	950	1,400	1,750	—	1,230
2005	1,150	950	1,400	1,750	—	1,330
2010	1,600	1,400	2,000	1,586	700	2,640
2011	1,600	1,400	2,000	2,300	700	2,640
2012	1,800	1,400	2,000	2,300	500	3,300
2013	1,800	1,400	2,000	2,300	500	3,300
2014	1,800	1,400	2,000	2,300	500	3,300
2015	1,800	1,400	2,000	2,300	500	3,700
2016	1,800	1,400	2,000	2,300	500	3,700
2017	1,800	1,400	2,000	2,300	500	3,700
2018	1,800	1,400	2,000	2,300	500	3,700
2019	1,800	1,400	2,000	2,300	500	3,700
2020	1,800	1,400	2,000	2,300	500	3,750
2021*)	2,250	1,700	2,400	2,300	800	4,200
r (%/thn)	4.18	3.63	3.32	2.03	2.42	7.42

Source: Ministry of Agriculture (2015–2021); ICBS [16].
Note: *New HRP, set as of December 30, 2020; **IDR = Indonesian rupiah.

Table 2: Analysis of average rice paddy farming in several production centers in Indonesia, 2020

Num	Description	Vol. (kg/ha)	Price (IDR/kg)	Value (IDR)	Share (%)
A	**Cost**				
	Seed	44	8,618	376,158	2.30
	Urea	266	1,960	521,566	3.18
	ZA	71	1,763	124,816	0.76
	SP-36	137	2,359	322,350	1.97
	KCl	6	5,191	32,810	0.20
	NPK	209	2,542	530,877	3.24
	Other fertilizers			147,483	0.90
	Pesticide			1,217,415	7.43
	Labor outside family			2,189,134	13.36
	Service worker			4,888,788	29.84
	Irrigation			136,992	0.84
	Rent			5,689,610	34.72
	Pump			208,074	1.27
	Total Cost			16,386,073	100.00
B	**Revenue**				
	a. Productivity	6,208	xxx	Xxx	
	b. Price	xxx	4,876	Xxx	
	c. Value	xxx	xxx	30,271,662	
C	**Profit**			13,885,589	
D	***R/C* (Revenue per Cost ratio)**			1.85	

Source: Indonesian Center for Socio-Economic and Agricultural Policy (2020) processed.

was found that the income level of farming is IDR. 30.27 million/ha and the cost of farming is IDR. 16.39 million/ha. By subtracting the income from the cost of farming, the value of the profit achieved is IDR. 13.89 million/ha and the *R/C* value is 1.85 (Table 2). Thus, lowland rice farming is financially quite profitable. In line with that, based on BKF farming cost structure data [19], lowland rice farming in Indonesia provides a farming profit rate of IDR 4.96 million/ha, and *R/C* = 1.37.

When viewed from the side of the average productivity of farming, it was obtained that there is an average of 6.21 t/ha MDR, and the average selling price of grain at the farm level is IDR. 6,208/kg. Comparing to the average national productivity of lowland rice is just around 5.40 t/ha, according to BKF data [20], this means that the average productivity of lowland rice, as shown in the results of studies in several rice production centers, is far above the national average productivity.

Furthermore, as for the cost structure of lowland rice farming, it was found out that farming costs include: (1) labor costs, both for non-family workers and services (including machinery and equipment), of IDR 7.08 million/ha or about 43.19%; (2) other costs (irrigation, rent, and pump) of IDR 6.03 million/ha or around 36.83%; (3) fertilizer costs of IDR. 1.68 million/ha or about 10.25%; (4) the cost of pesticides of IDR. 1.22 million/ha or about 7.43%; and (5) the cost of seeds of IDR. 376.16 thousand or about 2.30%.

Regarding the allocation of fertilizer costs, it was identified that the main types of fertilizers purchased in farming are Urea, ZA, SP-36, KCl, and NPK, besides other fertilizers. The volumes used are: 266, 71, 137, 6, and 209 kg/ha respectively. Meanwhile, the types of subsidized fertilizers used are Urea, ZA, SP-36, and NPK fertilizers. According to PT Petrokimia Gresik, farmers are encouraged to follow the dosage or recommendation for balanced fertilization of 5:3:2 (N:P:K). For 1 Ha of rice fields, at least 500 kg of organic Petroganik fertilizer, 300 kg of Phonska NPK fertilizer, and 200 kg of Urea fertilizer are needed. Balanced fertilization is a solution to the excessive use of fertilizers by farmers. So this ensures that the limited allocation of subsidized fertilizers can be more effective and efficient as reported by Ministry of Finance [21]. Based on the Ministry of Finance No. 40 of 2007 (Ministry of Finance

[22]), with a benchmark productivity of around 6.2 t/ha (according to Table 2), 300–400 kg/ha of Urea is needed. For P fertilizer in lowland rice, in areas where the nutrient content of P is low, medium, and high, the required P dose is 100, 75, and 50 kg/ha, respectively. Meanwhile, for K fertilizer in lowland rice, where the nutrient content of K is low, medium, and high, the dose of K required is 100, 50, and 50 kg/ha, respectively.

According to the research by Jaja and Barber [23], the food production system in Nigeria must operate in order to be socially acceptable, environmentally sustainable, and economically profitable. This success is influenced by the use of balanced fertilizers between organic and inorganic fertilizers. The same thing was also stated by Kuntyastuti et al. [24] that the application of balanced fertilizers can ensure the quality and productivity of soil and plant cultivation in sustainable agriculture. Likewise, Arora [25] and Gebska et al. [26] underlined that the use of inorganic fertilizers is not excessive and attention should be paid to aspects of sustainable agricultural practices. On another aspect it was also pointed out by Fahmid et al. [27] that in order to increase product competitiveness through increasing crop productivity, the presence of inputs, especially in terms of price, must also receive attention. Affordable input prices for farmers can encourage increased farming incentives.

4.4 Analysis of the effect of changes in fertilizer HRP on rice farming production

The analysis of the impact of increasing fertilizer HRP was conducted to determine the extent of the effect of increasing fertilizer HRP on these three areas, namely, the fertilizer use for rice farming, the national rice production and productivity, and the rice farming income. The analysis was conducted by increasing the HRP by IDR. 300/kg for Urea, ZA, SP-36, and NPK fertilizers.

The baseline data used in the analysis are the cost structure of rice farming in 14 districts of rice production centers spreading across these 5 provinces, West Java, Central Java, East Java, North Sumatra, and South Sulawesi. The data are from the National Farmers Panel (PATANAS) [28]. The data on the HRP of the subsidized fertilizers are the latest HRP policy issued by the government, namely: (1) Urea price is IDR. 1,800/kg; (2) ZA price is IDR. 1,400/kg; (3) SP-36 price is IDR 2,000/kg; and (4) the price of NPK is IDR. 2,300/kg. Meanwhile, the data on production, productivity, and harvested area are from those of the 2019 data released by World Bank [29] and Fiskal [30] namely: (1) national rice harvested area is 10.68 million ha; (2) national rice productivity is 5.1 t/ha; and (3) national rice production is 54.6 million tons of milled dry grain.

The procedure for analyzing the impact of increasing the HRP of the subsidized fertilizers on the level of fertilizer use is carried out in three stages. First, the elasticity of the price of fertilizer on the use of fertilizer is calculated. Next the percentage increase in the HRP of the subsidized fertilizers is calculated, and finally, calculating the level of fertilizer used after the increase in the HRP of the subsidized fertilizers by multiplying the elasticity value with the percentage increase in the HRP of the subsidized fertilizers.

Based on the analysis on the use of fertilizers for rice farming, it is known that (Table 3): (1) there was a decrease in the use of Urea fertilizer by 2.9%; (2) there was a decrease in the use of ZA fertilizer by 13.94%; (3) the use of SP-36 fertilizer decreased by 8.89%; and (4) there was a decrease in the use of NPK fertilizer by 13.95%. Urea fertilizer has the lowest elasticity compared to other types of fertilizer, which is −0.1739. This means that an increase in the price of urea fertilizer by 10% only reduces the level of use of urea fertilizer by 1.74%. Urea fertilizer is considered as one type of fertilizer that is always needed in rice farming. Thus, the impact of increasing the HRP of the subsidized fertilizers on decreasing amount of the use of urea fertilizer is the lowest compared to other types of fertilizers. This is in line with the study results of the Ranathilaka [31], which states that there is a significant relationship between rice production and fertilizer subsidies, agricultural infrastructure, and the level of education of farmers in the Sri Lanka study site.

Table 3: Analysis of the impact of increasing the HRP of subsidized fertilizer by IDR. 300/kg on the level of fertilizer use in rice farming in Indonesia, 2020

Num	Type of fertilizer	Price elasticity of fertilizer	HRP (IDR/kg)	Δ HRP IDR 300/kg (%)	Impact on fertilizer use (%)
1	Urea	−0.1739	1,800	16.67	−2.90
2	ZA	−0.6506	1,400	21.43	−13.94
3	SP-36	−0.5927	2,000	15.00	−8.89
4	NPK	−1.0698	2,300	13.04	−13.95

The biggest impact by decreasing the amount of subsidized fertilizer used is on NPK and ZA fertilizers. Although the percentage reduction in fertilizer use is almost the same (13.95 and 13.94%), both have different sources of decline. In NPK fertilizer, the decrease in fertilizer use was due to the elasticity level, which was −1.0698. This means that an increase in the price of NPK fertilizer by 10% will reduce the level of use of NPK fertilizer by 10.70%. NPK fertilizer is considered to be possibly substituted by other fertilizers. Meanwhile, for ZA fertilizer, the decrease in the amount level of its use was mainly due to the percentage increase in the HRP of ZA fertilizer. The increase in HRP for ZA fertilizer was the highest, with 21.43% increase from its original price of IDR. 1,400/kg to IDR. 1,700/kg.

The procedure for analyzing the impact of increasing the HRP of the subsidized fertilizers on the productivity, production, and national rice harvested area was carried out in four stages. First, a regression of rice productivity is carried out which is a function of the use of seeds per hectare, urea per hectare, ZA per hectare, SP-36 per hectare, NPK per hectare, KCl per hectare, and the use of labor per hectare. Then, the rate of decline in productivity is calculated as a result of the increase in the price of urea, ZA, SP-36, and NPK. After that, the decline in the national productivity level is calculated by multiplying the rate of decline in productivity resulting from the increase in the price of urea, ZA, SP-36, and NPK with the national rice productivity level in 2019. Lastly, based on the rate of decline in national rice productivity, the rate of decline in production and harvested area can then be calculated.

Based on the results of the analysis carried out on the level of productivity and the national rice production, it is known that (Table 4): (1) the national rice productivity is estimated to decrease by 0.09 t/ha from the original 5.11 to 5.02 t/ha; (2) national rice production is also estimated to decrease by 0.94 million tons of MDR from 54.60 million tons of MDR to 53.66 million tons of MDR; and (3) the national rice harvested area is also estimated to decrease by 186,219 ha from the original 10.68 million hectares to 10.49 million hectares. Even if there is a program to increase food production to be implemented on 60,000 ha of rice fields, it still cannot replace the decrease in national harvested area as a result of increasing the HET for the subsidized fertilizers which is similar to the results of the research by Abdullah et al. [32] and Hermawan [33].

5 Conclusion and recommendation

In Indonesia, the government has implemented the fertilizer subsidy policy since the early 1970s. Fertilizer subsidies are provided through a fertilizer selling price mechanism with the HRP set by the government. This HRP for fertilizer is the price of the subsidized fertilizer purchased by farmers or farmer groups at the line distributor or fertilizer kiosks organized by Planning Bureau of the Ministry of Agriculture [34].

The HRP of the subsidized fertilizers since 2012 had not increased, although the grain purchase prices at the farmer level had increased several times until 2020. This causes a decrease in the ratio of fertilizer prices to output prices, which can possibly lead to inefficiency in the use of the subsidized fertilizers. Until finally in December 2020, there was a central decision made on a new

Table 4: The results of the analysis of the impact of increasing the HRP of subsidized fertilizers by IDR. 300/kg on productivity, production, and harvested area of rice in Indonesia, 2020

Type of fertilizer	Impact of increasing HRP on fertilizer use (%)	Elasticity of productivity	Productivity baseline of PATANAS (t/ha)	Decrease in productivity (%)
(A)	(B)	(C)	(D)	(E) = B * C * D
Urea	−2.8979	−0.0038	6.21	0.0682
ZA	−13.9411	0.0039	6.21	−0.3394
SP-36	−8.8902	0.0102	6.21	−0.5615
NPK	−13.9544	0.0102	6.21	−0.8811
Total decline in productivity (E)				−1.7137
Decrease in national productivity (t/Ha) {(F) = E × 5.1 t/ha}				−0.0876
National productivity after increasing HRP (t/Ha) {(G) = 5.11 − F}				5.0247
National production (MDR) (1,000 tons) {(H) = G × 10.68 million Ha}				53.664
Decrease in national production (MDR) (1,000 Tons) {(I) = 54.6 million ton − H}				936
Equivalent reduction in national harvested area (Ha) {(J) = I/G}				186.219

fertilizer HRP policy and then made effective as of January 1, 2021. In the future, effort to gradually increase the HRP of subsidized fertilizers is one of the steps in increasing the efficiency of using the subsidized fertilizers.

The results of the financial analysis of lowland rice farming in several production centers in Indonesia reveal the value of farming profits of IDR. 13.89 million/ha and the *R/C* value of 1.85. Thus, lowland rice farming is financially quite profitable. In the cost structure of lowland rice farming, it is known that farming cost for fertilizer is around 10.25%. Types of fertilizer purchased at the farm include Urea, ZA, SP-36, KCl, NPK, and other fertilizers.

The HRP increase in the subsidized fertilizers, Urea, ZA, SP-36, and NPK fertilizers, by IDR. 300/kg can have an impact on a decrease in the level of their respective use by 2.9, 13.94, 8.89, and 13.95%, respectively. Consequently, it is estimated that this can cause a decrease in the national rice productivity by 0.09 t/ha, a decrease in the national rice production by 0.94 million tons MDR, and a decrease in the national rice harvest area equivalent to 186,219 ha, similar to that reported by Lipsey [35] and David [36].

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