

'Enhancing Farmers' Access to Subsidized Fertilizers: Empowering Farmer Institutions for Sustainable and Resilient Agriculture, A Review

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Abstract This review highlights the importance of institutional development in enhancing farmers' access to subsidized fertilizers in Indonesia. Institutional strengthening involves measures to bolster the functions of relevant institutions, foster collaboration, and optimize distribution systems. The Indonesian government has adopted strategies such as the development of farmer cooperatives, provision of direct subsidies, and enhancement of distribution systems to achieve this objective. However, challenges in policy implementation, limited access to information, and a lack of knowledge among farmers about the subsidy scheme have been identified. To tackle these issues, the review proposes comprehensive solutions including providing training, increasing funding, improving coordination, and promoting farmer literacy. By addressing these concerns, farmer institutions can better assist smallholder farmers, manage the distribution process effectively, and ensure the sustainability of the subsidized fertilizer program.

Keywords: Farmer institutions, Subsidized fertilizers, Farmer access, Policy implementation

Introduction

The subsidized fertilizer policy is an integral part of the country's agricultural development discourse, with the primary objective of ensuring national food security (Kodayama, 2011; Bala et al., 2014; Resnick et al., 2018; Banik and Chasukwa, 2019). However, the agricultural sector is currently facing challenges in meeting the increasing food demand due to population growth (Caliciouglu et al., 2019; Vos and Bellu, 2019) and the struggle to improve the welfare of farmers, who are the key food producers (Misselhorn et al., 2012; Praburaj et al., 2018; Otsuka and Fan, 2021). Subsidy policies have emerged as crucial instruments for enhancing farmers' performance and overcoming their limited resources (Jayne et al. 2014; Bikkina et al. 2017). To achieve sustainable food production, there is a growing demand from farmers for input production and equipment to support crop cultivation and increase profitability (Sims and Kienzle, 2016; Sibande et al., 2017; Sims and Kienzle 2017; Ricker-Gilbert and Jayne, 2017). Ensuring farmers' welfare is not only essential for achieving food sufficiency but also plays a vital role in ensuring the sustainability of the agricultural sector (Rae et al., 2007; Hadiprayitno, 2015; Fung et al., 2018).

Fertilizer is a strategic input that significantly contributes to increasing agricultural productivity and production (Prasad, 2009; Obi-Egbedi et al., 2017; Theriault and Smale, 2021). The success of the Green Revolution in Latin America and Asia contributed to the massive use of fertilizers (Evenson and Gollin, 2003; Estudillo and Otsuka, 2012). This contributed to the overall enhancement of agricultural productivity and profit for farmers, and laid the foundation for broader economic growth (Pingali, 2012; Warr and Yusuf, 2014; Pellegrini and

Fernandez, 2018). The subsidized fertilizer program was initially implemented in Indonesia in 1969 and has evolved from experimental stages to a massive implementation. However, the program faced challenges during the reform agenda, leading to its suspension for four years from 1998 to 2002, following concerns raised by the IMF (Gazzani, 2018). The program was resumed in 2003 with continuous efforts to improve data collection, distribution, and redemption mechanisms through the introduction of digital applications such as Group Needs Definitive Plan electronic system (e-GNDP), Farmer's Card, Application of Agricultural Extension Management Information System (AAEMI), and T-Puber (an application used in retail kiosks to input data on distribution of subsidized fertilizers every month which is integrated with a verification and validation system) (Sastra et al., 2021).

The current subsidized fertilizer program has shown substantial gaps and issues in a various area that require rapid response (Rozaki, 2021). A primary concern is disparities in the distribution subsidized fertilizers, leading to delays or inadequate supply, leading to delays or inadequate supply (Adam et al., 2022; Hatta et al., 2022), subsequently exerting a direct influence on agricultural productivity (Famid et al., 2022). Moreover, the distribution phase of subsidized fertilizers is susceptible to fraudulent activities, particularly for unauthorized retailers engaging in the resale of subsidized fertilizers at prices surpassing the stipulated Highest Retail Price (HRP) (Ashari et al., 2021), discrepancies in the data on the proposals (e-GNDP) submitted to the needs of farmers (Khasanah, 2016) and other malpractices. This distribution problems are also experienced by countries implementing similar policies, such as South Asia countries (Bista et al., 2016; Kishore et al., 2021; Gautam et al., 2022), Zambia (Namonje-Kapembwa et al., 2015), and another Sub-Saharan Africa (Liverpool-Tasie, 2014a; Ariga et al., 2019). Another issue is a lack of support facilities. such as digital agricultural information (Salampessy, 2022), limited EDC machine at each fertilizer kiosk (Wahyudi et al., 2021), roads (Susanawati et al., 2019) and soon. This constraint primarily arises from financial limitations, thereby rendering the fulfillment of farmers' requirements and the establishment of parity within the subsidized fertilizer program a formidable challenge (Alta et al., 2021) Despite the government's persistent dedication to enhancing the execution of the subsidized fertilizer program in the field, certain deficiencies persist that necessitate rectification.

The active participation of farmer groups in the management of subsidized fertilizer is a critical aspect that needs consideration. Previous studies have primarily focused on the response of farmers or farmer groups as one of the subjects of distribution mechanism and highlighted their role in improving distribution efficiency (Rachman and Sudaryanto, 2010; Chirwa et al., 2011; Liverpool-Tasie, 2014b; Suryana et al., 2016; Aswaf et al., 2017; Harun et al., 2021a; Minah, 2022; Maghfiroh et al., 2023; Mardiharini et al., 2023; Thapa et al., 2023). In order to increase the involvement and strengthen the accessibility of farmers, as the main actors and those most affected by the policy, an institutional strengthening strategy must be developed and implemented. This paper comprehensively reviews the strategies that should be implemented to enhance the role of farmer groups in Indonesia, particularly in the context of subsidized fertilizer management.

Subsidized Fertilizer Network Management in Indonesia

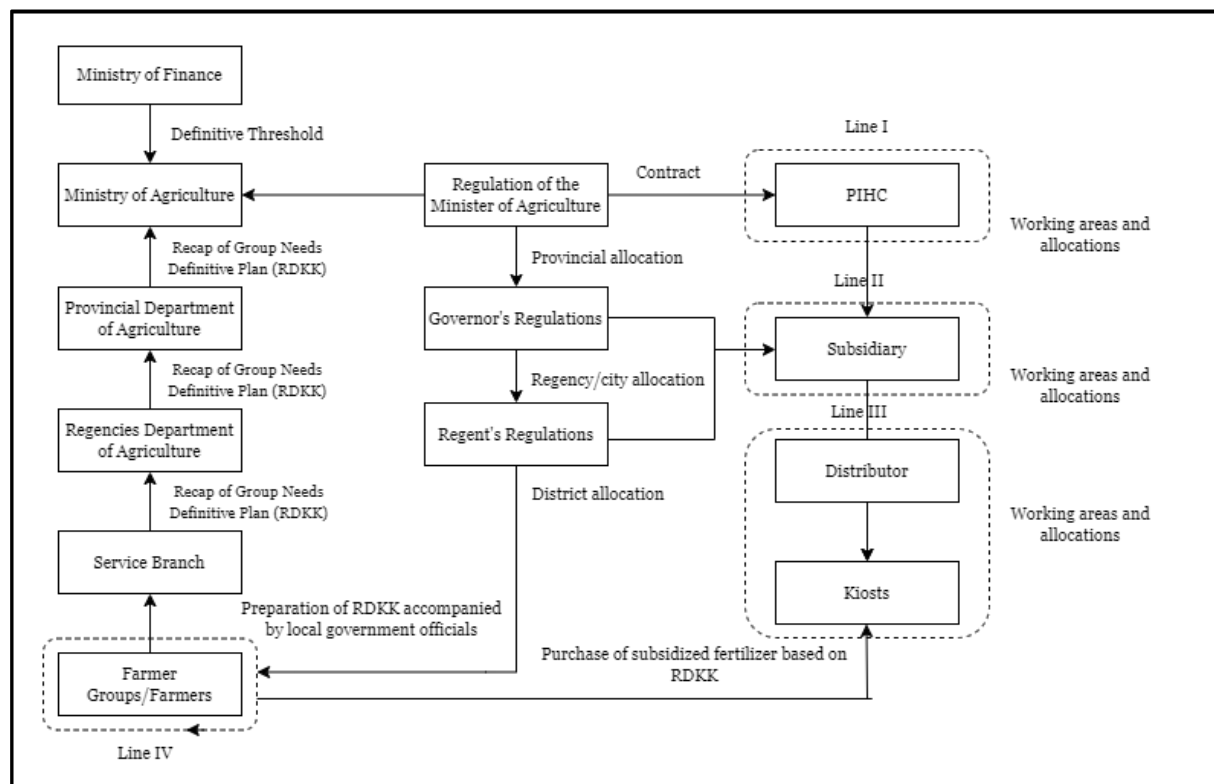
The management of subsidized fertilizers in Indonesia is a crucial aspect for achieving food security and improving the welfare of farmers. Since the implementation of the Fertilizer Subsidy Program in 1969, fertilizer use in Indonesia has experienced rapid growth, leading to a significant boost in crop production (Rozaki, 2021). In the context of the green revolution, there is a noteworthy upswing in fertilizer production within Indonesia, surging from 103 thousand tons in 1970 to an impressive 3.5 million tons in 1985. This massive utilization of fertilizers has played a fundamental role in elevating Indonesia's rice production by a remarkable 289 percent over the span of three decades. It was observed that Indonesia's rice production remained stable at 31.33 million tons in 2020 and subsequently increased to 31.68 million tons in 2021 (BPS-Statistics Indonesia, 2022). This upward trend in rice production is customarily accompanied by a significant level of fertilizer production and consumption. Presently, data sourced from the Indonesian Fertilizer Manufacturers Association revealed that fertilizer production reached 12.26 million tons in 2020 and 12.23 million tons in 2021, while the consumption of inorganic fertilizers for the agricultural sector amounted to 8.37 million tons in 2020 and 8.04 million tons in 2021 (Indonesian Fertilizer Manufacturers Association, 2023a; 2023b).

However, the nation's subsidized fertilizer management has encountered challenges in adhering to the six fundamental principles (indicators) of precision, which encompass aspects of timing, pricing, quantity, location,

quality, and type accuracy (Sahim et al., 2018; Mulyadiana et al., 2018; Dayanti et al., 2020; Rukka et al., 2021; Sahroni et al., 2022; Saputri et al., 2022; Busthanul et al., 2023). A study case in Southeast Minahasa found that the distribution of subsidized fertilizers remains uneven and at times fails to reach the intended beneficiaries. Furthermore, the complex bureaucratic framework involved in the distribution of subsidized fertilizers results in inconsistent availability during fertilization periods, along with limited supervision of unauthorized retailers (Kawuwung et al., 2021). These constraints contribute to complicating farmers' access to subsidized fertilizers, scarcity, and the realization of the six precision indicators in the field (Kautsar et al., 2020; Masnun and Astanti, 2020; Anisa and Adnan, 2021; Patiung et al., 2022; Wijayanto and Lestari, 2022; Ajina et al., 2023).

The mechanism for determining the allocation and distribution of subsidized fertilizer from the government to farmers is regulated in Minister of Trade Regulation No. 15 of 2013 and Minister of Agriculture Regulation No. 10 of 2022, which involves four-stage process, represented by Line I to Line IV (Figure 1). Line I represents the distribution of fertilizer from the factory to regional warehouses supervised by PT Pupuk Indonesia (Persero). Line II involves the distribution from regional warehouses to district/city warehouses, while Line III focuses on the distribution from district/city warehouses to fertilizer kiosks at the sub-district or village level. Finally, Line IV covers the distribution from fertilizer kiosks directly to farmers. The Indonesian government provides fertilizer subsidies through Lines I and II, while Lines III and IV depend on market prices. However, the distribution of subsidized fertilizers still encounters various challenges, including difficulties in monitoring distribution, deviations from the intended process, and unequal access throughout Indonesia. In response, the Ministry of Agriculture has implemented various measures, such as developing a subsidized fertilizer distribution information system and enhancing supervision of subsidized fertilizer distributors (Rachman and Sudaryanto, 2010; Nugroho, 2018; Sularno et al., 2017; Evand et al., 2019).

Fig. 1. Mechanism for determining the allocation and distribution of subsidized fertilizer

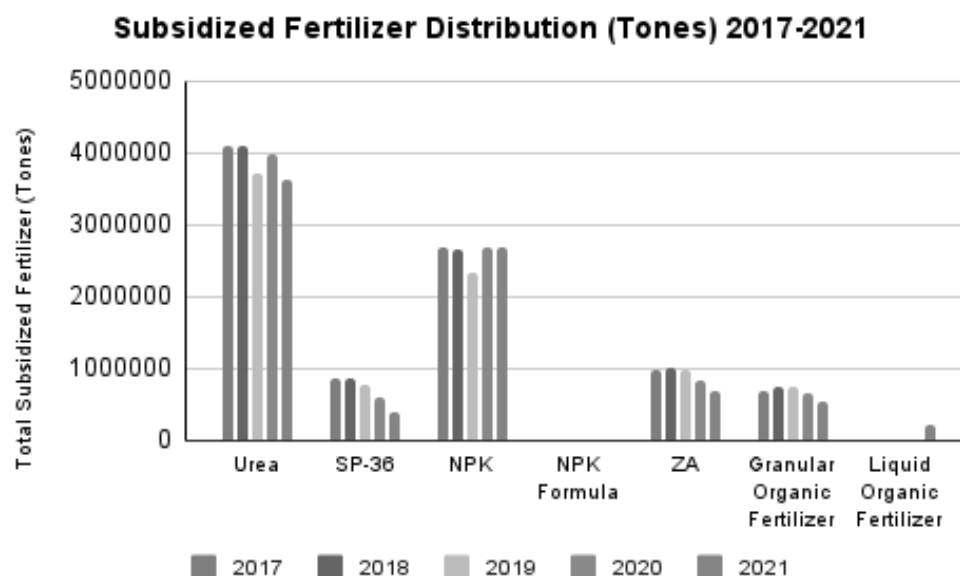


Source: Author's interpretation according to technical instructions for subsidized fertilizers, Directorate General of Agricultural Infrastructure and Facilities

Fertilizer companies (Line I), such as Pupuk Indonesia Holding Company (PIHC), have crucial position in the distribution of subsidized fertilizers in Indonesia. Established as one of State-owned enterprises (SOE), PIHC assumes responsibility for overseeing the nation's fertilizer sector, covering production, distribution, and vending of subsidized fertilizers, ensuring equitable availability to farmers (Milearosari and Ramadhan, 2023). These enterprises serve as both producers and distributors of subsidized fertilizers, adhering to governmental regulations and employing a robust distribution network to ensure timely provision to targeted areas (Ruminta, 2021). However, challenges persist, such limited quotas for subsidized fertilizers, farmers' unfamiliarity with non-urea and NPK fertilizers, inadequate stockpiles, and market dualism (Zulaiha et al., 2018). Collaboration among fertilizer companies, government, and relevant stakeholders ensures coordinated distribution. Furthermore, optimizing agricultural extension's role and increasing the budget must also receive attention in the distribution of subsidized fertilizers (Abdullah and Hakim, 2011; Rustinsyah, 2015; Rusliyadi et al., 2018; Managanta, 2020).

To address distribution problems, the Ministry of Agriculture in Indonesia has implemented a closed distribution system for subsidized fertilizers which refers to the Minister of Trade Regulation No. 21 of 2008 (Fahmid et al., 2022; Rachman and Sudaryanto, 2010; Rachman, 2012). Although the government conducted trials to provide direct subsidies to farmers instead of subsidizing fertilizer manufacturers, these attempts were not entirely successful, leading to the continuation of subsidies to manufacturers. The government established three policies related to fertilization: (1) the application of balanced fertilization, (2) the subsidy of specific fertilizers such as Urea, ZA, SP-36, NPK, and Organic Fertilizers (Figure 2) and 3) the establishment of fertilizer recommendations for rice, corn, and soybeans based on location-specific balanced fertilization. These policies aim to increase sustainable food production and the efficiency of fertilizer use while promoting environmentally friendly production practices (Maman et al., 2021; Hartono et al., 2022).

Figure 1Types of Subsidized Fertilizers distributed in the period 2017 – 2021



Source: Author's interpretation according to performance report of the Directorate General of Infrastructure and Agricultural Facilities

The government has the option of redistributing subsidized fertilizer to remedy shortages in specific locations. The Ministry of Agriculture determines inter-provincial reallocations, while Governors and District Heads are responsible for inter-district/city and inter-district reallocations, respectively. The reallocation process occurs upon the recommendation of the local Agriculture Office, before the Governor or Regent/Mayor is designated.

If the allocated amount of subsidized fertilizer is insufficient for a province, regency/city, or sub-district during the current month, producers can distribute the remaining allocation from previous months and/or the following month, provided that it does not exceed one year's allocation for that area (Tompunu et al., 2021).

The Role of Farmer Institutions in The Management of Subsidized Fertilizers

Farmer associations take an essential part in agricultural development, specifically the management of subsidized fertilizers. These farmers' institutions not only facilitate enhanced market access for farmers but also contribute to the provision of subsidized agricultural inputs (Hellin et al., 2009; Tolno et al., 2015; Otitoju and Ochimana, 2016; Arsyad et al., 2018; Abdul-Rahaman and Abdulai, 2018; Sathapatyanon et al., 2018; Azumah and Zakaria, 2019; Abdul-Rahaman and Abdulai, 2020; Rahmadanih et al., 2021; Methamontri et al., 2022).

Farmer Groups

Farmer institutions serve as social structures designed to meet the needs of rural community members engaged in agriculture and also subject of government programs (Hermanto and Swastika, 2011; Raya, 2014). They encompass norms, habits, and social culture that are organized to support the agricultural sector. The government supports institutional development programs, such as Padi Sentra, Mass Guidance, Village Unit Business Entities (VUBE), Village Unit Cooperatives (VUC), and Special Intensification (SI), to empower institutions and accelerate agricultural sector development (Teguh et al., 2017). Farmer groups, as agricultural institutions, are formed in rural areas based on commonalities in location, goals, vision and mission, needs, and types of crops cultivated (van den Berg et al., 2020a). These groups directly engage with farmers in various commodity production sectors, and their activities need to be actively maintained, organized, nurtured, strengthened, and empowered to facilitate the dissemination of knowledge and technology (Sumane et al., 2018; Adnyana et al., 2020; Kangogo et al., 2020; Listiana et al., 2021). The institutional potential of farmer groups is characterized by leadership attitudes, regulations, social norms, institutional structures, institutional roles, and community social tolerance (Lanuhu et al., 2019; Widjayhanti, 2020; Dada et al., 2021; Indardi and Marla, 2022; Elizabeth et al., 2023).

The term "Gapoktan" refers to the combination of farmer groups that share similar objectives and functions. By merging smaller groups into a Gapoktan, it becomes easier to achieve empowerment goals and enhance welfare (Roostian and Wulan, 2018; Tan and Mailena, 2021). The primary objective of this institution is to empower farmers as economic agents, ensuring their access to capital, effective farm management, and equitable income and welfare levels compared to other economic actors (Dolinska and d'Acquino, 2016; Aku et al., 2018; Bachke, 2019). In Indonesia, Gapoktan facilitates the needs of farming inputs such as subsidized fertilizers, pesticides, and seeds. Farm inputs come from distributors, authorized retailers, and the agriculture office.

Table 1. compares the diverse roles of farmer groups in multiple countries, particularly those related to managing subsidies for inputs crop production.

Table 1. Diverse roles of farmer groups in multiple countries

Country	Role of Gapoktan/Farmer Groups/Farmer Organizations	Study
Indonesia	- Gapoktan plays a vital part in improving crop production and income by supporting farmers to obtain supplies and equipment, as well as promoting the growth of a variety of agricultural commodities, with a focus on horticultural crops. - Farmer groups play a vital role in promoting agricultural development and have positive correlation with productivity. - Farmer groups play a role in regulating the management of agricultural land by farmers so that it is sustainable. - Farmer groups play a high role in maintaining rice availability through cooperation and food stock management, helping ensure a surplus of rice compared to consumption needs.	(Fariadi, 2017; Arsyad et al., 2018; Larasati et al., 2021; Ruhimat, 2021; Baga et al., 2023)

Country	Role of Gapoktan/Farmer Groups/Farmer Organizations	Study
	Farmer groups act as a forum to establish and strengthen cooperation among members of farmer groups in carrying out farming	
India	- Farmers' organizations connect together smallholders for backward linkages for inputs like seeds, fertilizers, financial support, insurance, knowledge, and extension services, as well as forward linkages like market-led collective marketing, processing, and agricultural production; - Integrate small and marginal farmers into the modern agricultural supply chains.	(Mondal, 2010; Bikkina et al., 2018)
Thailand	Farmer groups play a crucial role in collective marketing and production	(Methamontri et al., 2022)
Vietnam	The role of farmer groups is to facilitate small-scale farmers' access to supermarkets by providing quality control, promoting flexible contracts, and receiving public support, ultimately increasing profits and benefiting from support for food quality improvement.	(Moustier et al., 2010)
Europe	- Farmer groups, as part of regional Farmer Innovation Groups, played a role in exploring and enhancing online knowledge exchange among farmers, researchers, advisors, and practitioners to improve farming practices through feedback, testing practices, and sharing experiences and practical implications using various tools and platforms. - Farmer groups and agricultural supply chain associations serve as integral components in identifying socio-economic barriers and offering recommendations to facilitate the technology adoption in Europe	(Long et al., 2016; Bliss et al., 2019)
Nigeria	- Farmers' group membership doesn't guarantee equitable access to subsidized inputs, as the allocation of subsidized fertilizer is influenced by association with group leaders. In other side, farmer's group take part in coordinate farmers together for extension training. - Accommodating and coordinating farmers to obtain agricultural inputs because fertilizer distribution is carried out through farmer groups.	(Liverpool-Tasie, 2012; Liverpool-Tasie, 2014b)
Zambian	Farmer groups positively impact members' farm performance regardless of input subsidy reception, although external programs can cause uneven benefit distribution; these groups offer broader advantages for promoting women's empowerment and smallholder farm performance.	(Minah, 2021)
Kenya	Farmer groups serve as major accelerators for innovation uptake	(Fischer and Qaim, 2012)
South Africa	Farmer groups are recognized as effective mechanisms for reducing transaction costs and improving smallholder farmers' access to inputs and markets	(Sinyolo and Mudhara, 2018)
Canada	Farmer organizations (Farmer markets) linking local food systems to the social economy, serving as strategic platforms connecting producers and consumers of local food while navigating complexities related to authenticity, supply and demand dynamics, and their role within regional food systems	(Wittman et al., 2012)
Argentina	Farmer organizations have played a pivotal role in promoting and implementing technology/farming technique.	(Pairetti and Dumanski, 2014)
Haiti	Farmer associations play important roles in agricultural modernization	(Moore et al., 2021)

In Indonesia, farmer associations play a crucial role in the management of subsidized fertilizers, serving as government partners in their distribution to farmers as outlined in Minister of Agriculture Decree No. 49 of 2015. One of the primary functions of farmer organizations in managing subsidized fertilizers is to ensure their distribution aligns with the needs of farmers in their respective areas. Farmer groups conduct assessments to determine the fertilizer requirements and provide accurate information to the government regarding the demand for subsidized fertilizers. Additionally, they monitor the accuracy of data on farmers receiving subsidized fertilizer, ensuring it reaches those in need. Farmer groups also play a role in monitoring farmers' proper use of subsidized fertilizers by analyzing their usage patterns.

According to reprocessed data obtained from the Agricultural Extension Management Information System by Agricultural Extension and Human Resource Development Agency (Table 2.), Indonesia had a total of 642,293 farmer groups in 2020. These groups were categorized as beginner class (56% or 359,541 farmer groups), advanced class (24% or 154,426 farmer groups), middle class (4% or 26,948 farmer groups), and main class (2,788 farmer groups). Additionally, there were 104,594 farmer groups with an unknown status. The number of farmer groups showed a gradual increase from 2016 to 2020, starting from 531,287 in 2016 and reaching 646,293 farmer groups in 2020. These findings highlight the significant role and growth of farmer groups in Indonesia's agricultural sector.

Table 2. Development of farmer groups, farmer group associations, agricultural economic institutions, and agricultural extension workers 2020 - 2016.

Categorize	2016	2017	2018	2019	2020
Farm Group	531.287	561.791	588.653	616.419	646.293
Combine Farm Group	62.163	63.120	63.392	63.994	64.241
Farmer Economic Institutions	12.584	12.546	11.910	12.018	11.817
Agricultural Extension	68.171	68.674	63.972	67.036	66.995

Source: *Agricultural Statistics, Indonesian Ministry of Agriculture*

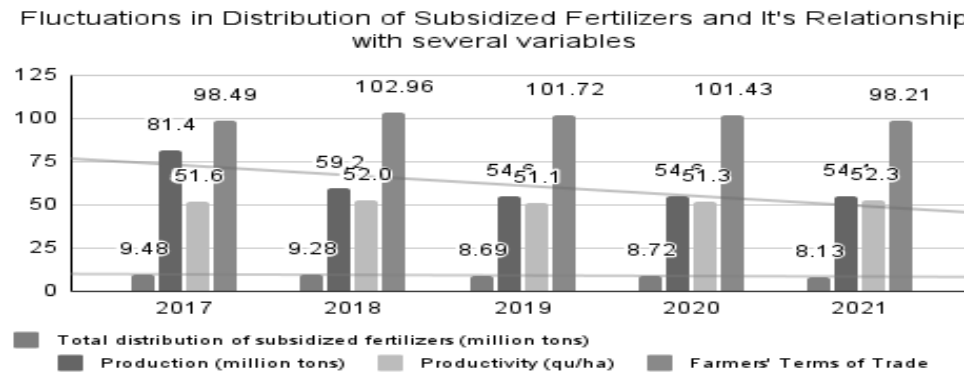
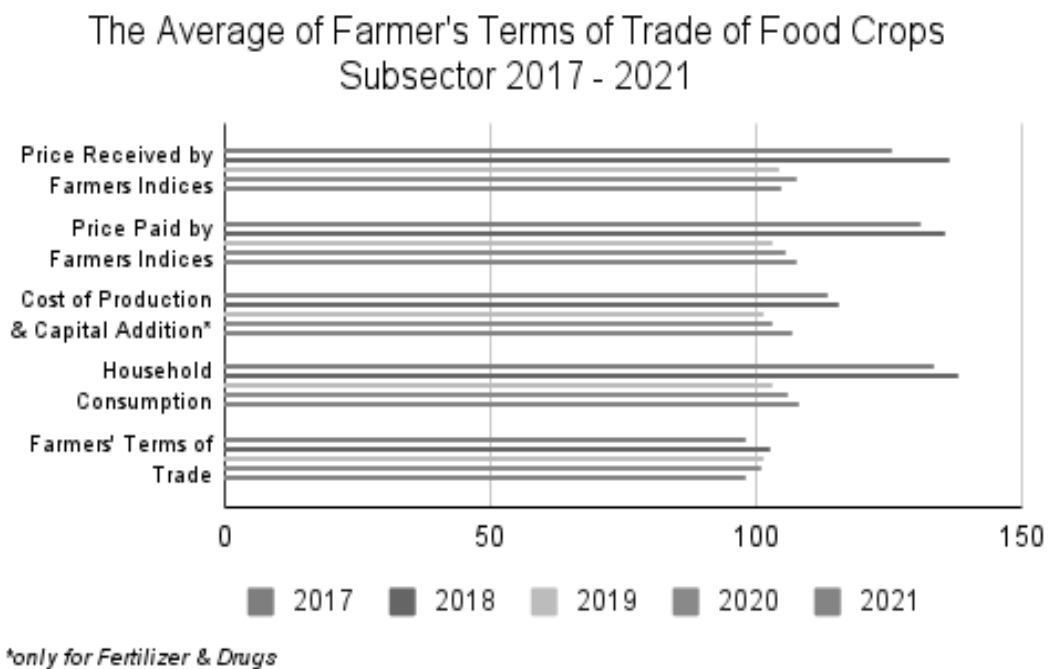
Accessing subsidized fertilizers presents significant challenges for farmers and farmer groups in Indonesia. Limited quotas restrict the availability of subsidized fertilizers, and farmers have limited knowledge about alternative fertilizer types beyond urea and NPK, impacting their decision-making process. Insufficient quantities and varieties of fertilizers further hinder farmers' access to necessary inputs for their agricultural activities. Market dualism also poses a barrier to the growth of the fertilizer industry in the country (Roni and Setyawan, 2020; Sari et al., 2022).

The high cost of non-subsidized fertilizers is another significant consideration for farmers when making purchasing decisions, as the prices discourage some from buying fertilizers. Misuse of subsidized fertilizers and the characteristics of the distributing agents also present additional challenges to the effective distribution of subsidized fertilizers. Therefore, involving agricultural extension workers and leveraging social capital are crucial to improving the efficiency and effectiveness of subsidized fertilizer distribution (Besa et al., 2022).

The appropriate distribution of subsidized fertilizers directly contributes to an increase in total rice production and also have positive impact on farmer's exchange rates. The average farmer exchange rate and its relationship with subsidized fertilizer are presented in Figures 3 and 4 respectively.

Figure 2The average farmer's terms of trade (paddy) in Indonesia for the period 2017 – 2021

Source: Author's interpretation according to BPS Statistic Indonesia 2017-2021

**Figure 3**Fluctuation of subsidized fertilizers and relationship with national paddy production,

productivity, and farmer's terms of trade indices for period 2017 – 2021

Source: Author's interpretation according to performance report of the Directorate General of Infrastructure Agricultural Facilities and BPS Statistic Indonesia 2017-2021

These data suggest a potential correlation between subsidized fertilizer distribution and rice production. The decrease in fertilizer distribution might have contributed to the decline in rice production. However, the stability in productivity indicates that farmer maintained a consistent level of output per unit of land. The exchange rates remained relatively steady, indicating minimal impact from the observed variables. The data shows the effectiveness of the subsidized fertilizer program during this period may be questionable, as the decline in distribution coincided with a decrease in rice production. Further analysis is needed to assess the underlying factors affecting this relationship and to evaluate the effectiveness of subsidized fertilizer program.

Strengthening Farmer Organizations to Increase Accessibility to Subsidized Fertilizers

Institutional strengthening is an important strategy to increase farmers' access to subsidized fertilizers in Indonesia. In this context, it is important to map the challenges faced by farmer groups in order to find solutions and formulate relevant strategies.

Institutional aspect

In this aspect, several deficiencies were found, such as the less optimal performance of the management and members of the farmer group organization which would affect the conditions of the farmer groups and all kinds of activities carried out by the farmers. In terms of function, the role of the organization is still lacking for members of farmer groups who are felt to be less than optimal for its members or farmers. In the perspective of innovation and contribution, Indonesian farmer groups are less active in innovating and contributing to developing agriculture, and tend to accept all suggestions from the government or continue existing farming traditions (Santoso and Darwanto, 2015).

Institutional strengthening is required to improve farmers' access to agricultural inputs. As a result, government interventions and supports, such as facilitating training, technical help, improving access to credit or financial resources, and resource allocation, are essential (Friis-Hansen, 2008; Shalaby et al., 2012; Pratiwi et al., 2019; Raharja et al., 2020; Tan and Mailena, 2021). By implementing these strategies, farmer organizations can be strengthened, enabling them to effectively represent and support their members, improve their productivity and income, and contribute to sustainable agricultural development.

In the context of subsidized fertilizer accessibility, institutional training and capacity building are critical to improving the effectiveness of subsidized fertilizer programs. A study conducted in Karawang district identified issues in the implementation of the Farmer's Card program for subsidized fertilizer distribution (Nurhasan et al., 2022). These issues included problems with farmers' utilization of the cards and the complex electronic data capture (EDC) system. The study highlights the need for training and institutional capacity building to enhance program effectiveness.

The Indonesian Government implements several strategies to address these issues, such as Farmer Field School Program that are enhanced farmers' capacity and profitability (Kariyasa, 2014; Khumairoh et al., 2018; Luther et al., 2018; van den Berg et al., 2020a; van den Berg 2020b), Food Self-Sufficiency Village Programme (Desa Mandiri Pangan) which focused on empowering communities, alleviating rural poverty, and ensuring food security at the village level (Rusliyadi et al., 2021), Simantri Program that concern in increasing the sustainability of farming businesses (Ekadina et al., 2022) and another empowering program that support technical skills and extension services (field assistance) (Wulanjari et al., 2022). These programs demonstrate the Indonesian government's commitment to increasing farmer empowerment through various strategies such as capacity building, access to resources, and institutional support.

Financial Aspect

Inadequate allocation of funds can jeopardize the sustainability of farmer organizations, underscoring the significance of sufficient funding to strengthen farmer institutions and promote active member participation (Tjondronegoro, 2015). Similarly, adequate funding in developing sustainable agricultural institutions is crucial part. Lack of funding can impede farmers' institutional capacity to acquire resources, adopt new technologies, and improve their overall welfare. Furthermore, adequate funding plays a vital role in enhancing the capacity of agricultural institutions to empower impoverished farmers. The study highlighted the necessity of allocating sufficient funds to support training, technology transfer, and infrastructure facilities, thereby strengthening institutions and improving farmers' welfare (Saravanakumar et al., 2019). Based on these findings, it can be concluded that limited funding represents a significant obstacle to the strengthening of farmer institutions or organizations.

Financial empowerment of farmer groups can be increased by facilitating farmer groups' access to credit and financial services, facilitating farmer groups' access to markets and value chains, enabling them to sell their products at fair prices and establish long-term relationships with buyers, providing financial incentives and subsidies to farmer groups, and supporting farmer groups in value-added processing activities (Assogba et al., 2017; Wulandari et al., 2017a; Wulandari et al., 2017b; Elahi et al., 2018; Hoq et al., 2021; Girma and Kuma,

2021; Ume, 2023). Furthermore, institutional strengthening can be accomplished through expanding credit availability or by strengthening farmer cooperatives (Fitriani, 2015; Yuliando et al., 2015; Hao et al., 2017; Sedana and Astawa, 2019; Sarkar et al., 2023).

In order to address these issues, the Indonesian government has implemented several financial strategies for farmer groups to strengthen farmer empowerment, such as establishing purchase of subsidized fertilizers with farmer cards (Kartu Tani) (Harun et al., 2021b; Puspita and Astuti, 2021; Fauzian et al., 2022; Fitriani et al., 2022; Patria and Mulyo, 2022), village unit cooperatives (Suratno et al., 2021; Gunadi and Susilastuty, 2023), implementing the People's Business Credit program (Farida et al., 2015; Susriani et al., 2022), so that farmer groups can access credit and financial services such as loans and microfinance to support their agricultural activities, and collaborating with private sector to implement Corporate Social Responsibility (CSR) which the programs provide assistance and support to farmer groups, including financial resources, technology, seeds, and fertilizers tailored to the needs of the farmers (Wahyudin et al., 2015; Sirine et al., 2020; Suryana et al., 2022).

Technological and Infrastructure Aspects

The problems identified in the technology aspect are the limited number of technologies and the large number of farmers still in the adoption stage, so improvement of technology literacy is essential. In this case, the active role of agricultural extension officers and farmer groups influences the level of adoption and knowledge of technology (Yilmaz et al., 2010; Margono and Sugimoto, 2011). In addition, farmers' access to information and training activities are also factors that contribute to strengthening farmer institutions. In the framework of agricultural policy, information exposure to farmers will support the government in developing a farmer institutional information system as a reference in distributing subsidies to farmers through farmer institutions as intermediaries.

To effectively train farmer groups to use technology and access agricultural inputs, the following strategies can be implemented to farmer groups: a) Digital literacy training on basic computer skills, internet usage, and mobile applications; b) Conduct technology demonstrations and field trials to showcase the benefits and functionalities of different agricultural technologies; c) Utilize mobile training approaches to reach large groups of smallholder farmers. Mobile training units or platforms can deliver agricultural extension services, including training on technology use, through mobile devices; d) Encourage peer-to-peer learning among farmer groups by facilitating knowledge sharing and exchange of best practices; and e) Provide ongoing support and follow-up to farmer groups after the initial training (Seminar and Sarwoprasodjo, 2018; Soeparna, 2018; Adam et al., 2021; Liu, et al. 2022). This can include regular monitoring, troubleshooting assistance, and additional training sessions to ensure that farmers are effectively utilizing technology for accessing agricultural inputs. From the perspective of accessibility to subsidized fertilizers, it is crucial to provide farmer groups with clear and easy-to-understand information about the program, including types of subsidized fertilizers, eligibility requirements, application procedures, subsidy amounts, and the benefits of using subsidized fertilizers (Raya, 2014; Ashari et al., 2021; Setiawan et al., 2021). In addition, farmers should be informed about non-subsidized fertilizer alternatives as options according to their needs and budget.

The Indonesian government has developed information and communication technologies that can be used to improve independent smallholder farmers' access to and utilization of technology for agriculture. These include mobile apps, internet-based platforms, and other digital tools that can help farmers access information on agricultural inputs and markets (Seminar and Sarwoprasodjo, 2019; Bunyamin et al., 2020). Several apps have been launched, such as: a) The Farmer App which is an information service related to solutions to agricultural problems, a place to sell agricultural equipment, agricultural training information, as well as an online forum with fellow farmers throughout Indonesia; b) The TaniHub application contains services regarding the distribution of agricultural and plantation products from regions to cities; c) The LimaKilo application allows farmers to directly sell their crops to consumers at competitive prices; d) The Pantau Harga application is a place to bargain and buy and sell between raw material providers and farmers; and e) The Nurbaya Initiatives application is a service provided for people's economic actors, both farmers and small and medium enterprises (SMEs), to be able to create a platform for selling their products. The presence of mobile-based applications is expected to help improve the welfare of farmers and cut the distribution chain of production products from farmers to consumers (Yashinata, 2017; Fidowaty and Supriadi, 2020; Pugara and Pradana, 2022).

The next strategy is the adoption of Smart Farming Technology (SFT) to support food agriculture in Indonesia, including rice, corn and potatoes. SFT can help farmers improve their productivity and efficiency by providing real-time data on soil moisture, temperature and other environmental factors that affect plant growth (Agussabti et al., 2022a). This can help farmers make informed decisions about the use of agricultural inputs such as fertilizers and pesticides. SFT has been carried out in Indonesia albeit on a limited scale such as the use of drones, sensors, online applications, robots and e-commerce to access agricultural inputs. These SFTs can help farmers improve productivity, efficiency and overall farming practices. However, its implementation in Indonesia is still low and far behind other Asian countries, such as China and Thailand. The majority of farmers have been introduced to SFT through programs organized by the government (Agussabti et al., 2022b).

Farmer groups in Indonesia can be trained to effectively use technology to access agricultural inputs, enabling them to utilize digital tools and platforms to improve productivity, efficiency, and overall farming practices. Collaboration between the government, the active role of agricultural extension officers, and the participation of farmer groups are needed to improve farmers' accessibility to agricultural inputs.

Conclusion

The subsidized fertilizer policy in Indonesia plays a crucial role in ensuring national food security and improving the welfare of farmers. However, the program faces various challenges that hinder its effectiveness. These challenges include rent-seeking behavior, limited budgets, data management issues, and uneven distribution. The active participation of farmer groups and the role of agricultural institutions are essential for effective distribution. The governance of subsidized fertilizers involves multiple government agencies with specific roles and responsibilities, requiring coordination and enhanced supervision. Institutional strengthening is crucial to increase farmers' access to subsidized fertilizers, and efforts should focus on enhancing the role of related agencies and optimizing distribution mechanisms. However, challenges related to training, funding limitations, and policy implementation and coordination need to be addressed. Overcoming these challenges through comprehensive measures, including training, increased funding, improved coordination, and enhanced transparency, will support the effective management of subsidized fertilizer distribution and benefit smallholders. Additionally, addressing limited access to information and low farmer literacy levels will facilitate active participation and improve program effectiveness. By implementing these strategies, the government can strengthen institutions, promote agricultural development, and ensure the success of subsidized fertilizer programs in Indonesia.

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