Does Government Assistance Increase the Yield of Food Crops in Indonesia?

Octavia Rizky Prasetyo[a,*], & Kadir[a]

[a]*BPS-Statistics Indonesia*

Abstract

Government assistance has been deployed to help food crop farmers enhance their yields. However, to our knowledge, studies assessing the impact of government assistance on food crop yield using a dedicated nationwide survey in the context of Indonesia are not available yet. Thus, our study aims to contribute to the literature by assessing the impact of government assistance (fertilizers, seeds, and agricultural tools and machinery) on food crops yield using the results of the 2018 and 2021 Crop Cutting Survey conducted by BPS. By applying multinomial logistic regression, we found that the fertilizers and seeds assistance significantly lower the chance of food crop farmers experiencing lower yield, provided that the distribution is on-time and suitable with the need of farmers. In contrast, our findings indicate that the benefit of tools and machinery assistance in enhancing food crop yield has not been optimized. The study recommends a more targeted distribution of tools and machinery assistance by taking into account farmers' needs, cultivation characteristics, and support for the maintenance and management.

Keywords: food crops; government assistance; seed; fertilizer; agricultural machinery
JEL Classification: Q1; H2; D6

*Corresponding Address: Jl. Dr. Sutomo 6–8 Jakarta 10710 Indonesia. Email: octavia.rizky@bps.go.id.

1. Introduction

The agricultural sector still plays a critical role in Indonesia's development agenda. The sector contributes to around 12 percent of the economy (BPS, 2023a) and becomes the source of livelihood for around 42 percent of the population (BPS, 2023b). In Indonesia, food crops, including paddy and secondary crops, play a significant role in promoting national food security, considering their role in fulfilling people's dietary needs and livelihood. Those roles would continue to grow with an increased demand for food driven by population growth, and thus promoting the production of food crops is essential to ensure national food security in the future. Technically, extending the area under cultivation and enhancing the yield are two prominent ways that could be used to boost crop production (Nkamleu, 2011). However, in a period of more limited land resources, enhancing the yield (output per unit area) can be a more promising strategy to escalate food crop production.

The use of adequate input, such as fertilizers and improved seeds, is essential to promote crop yield and production (Spielman et al., 2011; Adiraputra & Supyandi, 2021; Sigaye et al., 2020; Liu et al., 2021). Input like fertilizers can affect the change in soil nutrients and crop growth (Chen et al., 2017; Choudhary et al., 2021). Apart from production inputs, mechanization adoption has also taken place as a profound transformation in farming methods. As defined by Food and Agriculture Organization (FAO), agricultural mechanization implies the application of agricultural tools, implements, and machinery to generate agricultural production (Kormawa et al., 2018). Their utilization can be in the pre-harvest, harvest, and post-harvest stages (Kadir & Prasetyo, 2020). The adoption could benefit farmers in many ways, such as generating higher crop yields (Kadir & Prasetyo, 2020; Zhou & Ma, 2022), escalating cropping intensity, and increasing profitability due to better work quality and input efficiency (Verma, 2006).

However, most farmers in Indonesia (58.07 percent) work on land less than 0.5 hectares (BPS, 2019), and often spend a large part of their income on buying food (Rapsomanikis, 2015). In other words, they usually lack the financial resources to buy production input, such as feeds and fertilizers, and to invest in agricultural tools and machinery. In response to the situation, the Indonesian government, through the Ministry of Agriculture, has imposed policies that may support crop yield enhancement through assistance provision program for farmers, either in the form of direct provision of actual goods (such as fertilizers, seeds, and machinery assistance) or price subsidy. Theoretically, the policy instrument in the form of government assistance could increase agricultural production (UNCTAD India Team, 2017; Hemming et al., 2018). The government assistance in the form of input subsidies, for instance, may lead to the incremental use of subsidies inputs and eventually increase the productivity and production (Hemming et al., 2018). However, despite the increase in the use of inputs, it is possible that the intervention still fails to achieve its objectives of increased yield. As Alta (2022) pointed out, fertilizer subsidies could not guarantee to stimulate an increase in

staple food commodities production, even though it absorbed a large part of non-energy subsidy funds.

Some studies in different countries have examined the impact of government assistance or incentives on crop yield and productivity (Fuglie & Rada, 2013; Salunkhe & Deshmush, 2014; Hemming et al., 2018; Azumah & Zakaria, 2019; Nasrin et al., 2018; Yang et al., 2023). Most find a considerable role of government assistance to escalate crop yield or production. In the context of Indonesia, studies assessing the impact of government assistance on crop yield have also been conducted (Saputra et al., 2018; Shaleh et al., 2019; Hantoro, 2020; Wirakusuma, 2020; Gunawan et al., 2022; Adiraputra & Supyandi, 2021). However, they reported different conclusions. Some pointed out government assistance programs as an effective instrument to increase crop yield, while others pointed out that the programs have not been fully effective in increasing yield or production. These dilemmatic results leave the debate among researchers and policymakers on whether providing fertilizers, seeds, and agricultural tools and machinery assistance is an effective way to enhance food crop yield and under which conditions it may work.

Furthermore, most studies in the context of Indonesia focus on regional-specific analysis selected purposively, in which the finding cannot be generalized in a broader context of Indonesia. A most recent study by Wirakusuma (2020) has attempted to utilize the microdata from the 2014 Agricultural Census to assess the impact of input subsidies on rice yield. However, he limits the area coverage in the East Java Province. To our knowledge, well-documented studies focusing on assessing the impact of government assistance on the food crop yield using a dedicated nationwide survey in Indonesia are still very limited. Thus, our study aims to fill the gap by assessing the impact of government assistance on food crop yield based on farmers' experience using a nationwide survey called Crop-Cutting Survey (Survei Ubinan). We contribute to the literature by utilizing the most recent result of the survey in 2021 and provide additional comparisons based on the 2018 survey results. We cover three types of assistance: fertilizers, seeds, and agricultural tools and machinery. Crop-cutting survey allows us to assess the impact of those assistances on food crop yield based on farmers' declaration, and under which condition the assistances may work.

The rest of the paper is organized as follows. Section 2 deals with the methodology and the data used, while Section 3 discusses the empirical results and the analysis. Section 4 provides conclusion and recommendations.

2. Methodology

Our study made use of the results of the Crop-cutting Survey conducted by Statistics Indonesia (BPS) on a regular basis throughout the year. The data used in this study was the survey results of the 2018 and 2021 rounds. We use two rounds of data from the Crop-Cutting Survey results to see whether there is an improvement in government assistance during the period and whether the

impact of government assistance changes in different periods. The number of observations was 111,345 households for the year 2018 and 100,802 for the year 2021. The survey is carried out in the 34 provinces and provided information on the food crop yield and their development compared to the previous year as well as characteristics of food crop cultivation, such as the irrigation type, cultivation system, fertilizer use, impact of climate change, water sufficiency, past attack intensity, farmers group membership, harvest period, and government assistances (fertilizer, seed, and machinery and equipment). The food crops in our study cover all major crops in Indonesia, which are paddy and secondary food crops (maize, soybean, peanuts, sweet potato, cassava). For simplification, we categorized all food crops into three categories, namely paddy, maize, and beans and tubers.

The yield change from the previous year is a categorical variable obtained based on farmers' declaration during the interview. It consists of three categories: increase, no change, and decrease. All other variables are categorical variables with detailed explanations in Table 1. To analyse the influence and effectiveness of government assistance (including price subsidy) of seeds, fertilizers, and tools and machinery in increasing the yield of the food drops, we implement a multinomial logistic regression (MLR). An MLR was used since our independent variable is a categorical variable with three categories of yield change from the previous year: increase, no change, and decrease. The model specification used for analysis is represented as follows:

$$Y_{ij} = \alpha_j + X_{ij}^{'}\beta_j + \varepsilon_{ij} \tag{1}$$

In Equation (1), Y_{ij} is the yield change from the previous year of the $i-th$ household in the $j-th$ category; $X_{ij}^{'}$ is a vector of characteristics of the $i-th$ household in the $j-th$ category, which consists of government assistance variables and other cultivation characteristics independent variables described in Table 1; β_j a vector of regression coefficients for each household variables in the $j-th$ category; and ε_{ij} is error component. The MLR then may be represented as:

$$logit(Y_j) = \ln\left[\frac{P(Y=j|X)}{P(Y=J|X)}\right] = \alpha_j + X_{ij}^{'}\beta_j \tag{2}$$

where $J = 3$ and $j = 1, 2$. In such a way, there are two logit equations. Each of the logit equations is a linear function that models the logarithm of the odd as having response j to baseline category J (Agresti, 2002). In Equation (2), all logits are defined relative to a predetermined base category, which is "higher". The estimation of the regression coefficient (β_j) provides information on how much the change in logit occurred due to one unit increase of the value of particular household characteristics holding other variables remaining constant. For the convenience of the analysis, we also estimate the relative risk ratio (RRR), which is the exponential function of a regression coefficient, for each characteristic. The

mathematical representation for RRR can be written as follows.

$$\frac{P(Y = j|X)}{P(Y = J|X)} = \exp(\alpha_j + X'_{ij}\beta_j) \tag{3}$$

The interpretation of RRR is quite simple, where RRR greater than 1 means that the probability of the $j - th$ category to occur is larger than the probability of obtaining the baseline category J. Given the sum of all probabilities $P(Y = j|X)$ for $j = 1, 2, 3$ equals to 1, the following expressions can be established.

$$P(Y = j|X) = \frac{\exp(\alpha_j + X'_{ij}\beta_j)}{1 + \sum_{j=1}^{J-1} \exp(\alpha_j + X'_{ij}\beta_j)} \tag{4}$$

$$P(Y = J|X) = \frac{1}{1 + \sum_{j=1}^{J-1} \exp(\alpha_j + X'_{ij}\beta_j)} \tag{5}$$

We estimate the MLR separately for the year 2018 and 2021 to see the change in the influence of government assistance factors on the yield change from the previous year during 2018 to 2021. The descriptions of variables used in the model specification are presented in Table 1.

3. Result and Analysis

3.1. Government Assistance and Cultivation Characteristics

The results of the crop-cutting survey indicate that among the three types of government assistance included in the analysis, assistance in the form of fertilizer continues to be the focus of the government as an incentive for food crop farmers. The proportion of food crop farmers who received fertilizer assistance in 2018 and 2021 is remarkably high, reaching around 55 percent and 61 percent, respectively. Most farmers declared that the fertilizer assistance received was on time. Instead, in 2021, the proportion of food crop farmers who received seed assistance from the government was only around 12 percent, slightly lower than in 2018, with about 14 percent of the total food crop farmers. Even though relatively lower, those who received seed assistance mostly also stated that it was on time and meet their needs, indicating a well-managed distribution of fertilizer and seed assistance from the government.

On the other hand, in 2021, around 31 percent of food crop farmers declared that they received agricultural tools and machinery assistance from the government through their membership in the farmer group, while it was around 32 percent in 2018. Interestingly, around 2–3 percent of food crop farmers stated that they did not utilize those assistances for their crops (or around 8–10 percent of the total recipients). It may be due to some reasons, such as lack of accordance between the type of tools and machinery with the agroecosystem condition, the

Table 1: Variable Description

Dependent variable:	yield change from the previous year. The variable is a categorical variable consisting of higher (base outcome), lower, no change
Independent variable:	
Seed assistance	Seed government assistance was categorized into four categories based on the timing: not receiving (reference category), receiving but not on-time, receiving on-time but not suitable with the need, receiving on-time and suitable with the need
Fertilizer assistance	Fertilizer government assistance was categorized into three categories: not receiving (reference category), receiving but not on-time, receiving and on-time
Tools and machinery equipment assistance	Agricultural tools and machinery government assistance was categorized into three categories based on the utilization: not receiving (reference category), receiving but not utilized, receiving and utilized
Fertilizer use	Fertilizer use was categorized into four categories based on the type of fertilizer: not using (reference category), using organic only, using non-organic only, and using a combination of organic and non-organic.
Farmer group membership	Farmer group membership was categorized into two categories: not a member (reference category) and a member. Farmer group refers to a group of farmers (20–30 farmers or adapted to the environmental conditions of society and the holding) formed by farmers based on common interest; similar social, economic, and resource environmental conditions; similar commodities; and familiarity to improve and develop members' holdings.
Land type	Land type used for cultivation was categorized into three categories based on the irrigation: dryland (reference category), wetland without irrigation, wetland with irrigation system.
Cultivation system	Cultivation system applied was categorized into two categories: mixed-crops/intercropping (reference category) and monoculture.
Crops type	Type of crops cultivated was categorized into three categories: beans and tubers (reference category), maize, and paddy.
Climate change impact	Climate change impact in the form of drought or flood based on farmers report was categorized into two categories: not-impacted (reference category) and impacted.
Pests attack intensity	Pest attack intensity compared to the previous year on the crops cultivated based on farmers report was categorized into three categories: lower intensity (reference category), not change, higher intensity
Water sufficiency	Water sufficiency for cultivated crops compared to the previous year was categorized into three categories based on farmers report: sufficient (reference category) and not sufficient.
Harvest period	Period of three months length (sub-round) when harvest conducted was categorized into three categories: September–December (Sub-round III) (reference category), March–August (Sub-round II), January-April (Sub-round I).

limited capacity of human resources in operating those assistances, or the unavailability of the workshop and spare parts needed around the area (Hermanto et al., 2018).

Regarding fertilizer use, most food crop farmers used non-organic fertilizers only, either in 2018 or 2021. Less than 25 percent of food crop farmers applied a combination of organic and non-organic fertilizers for their crops. Nevertheless, most of them had membership in the farmer group. Membership in farmer group

might allow them to have easier access to production input, more information, and agricultural extension services (Ingutia & Sumelius, 2022). In terms of the type of land, most food crop farmers cultivated their crops on the wetland and applied a monoculture cultivation system. However, more food crops farmers applied mixed-crop/intercropping cultivation systems in 2021 compared to 2018. Further, as expected, most farmers in Indonesia cultivated paddy. Paddy farmers made up around 61 percent and 54 percent of the total food crop farmers in 2018 and 2021, respectively.

Food crops farmers may still need more strategies to mitigate the impact of climate change. Indeed, in 2021, around 15 percent of them experienced climate change impacts, such as drought or flood, on their crops, even though it slightly decreased compared to the figure in 2018. Align with climate change impact, the proportion of food crop farmers experiencing water insufficiency in 2021 decreased compared to 2018. Around 9 percent of food crop farmers declared an experience of water shortage for their crops, while it reached around 19 percent in 2018. In contrast, the proportion of farmers experiencing higher intensity of pest attacks in 2021 is around 16 percent, which is higher than the 2018 figure.

3.2. Government Assistance Impact on Yield

Table 3 and 4 summarizes the estimation results of the MLR model. As we mentioned previously, we estimate the MLR separately for the years 2018 and 2021 to see the change in the effect of government assistance on yield change. As expected, seed assistance from the government significantly affects yield change in both years consecutively. This finding aligns with Hutagaol & Hartoyo (2013), Prayoga & Sutoyo (2017), Hemming et al. (2018), and Saputra et al. (2018) findings. However, our results indicate it only works if the seed assistance is on time and suitable with the need of farmers. Holding other variables constant, the estimation results suggest that when farmers receive government seed assistance on time and as needed, the expected chance of having a lower yield will decrease by a factor of around 0.17 than having a higher yield compared to the previous year in 2018 and 2021. Similarly, the chance of maintaining yield (no change) will decrease relatively to a higher yield if the seed assistance received is on time and suitable for farmers' needs in 2018 or 2021.

As anticipated, even though it is on time, the seed assistance may not benefit yield if it is unsuitable with farmers' needs. The estimate for 2018 data shows that the chance of farmers having lower yields relative to higher yields significantly increases if the seed assistance received does not meet the need of farmers. Further, the 2021 estimation results show that if the seed assistance received is not on time, it will not significantly affect a higher yield. It may happen since a delay in the seed distribution could affect the cultivation timeliness and crop growth, which highly depends on rainfall. Our finding aligns with Shaleh et al. (2019) and Gunawan et al. (2022), that pointed out the lack of government seed assistance effectiveness in increasing crop yield if the distribution does not

Table 2: Summary of the Variables

Variable	2018	2021
Categorical variable (percent)		
Seed assistance		
Not receiving	86.35	87.80
Receiving but not on-time	1.62	1.47
Receiving on-time but not suitable with the need	1.63	1.92
Receiving on-time and suitable with the need	10.40	8.81
Fertilizer assistance		
Not receiving	44.57	39.16
Receiving but not on-time	4.82	10.24
Receiving and on-time	50.61	50.60
Tools and machinery assistance		
Not receiving	67.55	69.25
Receiving but not utilized	2.59	3.07
Receiving and utilized	29.86	27.68
Fertilizer use		
Not using	12.17	12.40
Using organic only	2.60	2.66
Using non-organic only	61.69	64.89
Using a combination of organic and non-organic	23.55	20.04
Farmer group membership		
Not a member	34.95	35.61
A member	65.05	64.39
Type of land		
Dryland	30.79	40.85
Wetland without irrigation	25.54	23.17
Wetland with irrigation system	43.67	35.98
Cultivation system		
Mixed-crops/intercropping	10.25	16.94
Monoculture	89.75	83.06
Crops Type		
Beans and tubers	20.49	25.09
Maize	18.02	18.47
Paddy	61.49	56.44
Climate change impact		
Not impacted	81.47	85.05
Impacted	18.53	14.95
Pest attack intensity		
Lower intensity	19.44	16.66
No change	67.29	67.74
Higher intensity	13.27	15.60
Water sufficiency		
Sufficient	80.99	91.11
Not sufficient	19.01	8.89
Harvest period		
September–December (Sub-round III)	23.96	14.59
March–August (Sub-round II)	37.27	41.09
January–April (Sub-round I).	38.77	44.32

Note: The number of observations is 111,345 households for 2018 and 100,802 food crops farmers for 2021.

take into account the timeliness and suitability of seed varieties with farmers' preferences. In terms of RRR, for receiving government seed assistance on time and suitable with the need relative to not receiving any seed assistance from the government, food crop farmers are 0.84 (or 16 percent lower) more likely to experience a lower yield than the previous year as compared to experiencing a higher yield in both years, 2018 and 2021, given all other variables remain constant. In other words, the probability of food crop farmers experiencing a lower yield is lower than experiencing a higher yield.

Align with seed, government assistance in the form of fertilizer will only work if the fertilizer assistance is distributed on time. If it is not on time, the chance of farmers having lower and the same yields is more likely to increase relative to higher yields in 2018 and 2021. This finding is partially supported by Namonje-Kapembwa et al. (2015), who found that a late distribution of subsidized fertilizer led to a reduction in maize yield. It could be due to the importance of proper timing of fertilizer application in determining crop growth and yield (Scharf & Lory, 2006). On-time distribution assistance could ensure an adequate supply of fertilizer when the crop needs it to optimize yield.

In contrast, our results revealed that agricultural tools and machinery assistance were only significant in maintaining the yield in 2018, while in 2021, the odds coefficient for those utilizing machinery assistance turned out to be positive, with a higher probability of having a lower yield than having a higher yield. Our findings were partially supported by Yang et al. (2023) finding, who found no significant effect of agricultural machinery subsidies on grain yield. It may be explained since not all machinery assistance is dedicated to increasing crop yield, some for reducing harvest and post-harvest losses. It could also be due to the unsuitable machinery assistance with the need of farmers or agroecosystem conditions (Hermanto et al., 2018; Shaleh et al., 2019), the lack of technical training (Shaleh et al., 2019; Gunawan et al., 2022), or the weak workshop and spare parts support around the area (Hermanto et al., 2018). Besides, the machinery assistance utilized by farmers in 2021 includes those received a few years earlier, such as those distributed massively in the Jokowi-JK governmental period of 2014–2019 (Hermanto et al., 2018), while there is no guarantee that they are still well-maintained, which may result in diminishing effect of it in enhancing crop yield.

We also provide the estimation result of other cultivation characteristics impact on yield change in Table 3 and 4. In terms of fertilizer use, the coefficient of the combined use of organic and non-organic fertilizer has a negative sign on the odds of farmers having lower and no change in yield as compared to higher yield. The RRR result also shows that those who applied organic and non-organic fertilizers on their crops have a lower probability to obtain lower yield or unchanged yield than those not using any fertilizer, indicating that combined applications of organic and non-organic fertilizer could be the best option for food crop farmers to promote their yield. Our findings are consistent with Usman et al. (2015) and Sigaye et al. (2020) that pointed out the importance of integrated

Table 3: Estimation Results of Multinomial Logistic Regression, 2018

Independent variable (baseline: higher)		Regression coefficients		Relative risk ratio	
		Lower	No Change	Lower	No Change
Seed assistance	Receiving but not on-time	-0.0353	-0.0642	0.9653	0.9378
		(0.0738)	(0.0590)	(0.0712)	(0.0554)
	Receiving on-time but not suitable with the need	0.4001***	-0.2366***	1.4919***	0.7893***
		(0.0657)	(0.0612)	(0.0980)	(0.0483)
	Receiving on-time and suitable with the need	-0.1712***	-0.1616***	0.8427***	0.8508***
		(0.0315)	(0.0242)	(0.0266)	(0.0206)
Fertilizer assistance	Receiving but not on-time	0.1451***	0.0590	1.1561***	10.608
		(0.0458)	(0.0367)	(0.0529)	(0.0389)
	Receiving and on-time	-0.0699***	-0.0365**	0.9325***	0.9642**
		(0.0211)	(0.0165)	(0.0197)	(0.0159)
Tools and machinery assistance	Receiving but not utilized	0.1286**	-0.1768***	1.1373**	0.8380***
		(0.0571)	(0.0479)	(0.0650)	(0.0401)
	Receiving and utilized	-0.0366	-0.1251***	0.9640	0.8824***
		(0.0236)	(0.0184)	(0.0227)	(0.0163)
Fertilizer use	Using organic only	-0.1446**	-0.1556***	0.8654**	0.8559***
		(0.0704)	(0.0581)	(0.0609)	(0.0498)
	Using non-organic only	-0.2828***	-0.3370***	0.7537***	0.7139***
		(0.0370)	(0.0298)	(0.0279)	(0.0213)
	Using a combination of organic and non-organic	-0.4874***	-0.4237***	0.6142***	0.6546***
		(0.0396)	(0.0316)	(0.0243)	(0.0207)
Farmer group membership	A member	-0.2578***	-0.2833***	0.7727***	0.7533***
		(0.0238)	(0.0187)	(0.0184)	(0.0141)
Type of Land	Wetland without irrigation	-0.2011***	-0.1334***	0.8178***	0.8751***
		(0.0312)	(0.0249)	(0.0255)	(0.0218)
	Wetland with irrigation system	-0.1969***	-0.2074***	0.8212***	0.8127***
		(0.0306)	(0.0243)	(0.0252)	(0.0198)
Cultivation system	Monoculture	-0.1999***	0.0201	0.8188***	10.203
		(0.0347)	(0.0284)	(0.0284)	(0.0290)
Crops Type	Maize	0.1895***	0.3179***	1.2087***	1.3742***
		(0.03516)	(0.0281)	(0.0425)	(0.0386)
	Paddy	-0.1058***	-0.3748***	0.8996***	0.6874***
		(0.0293)	(0.0231)	(0.0264)	(0.0159)
Climate change impact	Impacted	0.8169***	0.0879***	2.2634***	1.0919***
		(0.0275)	(0.0248)	(0.0623)	(0.0271)
Pest attack intensity	No change	1.2121***	0.9639***	3.3605***	2.6219***
		(0.0268)	(0.0173)	(0.0900)	(0.0454)
	Higher intensity	3.0293***	1.0786***	20.6824***	2.9407***
		(0.0362)	(0.0315)	(0.7480)	(0.0927)
Water sufficiency	Not sufficient	1.3717***	0.2704***	3.9420***	1.3105***
		(0.0283)	(0.0258)	(0.1114)	(0.0338)
Harvest period	March–August (Sub-round II)	0.3146***	0.2045***	1.3696***	1.2269***
		(0.0252)	(0.0204)	(0.0345)	(0.0250)
	January–April (Sub-round I)	-0.1245***	-0.1069***	0.8830***	0.8986***
		(0.0267)	(0.0204)	(0.0236)	(0.0183)
Constant		-1.2240***	0.4667***	0.2941***	1.5947***
		(0.0540)	(0.0420)	(0.0159)	(0.0669)

Note: The number of observations is 111,345 food crops farmers; robust standard errors in the parentheses;
*** is significant at 1 percent of level of significance and ** is significant at 5 percent of level of significance.

Table 4: Estimation Results of Multinomial Logistic Regression, 2021

Independent variable (baseline: higher)		Regression coefficients		Relative risk ratio	
		Lower	No Change	Lower	No Change
Seed assistance	Receiving but not on-time	-0.0352	-0.1798***	0.9655	0.8355***
		(0.0842)	(0.0642)	(0.0813)	(0.0537)
	Receiving on-time but not suitable with the need	-0.0783	-0.1469***	0.9247	0.8634***
		(0.0718)	(0.0558)	(0.0664)	(0.0481)
	Receiving on-time and suitable with the need	-0.1729***	-0.1749***	0.8412***	0.8396***
		(0.0370)	(0.0272)	0.0311	(0.0229)
Fertilizer assistance	Receiving but not on-time	0.2234***	0.1403***	1.2504***	1.1506***
		(0.0372)	(0.0287)	(0.0465)	(0.0330)
	Receiving and on-time	-0.0617**	-0.0643***	0.9401**	0.9378***
		(0.0251)	(0.0188)	(0.0236)	(0.0177)
Tools and machinery assistance	Receiving but not utilized	0.2398***	0.0729	1.2710***	1.0756
		(0.0596)	(0.0456)	(0.0758)	(0.0491)
	Receiving and utilized	0.2050***	0.1920***	1.2276***	1.2117***
		(0.0266)	(0.0200)	(0.0326)	(0.0242)
Fertilizer use	Using organic only	0.1494**	-0.1492**	1.1611**	0.8614**
		(0.0713)	(0.0621)	(0.0828)	(0.0535)
	Using non-organic only	-0.2112***	-0.0916***	0.8096***	0.9125***
		(0.0408)	(0.0321)	(0.0330)	(0.0293)
	Using a combination of organic and non-organic	-0.2746***	-0.1288***	0.7598 ***	0.8792***
		(0.0445)	(0.0351)	(0.0338)	(0.0309)
Farmer group membership	A member	-0.2256***	-0.2682***	0.7981****	0.7648***
		(0.0260)	(0.0196)	(0.0208)	(0.0150)
Type of Land	Wetland without irrigation	-0.1639***	-0.7733***	0.8488***	0.4615***
		(0.0318)	(0.0268)	(0.0270)	(0.0124)
	Wetland with irrigation system	-0.0397	-0.7644***	0.9610	0.4656***
		(0.0324)	(0.0277)	(0.0312)	(0.0129)
Cultivation system	Monoculture	-0.4604***	-0.7571***	0.6310***	0.4690***
		(0.0349)	(0.0282)	(0.0220)	(0.0132)
Crops Type	Maize	0.1583***	0.4465***	1.1716***	1.5628***
		(0.0363)	(0.0300)	(0.0425)	(0.0468)
	Paddy	-0.4386***	0.3182***	0.6449***	1.3747***
		(0.0290)	(0.0252)	(0.0187)	(0.0347)
Climate change impact	Impacted	0.8160***	0.1726***	2.2614***	1.1884***
		(0.0307)	(0.0260)	(0.0695)	(0.0309)
Pest attack intensity	No change	1.1043***	1.1991***	3.0172***	3.3172***
		(0.0311)	(0.0205)	(0.0939)	(0.0679)
	Higher intensity	2.8916***	1.6375***	18.0227***	5.1422***
		(0.0393)	(0.0314)	(0.7080)	(0.1616)
Water sufficiency	Not sufficient	1.1210***	0.3977***	3.0680***	1.4884***
		(0.0387)	(0.0353)	(0.1188)	(0.0525)
Harvest period	March–August (Sub-round II)	2.6219***	1.3511***	13.7622***	3.8615***
		(0.0468)	(0.0241)	(0.6440)	(0.0932)
	January–April (Sub-round I)	2.1334***	1.0976***	8.4434***	2.9969***
		(0.0474)	(0.0248)	(0.4003)	(0 .0743)
Constant		-3.1518***	-0.5616***	0.0428***	0.5703***
		(0.0760)	(0.0502)	(0.0033)	(0.0286)

Note: The number of observations is 100,802 food crops farmers; robust standard errors in the parentheses;
*** is significant at 1 percent of level of significance and ** is significant at 5 percent of level of significance.

organic and non-organic fertilizer implementation in crop cultivation to maintain soil quality and crop yield. Unfortunately, most food crop farmers in Indonesia still utilize non-organic fertilizer only meaning more effort is still needed to increase farmer participation.

Moving to farmer group membership, as expected, it could benefit food crop farmers by increasing yield. This finding is supported by Mwaura (2014), Abdul-Rahaman & Abdulai (2018), and Ingutia & Sumelius (2022). Furthermore, the estimation results confirm the critical role of climatic factors on food crop yield. Our findings point out that the more likely food crop farmers experience climate change impacts, such as drought or flood, on their crops' cultivation, the more likely they have lower yields. A similar result is shown for water sufficiency, where insufficient water could lead to a higher probability of food crop farmers experiencing a lower yield. It could be explained since crop growth rely highly on precipitation and temperatures, water resource availability, and other climatic factors (World Bank & Asian Development Bank [WB & ADB], 2021). Our results also reveal that pest attack intensity is a critical issue for crop yield in Indonesia, either in 2018 or 2021. Food crop farmers experiencing higher pest attack intensity than the previous year relative to those experiencing lower intensity of pest attack are more likely to have lower yields than higher yields.

3.3. Adjusted Prediction of the Probability

To enrich our analysis, we also provide the adjusted prediction of probability belongs to one particular outcome of yield change category for each government assistance category in 2018 and 2021 as shown in Figure 1. Aligning with our RRR result, Figure 1 shows that the probability of food crop farmers experiencing higher yield is highest when the seed assistance is received on time and as needed. Similarly, with regard to fertilizer assistance, the highest probability of food crop farmers experiencing higher yield belongs to the group receiving fertilizer assistance on time, while the highest probability of food crop farmers experiencing lower yield belongs to food crop farmers receiving fertilizer assistance not on time or late. These results, again, highlight the importance of on-time distribution and suitability of government assistance in ensuring the effectiveness of the assistance received by the farmers.

On the other hand, the adjusted prediction shows that food crop farmers receiving and utilizing agricultural machinery and equipment assistance had the lowest probability of having a higher yield than other groups in 2021. Contrary, a relatively higher probability of having higher yields if food crop farmers utilize those assistances was found in 2018. These results support our RRR results, which indicate an increase in the probability of experiencing a lower yield resulting from the use of machinery assistance in 2021. As we mentioned earlier, it may be due to the machinery assistance portrayed in the Crop-Cutting Survey not only limited to those types of machinery dedicated to increasing crop yield but also those for reducing harvest or post-harvest losses. Besides, it may also be

Figure 1: Adjusted Prediction of Probability Belongs to One Particular Outcome for Each Government Assistance Category, in 2018 and 2021

explained by the possibility of unsuitable machinery assistance type with the agroecosystem condition (Hermanto et al., 2018; Shaleh et al., 2019), the lack of training provided (Shaleh et al., 2019; Gunawan et al., 2022), or the diminishing effect of the machinery used over the years, which usually has its wear-out stage (Afsharnia et al., 2013). In 2018, there was a massive distribution of agricultural and machinery assistance (Hermanto et al., 2018), meaning many farmers are receiving the assistance for the first time, which might still work at its best state.

4. Conclusion and Implication

Our study aims to assess the impact of government assistance in the form of seeds, fertilizer, and tools and machinery targeted to food crop farmers to improve or maintain their yield. Using the results of a nationwide crop-cutting survey in the year 2018 and 2021 that ensure a national inference, we found that seeds and fertilizer assistance provided by the government has a significant impact in improving or maintaining the yield as long as those assistances are on-time and meet the farmers needs. In contrast, we figured out that agricultural tools and machinery assistance are only optimal in maintaining or improving the yield in 2018. Our study recommends up-scale coverage of seeds and fertilizer assistance, particularly for the areas with relatively low yields. With regard to the agricultural tools and machinery assistance, we recommend to improve the effectiveness of the distribution by taking into account farmers' needs, cultivation characteristics, and support to farmers for the maintenance as well as the management of the tools and machinery.

References

[1] Abdul-Rahaman, A., & Abdulai, A. (2018). Do farmer groups impact on farm yield and efficiency of smallholder farmers? Evidence from rice farmers in northern Ghana. *Food Policy, 81*, 95-105. doi: https://doi.org/10.1016/j.foodpol.2018.10.007.

[2] Adiraputra, P., & Supyandi, D. (2021). The effectiveness of fertilizer subsidy: how the impact to the production. *Jurnal Sosial Ekonomi Pertanian, 15*(2), 345-56. doi: https://doi.org/https://doi.org/10.24843/SOCA.2021.v15.i02.p10.

[3] Afsharnia, F., Asoodar, M. A., Abdeshahi, A., & Marzban, A. (2013). Failure rate analysis of four agricultural tractor models in southern Iran. *Agricultural Engineering International: CIGR Journal, 15*(4), 160-170.

[4] Agresti, A. (2002). *Categorical data analysis* (2nd edition). John Wiley & Sons, Inc.

[5] Alta, A. (2022, 12 Juni). *Evaluasi program subsidi pupuk 2021 dan proyeksi ke depan*. Center for Indonesian Policy Studies. https://www.cips-indonesia.org/post/opini-evaluasi-program-subsidi-pupuk-2021-dan-proyeksi-ke-depan?lang=id.

[6] Azumah, S. B., & Zakaria, A. (2019). Fertilizer subsidy and rice productivity in Ghana: A microeconomic study. *Journal of Agricultural Studies, 7*(1), 82-102. doi: https://doi.org/10.5296/jas.v7i1.14367.

[7] BPS. (2019). *Hasil Survei Pertanian Antar Sensus (SUTAS) 2018*. Badan Pusat Statistik.

[8] BPS. (2023a). Pertumbuhan ekonomi Indonesia triwulan IV-2022. *Berita Resmi Statistik, 15/02/Th. XXVI*. Badan Pusat Statistik. https://www.bps.go.id/id/pressrelease/2023/02/06/1997/ekonomi-indonesia-tahun-2022-tumbuh-5-31-persen.html.

[9] BPS. (2023b). *[SAKERNAS] Penduduk 15 tahun ke atas yang bekerja menurut kelompok lapangan usaha utama (jiwa), 2020-2022*. Badan Pusat Statistik. https://ppukab.bps.go.id/indicator/6/296/1/-sakernas-penduduk-15-tahun-ke-atas-yang-bekerja-menurut-kelompok-lapangan-usaha-utama.html.

[10] Chen, T., Xia, G., Wu, Q., Zheng, J., Jin, Y., Sun, D., ... & Chi, D. (2017). The influence of zeolite amendment on yield performance, quality characteristics, and nitrogen use efficiency of paddy rice. *Crop Science, 57*(5), 2777-2787. doi: https://doi.org/10.2135/cropsci2016.04.0228.

[11] Choudhary, M., Meena, V. S., Panday, S. C., Mondal, T., Yadav, R. P., Mishra, P. K., ... & Pattanayak, A. (2021). Long-term effects of organic manure and inorganic fertilization on biological soil quality indicators of soybean-wheat rotation in the Indian mid-Himalaya. *Applied Soil Ecology, 157*, 103754. doi: https://doi.org/10.1016/j.apsoil.2020.103754.

[12] Fuglie, K. O., & Rada, N. E. (2013). Resources, policies, and agricultural productivity in Sub-Saharan Africa. *Economic Research Report, 145*. United States Department of Agriculture. https://www.ers.usda.gov/publications/pub-details/?pubid=45047.

[13] Gunawan, A., Wulandari, E., & Suminartika, E. (2022). Efektivitas pelaksanaan program bantuan benih jagung hibrida di Kecamatan Nagreg Kabupaten Bandung. *Jurnal Agrinika: Jurnal Agroteknologi dan Agribisnis, 6*(2), 161-175. doi: https://doi.org/10.30737/agrinika.v6i2.2140.

[14] Hantoro, F. R. P. (2020). Dampak penggunaan alat dan mesin pertanian pada Program Upaya Khusus (UPSUS) terhadap kinerja sistem produksi padi di Kabupaten Tegal. *Jurnal Pangan, 29*(3), 171-180. doi: https://doi.org/10.33964/jp.v29i3.482.

[15] Hemming, D. J., Chirwa, E. W., Dorward, A., Ruffhead, H. J., Hill, R., Osborn, J., ... & Phillips, D. (2018). Agricultural input subsidies for improving productivity, farm income, consumer welfare and wider growth in low-and lower-middle-income countries: a systematic review. *Campbell Systematic Reviews, 14*(1), 1-153. doi: https://doi.org/10.4073/csr.2018.4.

[16] Hermanto, Ashari, Tarigan, H., Dabukke, F. B. M., & Rachmita, A. R. (2018). Optimalisasi pemanfaatan bantuan alat dan mesin pertanian dan dampaknya terhadap peningkatan produksi. *Laporan Analisis Kebijakan*. Pusat Sosial Ekonomi dan Kebijakan Pertanian Sekretariat Jenderal Kementerian Pertanian. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://psekp.setjen.pertanian.go.id/web/wp-content/uploads/2022/12/2018-ANJAK-HMT.pdf.

[17] Hutagaol, M. P., & Hartoyo, S. (2013). Ekonomi pangan: efektivitas kebijakan bantuan langsung benih unggul dan pupuk untuk usahatani pangan. *Jurnal Pangan, 22*(1), 11-20. doi: https://doi.org/10.33964/jp.v22i1.147.

[18] Ingutia, R., & Sumelius, J. (2022). Do farmer groups improve the situation of women in agriculture in rural Kenya?. *International Food and Agribusiness Management Review, 25*(1), 135-156. doi: https://doi.org/10.22434/IFAMR2020.0142.

[19] Kadir, K., & Prasetyo, O. R. (2020). Adoption of agriculture mechanization on paddy farmers in Indonesia: demographic determinants, internet access influence, and the impact of adoption on the yield. *Jurnal Aplikasi Statistika & Komputasi Statistik, 12*(3), 118-130. doi: https://doi.org/10.34123/jurnalasks.v14i1.392.

[20] Kormawa, P., Mrema, G., Mhlanga, N., Fynn, M. K., Kienzle, J., & Mpagalile, J. (eds.) (2018). *Sustainable agricultural mechanization: A framework for Africa*. Food and Agricultural Organization and African Union Commission. http://www.fao.org/3/CA1136EN/ca1136en.pdf.

[21] Liu, Q., Xu, H., & Yi, H. (2021). Impact of fertilizer on crop yield and C: N: P stoichiometry in arid and semi-arid soil. *International Journal of Environmental Research and Public Health, 18*(8), 4341. doi: 10.3390/ijerph18084341.

[22] Mwaura, F. (2014). Effect of farmer group membership on agricultural technology adoption and crop productivity in Uganda. *African Crop Science Journal, 22*, 917-927.

[23] Namonje-Kapembwa, T., Black, R., & Jayne, T. S. (2015). Does late delivery of subsidized fertilizer affect smallholder maize productivity and production?. *paper presentation at the 2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association (AAEA & WAEA) Annual Meeting*, July 26-28, San Francisco, California. https://ageconsearch.umn.edu/record/205288/files/AAEA%20selected%20paper%20-Thelma%20NamonjeKapembwa.pdf.

[24] Nasrin, M., Bauer, S., & Arman, M. (2018). Assessing the impact of fertilizer subsidy on farming efficiency: A case of Bangladeshi farmers. *Open Agriculture, 3*(1), 567-577. doi: https://doi.org/10.1515/opag-2018-0060.

[25] Nkamleu, G.B. (2011). *Extensification versus intensification: revisiting the role of land in African agricultural growth.* African Economic Conference 2011. African Development Bank. https://archive.uneca.org/sites/default/files/uploaded-documents/AEC/2011/nkamleu-extensification_versus_intensification_1.pdf.

[26] Prayoga, A., & Sutoyo, S. (2017). Produktivitas dan pendapatan usahatani padi sawah dampak program bantuan alat mesin pertanian, benih dan pupuk di Kabupaten Malang Provinsi Jawa Timur. *Jurnal Ilmu-Ilmu Pertanian, 24*(1), 1-9. doi: https://doi.org/10.55259/jiip.v24i1.228.

[27] Rapsomanikis, G. (2015). *The economic lives of smallholder farmers: An analysis based on household data from nine countries*. Food and Agriculture Organization of the United Nations. https://www.fao.org/agrifood-economics/publications/detail/en/c/358044/.

[28] Salunkhe, H. A., & Deshmush, B. B. (2014). Impact of subsidy on agriculture sector in India - an analytical study. *International Journal of Agricultural Science and Research, 4*(2), 9-16.

[29] Saputra, M. D., Antara, M., & Effendy, E. (2020). Dampak program Pajala terhadap produktivitas padi sawah di Desa Jono Oge Kecamatan Sigi Biromaru Kabupaten Sigi. *Agroland: Jurnal Ilmu-ilmu Pertanian, 25*(2), 96-105.

[30] Scharf, P., & Lory, J. (2006). *Best management practices for nitrogen fertilizer in Missouri*. MU Extension, University of Missouri-Columbia. https://extension.missouri.edu/publications/ipm1027.

[31] Shaleh, S. M., Noor, T. I., Sulistyowati, L., & Setiawan, I. (2019). Efektivitas bantuan pemerintah (Suatu kasus program upaya khusus Pajale penyediaan sarana kedelai Desa Jatiwaras, Kecamatan Jatiwaras, Kabupaten Tasikmalaya, Jawa Barat). *Jurnal Agribisnis Terpadu, 12*(2), 262-277. doi: http://dx.doi.org/10.33512/jat.v12i2.6786.

[32] Sigaye, M. H., Nigussei, A., Lulie, B., Mekuria, R., & Kebede, K. (2020). Effects of organic and inorganic fertilizers on soil properties, yield and yield components of Maiz e (Zea mays L.) grown on an Andisols at Hawassa Zuria, Ethiopia. *Advances in Applied Science Research, 11*(4), 9.

[33] Spielman, D. J., Kelemwork, D., & Alemu, D. (2011). Seed, fertilizer, and agricultural

extension in Ethiopia. *Ethiopia Strategy Support Program II (ESSP II) Working Paper, 020*. International Food Policy Research Institute. https://www.ifpri.org/publication/seed-fertilizer-and-agricultural-extension-ethiopia.

[34] UNCTAD India Team. (2007). *Green box subsidies: a theoretical and empirical assessment*. United Nations Conference on Trade and Development. https://wtocentre.iift.ac.in/DOC/Studies_GreenBoxSubsidiesATheoreticalAndEmpericalAssessmen.pdf.

[35] Usman, M., Madu, V. U., & Alkali, G. (2015). The combined use of organic and inorganic fertilizers for improving maize crop productivity in Nigeria. *International Journal of Scientific and Research Publications, 5*(10), 1-7.

[36] Verma, S. R. (2006). Impact of agricultural mechanization on production, productivity, cropping intensity income generation and employment of labour. In: *Status of farm mechanization in India* (pp. 133-153), Punjab Agricultural University.

[37] WB & ADB. (2021). *Climate risk country profile: Indonesia*. World Bank & Asian Development Bank. https://www.adb.org/publications/climate-risk-country-profile-indonesia.

[38] Wirakusuma, G. (2020). Is input subsidy still useful for Indonesian agriculture?. *Jurnal Ekonomi dan Pembangunan, 28*(1), 17-28. doi: https://doi.org/10.14203/JEP.28.1.2020.17-28.

[39] Yang, T., Chandio, A. A., Zhang, A., & Liu, Y. (2023). Do farm subsidies effectively increase grain production? Evidence from major grain-producing regions of China. *Foods, 12*(7), 1435. doi: https://doi.org/10.3390/foods12071435.

[40] Zhou, X., & Ma, W. (2022). Agricultural mechanization and land productivity in China. *International Journal of Sustainable Development & World Ecology, 29*(6), 530-542. doi: https://doi.org/10.1080/13504509.2022.2051638.

this page intentionally left blank