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## Abstract

The governance of fertilizer quality is critical to food security, as the prevalence of low-quality fertilizers hinders fertilizer use and stagnates agricultural production. This paper documents and assesses the government and market initiatives to address this issue in Vietnam. We conduct in-depth field interviews with stakeholders and identify three initiatives related to fertilizer quality control in the markets: (1) government regulation and control through licensing, mandatory quality labeling, and random inspections; (2) producer efforts to maintain quality and brand through warranty and dealer certification; and (3) hierarchical social learning, where fertilizer retailers update product assortments based on reputations among farmers, who regularly evaluate fertilizer quality. We highlight the importance of public regulation by discussing how government and market initiatives interact and complement each other.

*Keywords:* low-quality fertilizer, experience goods, Vietnam

JEL codes: L15, L51, Q16, Q18

## 1. Introduction

Fertilizer application is an essential part of modern agriculture to improve production and yields (Evenson and Gollin, 2003; Foster and Rosenzweig, 2010; Njeru et al., 2016). While the green revolution with modern varieties and fertilizers has been successful in South Asia, Africa has been left behind (Otsuka et al., 2023). While a number of reasons have been discussed, under-application of fertilizer is one of the main considerations (Carter et al., 2021; Gollin et al., 2021).<sup>1</sup> Studies have identified several barriers to fertilizer application in Africa, including lack of knowledge and information, credit constraints, costs, uncertain or low expected returns, and behavioral constraints (see Foster and Rosenzweig (2010), Magruder (2018), Macours (2019), and Suri and Udry (2022) for reviews).<sup>2</sup> Moreover, recent studies suggest that concerns about fertilizer quality hinder adoption and use, resulting in stagnant yields and agricultural productivity, and low farmer profitability (Suri et al., 2022).

Low-quality or counterfeit fertilizers are commonly reported in many developing countries,<sup>3</sup> and farmers often assume poor quality because they cannot determine the actual quality from observable characteristics or market signals (e.g., price) (Ashour et al., 2019; Ariga et al., 2019; Bold et al., 2017; Michelson et al., 2021; Ola and Menapace, 2020). Countermeasures and practical policies are needed to reduce the low-quality fertilizers in the market and to correct farmers' perceptions of fertilizer quality.<sup>4</sup>

This paper documents and discusses the government and market initiatives<sup>5</sup> that shape fertilizer supply chains and influence fertilizer quality in Vietnam, which is a leading rice-producing and exporting country. We conducted intensive reviews of newspaper reports

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<sup>1</sup> Another important factor is that proper rice cultivation practices, which have been widely adopted and proven effective in Asia, are not sufficiently disseminated in sub-Saharan Africa (Otsuka et al., 2023).

<sup>2</sup> Khor et al. (2018) show risk aversion to reduced fertilizer use among low-income farmers in Vietnam, the context of our study.

<sup>3</sup> A recent study raises the possibility that the reported findings of the nutrient deficiencies may be susceptible to measurement error in nutrient content (Hoel et al., 2021).

<sup>4</sup> For non-quality barriers, various policies have been discussed and implemented to promote fertilizer application, including technical assistance and extension services (Bernard et al., 2017; Harou et al., 2022; Kondylis et al., 2017; Suri et al., 2022), subsidies (Carter et al., 2021; Jayne et al., 2018, Harou et al., 2022; Holden, 2019), and nudges to overcome procrastination in fertilizer purchase (Duflo et al., 2011).

<sup>5</sup> We use the term “market” rather than “private” initiatives because many (large) fertilizer producing companies in Vietnam are state-owned.

documenting fertilizer quality problems and relevant regulatory frameworks. We also conducted in-depth interviews and discussions with stakeholders to learn about government and market initiatives, their implementation and effectiveness, and respondents' perceptions of fertilizer quality.

We identify three government and market initiatives. First, the government has strengthened direct control through a comprehensive regulatory framework consisting of training, licensing, mandatory quality labeling, and random inspections. Our interviews with retailers confirm that the government's controls have indeed been implemented and complied with. However, we also found room for improvement in streamlining the complicated regulatory structure, improving coordination among government agencies, strengthening inspections, and verifying compliance on the government side. Second, large fertilizer producers establish and maintain their brands by providing a warranty against customer loss due to quality problems and by certifying dealers to manage and control the distribution chain. Third, farmers and retailers try to avoid low-quality fertilizers through a hierarchical social-learning mechanism. Farmers assess fertilizer quality through careful observation, and retailers determine product selection by aggregating farmer feedback.

Vietnam is an important case to study. Vietnam shares with sub-Saharan Africa (SSA) the common experience and perception of low-quality fertilizer flooding (Bold et al., 2017; Michelson et al., 2021). However, unlike SSA, the government of Vietnam has taken steps to mitigate the problem through policies and regulations. In addition, the fertilizer market has evolved into a small number of large producers with well-established brands that dominate the market.<sup>6</sup> In this regard, Vietnam meets several criteria for the late growth stage of fertilizer markets within the framework of Ariga et al. (2019). While the effectiveness of these initiatives requires further evaluation, nitrogen inputs increased 20-fold and rice yields tripled between 1980 and 2020. Today, Vietnam is one of the world's largest rice producers and exporters.

This paper contributes to the policy discussion on the governance of fertilizer quality. Emerging literature has examined the extent of low-quality inputs in the market, their potential mechanisms, and farmers' perceptions and use (Ashour et al., 2019; Ariga et al., 2019; Bold et al.,

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<sup>6</sup> These conditions differ from those in SSA, where fertilizer quality governance is not well established, unbranded fertilizers are still common, and farmers often underuse chemical fertilizers (Ashour et al., 2019; Ariga et al., 2019; Bold et al., 2017; Hoel et al., 2021; Michelson et al., 2021).

2017; Michelson et al., 2021; Ola and Menapace, 2020). Less discussed are policies and strategies to mitigate this problem. We add to this literature by documenting the government and market initiatives taken in Vietnam to address the problem of low-quality fertilizer, and we highlight how these initiatives interact and complement each other. Our materials will also be useful for better understanding the fertilizer quality problem and formulating policies and initiatives to address it in SSA.

This study also contributes to the understanding of fertilizer quality in Vietnam. Mano et al. (2023) examine the quality of unbranded fertilizers, the most vulnerable segment of the market, in the Mekong River Delta and find that the nutrient labels are reliable on average, but suffer from large quality variability. We directly complement this finding by providing detailed institutional context.

The remainder of this paper is organized as follows. Section 2 presents the conceptual framework of the fertilizer quality problem and the background of the fertilizer market in Vietnam. Sections 3 and 4 describe government and market initiatives to address the fertilizer quality problem. Section 5 summarizes the findings and discusses their implications.

## 2. Conceptual framework and background

### 2.1. Fertilizers as “noisy” experience goods

If product quality is known to sellers but not fully observed by buyers, low-quality products may drive high-quality products out of the market, and farmers may reduce fertilizer application. The case of fertilizer is particularly problematic because it is a noisy experience good, and farmers cannot accurately assess product quality, but only observe noisy signals from its use (e.g., crop growth) that are also influenced by other factors (e.g., weather conditions and farming practices) (Bold et al., 2017).<sup>7</sup> Therefore, typical reputation mechanisms, in which consumers stop buying when they perceive poor quality, are not sufficient to address the market failure alone. Government control is expected to play an important role through licensing and certification, mandatory quality labeling, and random inspections (Dranove and Jin, 2010), as will be discussed in Section 3.

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<sup>7</sup> This is a common problem for noisy experience goods such as seeds, pesticides, herbicides (Ashour et al., 2019), or antimalarial drugs (Björkman Nyqvist et al., 2022).

## 2.2. Vietnamese agriculture in the *doi moi* era

Vietnam's society and economy have undergone drastic changes since the start of *doi moi* in 1986, which aimed to transition from a centrally planned economy to a socialist-oriented market economy. Agriculture was no exception. Farmers who had been involved in agricultural production only as members of cooperatives under the planned economy were allowed to manage their own farms at their own discretion after the start of *doi moi*. With the increased incentives for farmers to increase production, rice production soon exceeded policy targets after the introduction of the *doi moi* policy (**Figure 1(a)**).

Today, Vietnam is the fifth-largest rice producer in the world and the third-largest exporter in 2018 (FAOSTAT). Our study area, the Mekong River Delta, is the largest rice bowl, followed by the Red River Delta. The increase in rice production and yields in the early *doi moi* period was driven by improved farmer motivation to produce rice and technological improvements, such as the construction and maintenance of irrigation facilities, the adoption of modern varieties, and a rapid increase in fertilizer application (**Figure 1(b)**). The Mekong River Delta has also benefited from the expansion of cultivated areas by constructing high dikes that allow triple rice cropping, which explains the widening gap between production and yield (Tsukada et al., 2023; Vu et al., 2022).

Since Vietnam began to industrialize in the 2000s, the rural economy has undergone a structural transformation with high and increasing factor reallocation across farms (Ayerst et al., 2020; Liu et al., 2020). Increased non-farm income opportunities attracted young household members, leading to an aging of the agricultural labor force. In response to these changes, agricultural policies since 2010 have promoted structural reforms for agricultural development, including consolidation of farmland, mechanization, digitalization, expanded cultivation of high-value and safe products, and promotion of environmentally sustainable agriculture.

## 2.3. Fertilizer market

Vietnam used to be largely self-sufficient in phosphate, but depended on imports for nitrogen and potassium (**Figure 2**). With the introduction of the *doi moi* policy in 1986, fertilizer use increased significantly, which improved rice production and yields (**Figure 1**). State-owned enterprises in Vietnam responded to this increase in fertilizer demand by increasing nitrogen and phosphate production. Self-sufficiency in nitrogen has increased over time, while self-sufficiency

in phosphate has gradually decreased. The country remains completely dependent on imports for potassium.

In the 1990s and 2000s, several large-scale state-owned enterprises and many small fertilizer producers emerged. According to newspaper reports, the number of fertilizer producers in the country increased to 300 in 2009, and the number of fertilizer products distributed domestically reached 3,000 (Công, 2009). In 2017, the number of fertilizer producers further increased to 706, with a total production capacity of 28.5 million tons per year, while the number of fertilizer products exceeded 14,000, of which 12,000 were NPK-fertilizers. However, the supply of DAP (diammonium phosphate) is still dependent on imports as domestic production does not meet the demand in terms of quantity and quality. The domestic supply of NPK, urea, and phosphate, which accounts for about 70% of fertilizer demand in Vietnam, exceeds domestic consumption (Bùi, 2019: 18-19; Vũ, 2018). Large-scale state-owned enterprises belonging to either the Vietnam National Chemical Group (VINACHEM) or the Vietnam Oil and Gas Group (PVN) and four other large enterprises (**Appendix Table A1**) account for about 95% of the total fertilizer production in Vietnam (Vũ, 2018).<sup>8</sup>

In Vietnam, fertilizer is generally distributed in the following order: producer, agent (*đại lý*), and retailer (cửa hàng), whether produced by large companies or small producers. Other distribution channels include direct sales to contract farmers and large farmers, and distribution through cooperatives, but in order to control fertilizer quality, it is important first to ensure control in the main distribution channels.<sup>9</sup>

#### 2.4. Fertilizer quality in the past

In Vietnam, due to the requirement to label nutrient content on packaging, we consider fertilizers to be *low quality* if the nutrient content is less than the label and *substandard* if the content is more than 10% deficient (see Section 3.1). An increase in the number of fertilizer producers and products has led to difficulties in quality control. As summarized in **Table 1**, several

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<sup>8</sup> Bùi (2019: 18) notes that in 2018, 10 large-scale state-owned enterprises belonging to either VINACHEM or PVN accounted for the majority of annual fertilizer production. Moreover, An Giang officials admitted that about 70 percent of fertilizer products distributed in the province were products of large-scale enterprises (interviewed on August 22, 2019).

<sup>9</sup> Mano et al. (2023) provide a detailed description of the fertilizer distribution channels in Vietnam.

newspaper articles reported the results of fertilizer quality inspections conducted by central or local government agencies. It appears that low-quality fertilizers have been prevalent in the market for more than a decade. Violations include missing ingredients as well as fake packaging of well-known brands (BBC, 2020; Minh, 2019), counterfeiting with silicone (Minh, 2018), and disguising the country of production (BBC, 2020).<sup>10</sup>

Proposed reasons for low-quality fertilizers include insufficient knowledge and technology of incompetent producers (Minh, 2018; Nguyễn, 2013), collusion between producers and retailers (Khánh, 2017),<sup>11</sup> importation of low-quality/fake fertilizers (Bá 2018), corruption in authorized organizations that conduct fertilizer testing required for distribution approval (Bá, 2018; Chung, 2017),<sup>12</sup> insufficient penalties for the production and distribution of low-quality/fake fertilizers (Khánh, 2017), and cheap taste of farmers, especially in remote areas (Minh, 2019). Nevertheless, **Table 1** shows that the probability of finding low-quality fertilizers in various inspections has decreased over the past decade, especially since 2018, suggesting that overall fertilizer quality has improved.

### 3. Government control

This section documents initiatives to control fertilizer quality. We first review the government policies on fertilizer management and then describe market responses. The information in this section is based on our detailed review of the relevant regulatory framework and in-depth interviews with government officials, fertilizer retailers and wholesalers, large-scale producers, farmers, and cooperatives in Can Tho City and An Giang Province in the Mekong Delta , as well

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<sup>10</sup> In 2015, an inspection by the National Steering Committee 389 revealed that Thuan Phong Company, a fertilizer manufacturing company in Long An Province, had been producing fake fertilizer under the trademark VITOL and disguising the country of production as the US. Once the details of the violation were revealed, the Long An Provincial Public Security Department considered the case closed and decided not to prosecute. The farmers' association, the fertilizer association, and several members of the National Assembly have called for severe punishment under the law, but no action has yet been taken (BBC, 2020; Hoàng, 2020; Lê, 2020).

<sup>11</sup> According to Khánh (2017), a local government official in Vinh Long province noted that some agents order low-quality products from producers and profit together.

<sup>12</sup> According to Bá (2018) and Chung (2017), there have been cases where the authorized organizations that conduct fertilizer testing and issue certificates, which are supposed to be responsible for stopping the distribution of substandard products, issue certificates for fertilizer products that do not meet standards, in exchange for bribes.



as soil scientists and fertilizer experts in Hanoi. The interviews were conducted in August 2018 and August 2019. Retailers and farmers were introduced by local government officials, following standard research protocols in Vietnam.

### 3.1. Current regulations

At the time of the most recent interviews (August 2019), the regulatory framework for fertilizers in Vietnam consists of three points, based on Decree 108 of 2017 (108/2017/NĐ-CP). First, a license or certification is required at all stages of fertilizer production, distribution, testing, import, and sampling inspection. **Table 2** summarizes the details. The licensing system requires the product to meet a certain quality standard, producers to have a certain facility, retailers to be knowledgeable about the fertilizers and their use, and inspectors to be trained in sampling. Organizations involved in certification must be accredited as conformity assessors.

Second, Decree 108 (Article 34) requires fertilizer products to label and disclose the nutrient content in accordance with Decree 43 (43/2017/NĐ-CP), which establishes general product labeling requirements. The content of the label should not differ from the content certified with the *distribution approval*.

Finally, these regulations are enforced through sampling and inspection. Decree 108 provides detailed procedures. Sampling must be performed by a person holding a *fertilizer sampling certificate*. In addition, the fertilizer sample must be tested by a laboratory designated by the “authoritative state management agencies (cơ quan quản lý nhà nước có thẩm quyền chỉ định)” using the specified testing method. Decree 108 also defines the lower limit of ingredient content associated with the registered content by the type of fertilizer. For example, NPK and DAP must contain more than 90% of the registered content of each nutrient.

The local government has been heavily involved in fertilizer management under Decree 108. In An Giang province, several provincial departments conducted 11 fertilizer, pesticide, and seed inspections at 27 producers and retailers in the first half of 2018. Five fertilizer samples were collected for laboratory testing, and two did not meet quality standards.<sup>13</sup> Violations are usually reported to the Department of Plant Protection (Cục Bảo vệ thực vật) of the Ministry of Agriculture and Rural Development (MARD) (hereafter, MARD-DPP) at the national level.

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<sup>13</sup> Based on a report prepared by the Plant Protection Sub-Department of the Department of Agriculture and Rural Development (DARD) in An Giang province on June 12, 2018.

Violating fertilizer products are recalled, and their producers/retailers are punished at the provincial level where they are located.

### 3.2. Transition of government regulations and limitations<sup>14</sup>

Government regulations were updated four times between 2003 and 2019. The first government decree on fertilizer management (Decree 113, 113/2003/NĐ-CP) was issued in 2003. The regulations were vague, which caused the following problems. First, because the requirements for starting a fertilizer production business were loosely defined, many small fertilizer producers without adequate production facilities mushroomed. Second, the *approval of new fertilizers* (công nhận phân bón mới) was often obtained through political connections because the standards for fertilizer testing required for approval were not clear. Third, fertilizer management was divided between the Ministry of Industry and Trade (MOIT) and the Ministry of Agriculture and Rural Development (MARD). The division of responsibilities between the two government agencies was unclear, and neither had sufficient information about fertilizer production, distribution, or import and export.

In 2013, the government issued the new Decree 202 (202/2013/NĐD-CP), which replaced Decree 113 of 2003. The new Decree was issued to address the rampant use of illegal and adulterated fertilizers, which occurred in parallel with the rapid increase in the number of small-scale fertilizer producers and products on the market. Decree 202 tightened controls over Decree 113 in the application procedures for *fertilizer production licenses* (Giấy phép sản xuất phân bón) and specified detailed conditions for the sale of fertilizers.<sup>15</sup>

However, other problems remain. For example, a third classification of “other fertilizers” was created alongside inorganic and organic fertilizers without a clear definition. In addition, two separate ministries managed fertilizer control, with MOIT and MARD both managing inorganic, and organic, and “other” fertilizers. As a result, the number of fertilizer producers and products

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<sup>14</sup> This section is based on Nguyễn (2013), our interviews at the Vietnam Academy of Agricultural Sciences, Soils and Fertilizers Research Institute in Hanoi (August 30, 2018; August 30, 2019) and authorities in An Giang province (August 23, 2019).

<sup>15</sup> Decree 202 required fertilizer retailers to: obtain business registration; have stores and warehouses suitable to ensure fertilizer quality; maintain legal documents verifying the producer, importer, or distributor of each fertilizer product; and comply with fire prevention, environmental protection, and occupational safety requirements.

continued to grow after the issuance of Decree 202, and the problem of low-quality fertilizer persisted, if not worsened. According to a newspaper report, there were as many as 4,000 violations in 2015 (VNS, 2017).

Decree 108 of 2017 (108/2017/ND-CP), which replaced Decree 202 after only four years, contains many notable improvements. MARD has become the sole agency responsible for fertilizer management. Fertilizer categories are clarified with definitions for chemical, organic, and biological fertilizers. Most importantly, it established detailed regulations for each stage of fertilizer testing, production, distribution, and quality management.

Meanwhile, the following issues hinder efficient fertilizer management. First, the regulations still need to be organized. For example, Decree 108 specifies sampling protocols, but it does not specify inspection procedures; the Ministry of Science and Technology provided the conditions for inspection in 2012 and 2017 (26/2012/TT-BKHHCN, 12/2017/TT-BKHHCN).<sup>16</sup> In addition, Decree 108 does not contain provisions on penalties for violations. Depending on the type of violation, local authorities must comply with three other decrees.<sup>17</sup>

Second, the agency responsible for fertilizer management has not been unified at the provincial level, even though Decree 108 establishes MARD as the sole responsible agency at the national level. According to our interview in An Giang province, both the provincial-level MOIT (i.e., the Department of Industry and Technology (DOIT)) and MARD (i.e., the Department of Agriculture and Rural Development (DARD)) have the authority to conduct fertilizer inspections. In addition, the Provincial People's Committee organizes and sends members to the Steering Committee 389 in An Giang Province.<sup>18</sup> DOIT, DARD, Steering Committee 389, the Department of Market

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<sup>16</sup> These inspection instructions apply not only to fertilizers, but also to other products sold on the market.

<sup>17</sup> The Decree 185 of 2013 (185/2013/ND-CP) deals with violations of production and sales activities in general, Decree 119 of 2017 (119/2017/ND-CP) deals with violations of product quality in general, and Decree 55 of 2018 (55/2018/ND-CP) deals with violations of administrative procedures in the fertilizer sector. Each decree specifies the form of punishment according to the type of violation (for example, the amount of the fine, revocation, and suspension of certificates or approvals for production, sale, and inspection).

<sup>18</sup> The Committee is a substructure of the National Steering Committee 389. The National Steering Committee 389 was established in 2014 pursuant to Prime Ministerial Decision 389

Management, and the police conduct inspections without coordination. The frequency of inspections per retailer is limited to once a year, and to avoid duplication of inspections, these agencies must identify uninspected retailers.

Third, these complex regulations are further exacerbated by repeated and disorganized policy changes. In November 2019, the government replaced Decree 108 with Decree 84 (84/2019/ND-CP). In conjunction with the implementation of the 2018 Crop Protection Law, this policy change consolidated many related but scattered regulations that were complicated to administer.<sup>19</sup> Decree 84 was issued as the implementing regulation for the Crop Production Law, but confusingly, Decree 84 was accompanied by various implementing regulations. As a result, the complexity of the fertilizer management system at the local government level was not resolved and may have been exacerbated.

#### 4. Market initiatives

We now turn to a description of the market initiatives taken by fertilizer producers and retailers.

##### 4.1. Producers and retailers

**Control and compliance.** Our interviews with retailers suggest that the regulation and control of Decree 108 is generally being implemented. Most of the producers and retailers interviewed are aware of the Decree. All retailers covered by our interview survey held the specified *retailer certificate* and were inspected by government officials within 12 months of the interview. The inspection included the possession of certain licenses or certifications (i.e., *retailer certificate* and *fertilizer specialist certificate*) and whether the fertilizers sold had *distribution approval*.

**Branding and reputation building.** Producers and retailers improve their reputation and product quality in several ways. First, large producers offer retailers a warranty for losses caused by quality problems.<sup>20</sup> Government authorities may inspect and fine retailers; the warranty covers

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(389/2014/QD-TT) with the aim of combating smuggling, trade fraud, and counterfeiting.

<sup>19</sup> The report was prepared by the Science, Technology, and Environment Committee of the National Assembly, on May 11, 2018 (858/BC-UBKHCNMT14).

<sup>20</sup> Binh Dien Fertilizer Joint Stock Company states on its website that “Binh Dien is responsible for quality at all stages of production, retail, and use.” They have a system to confirm any problem

any such losses. Some producers have explicit warranty clauses in their sales contracts. Retailers perceive them as an implicit norm, even if there is no legal basis, at least in contracts with the major producers.

Second, in order to strengthen branding, some producers have introduced a certification for the agents in the distribution system. For example, Binh Dien Fertilizer Joint Stock Company, a major producer with its representative brand “*Đầu Trâu*,” grants the Dau Trau dealer certification (Professional Dau Trau fertilizer agent / *Đại lý phân bón Đầu Trâu chuyên nghiệp*) only to agents who have received a certain level of training on fertilizer use and have passed the examination.<sup>21</sup> The producer expects that this system will help farmers identify trustworthy agents and retailers, and the producer can be confident that the agent is worthy of selling its products.

Third, in order to verify the quality, the retailers require producers to submit the *approval of distribution* for each product in each season, as required by Decree 108. Retailers ask producers to send a sample of the product before signing a sales contract. Retailers check the color and appearance of the nutrient granules, and some retailers even test the product in their paddy fields.

Fourth and finally, retailers primarily consider brands when selecting products for sale.<sup>22</sup> Farmers are aware of major brands, and brands appear to be a critical factor in product selection, as we discuss below.

However, retailers are reluctant to deal with new, small-to-medium-sized producers, and these producers often engage in aggressive sales with attractive promotions, including reduced prices. Retailers are concerned that these producers are not trustworthy, that their approvals, certificates, and licenses may be fraudulent, and that they may not honor warranty terms.

**Competition among retailers.** Competition among retailers can help eliminate low-quality fertilizer because farmers can switch to other local retailers if the retailer’s fertilizer assortment is not attractive. Many farmers interviewed reported having access to multiple retailers, and retailers compete on product variety, credit sales, delivery services, and fertilizer prices. Since

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found at the farmer level within 24 hours (according to an interview at the Long An factory of Binh Dien Fertilizer Joint Stock Company on August 26, 2019, and the company’s website [<https://binhdien.com/gioithieu/about-binh-dien/>, accessed on December 8, 2020]).

<sup>21</sup> Interview at the Long An factory of Binh Dien Fertilizer Joint Stock Company on August 26, 2019, and the company's website (<https://binhdien.com/gioithieu/about-binh-dien/>, accessed on February 28, 2020).

<sup>22</sup> Currently, there is no exclusive agency/distributor system in Vietnam, and a retailer can deal with any fertilizer product from any producer.

most retailers offer credit sales (payment after harvest) and deliver fertilizer to customers' paddy fields (mostly) for free, the product assortment seems to be the most important strategy to differentiate themselves from other retailers. In deciding which products and brands to stock, retailers pay attention to farmer preferences and change products based on farmer complaints.

**Perception of low-quality fertilizer.** All of the retailers interviewed said that they had never encountered low-quality fertilizer. They claimed that they believed the problem of low-quality fertilizer was prevalent in other provinces, but not in their own. They may have been telling us the truth, but it is also possible that they did not want to be seen as retailers of low-quality fertilizer and ruin their reputation.

#### 4.2. Farmers

**Perception of low-quality fertilizer.** No farmer expressed concern about low-quality fertilizer, although they were aware of the problem. Most news about low-quality fertilizer problems comes from other provinces, and the farmers do not consider it an immediate problem. Vietnamese farmers use fertilizer intensively, perhaps in part to compensate for reduced nutrient levels (Nguyen 2017: 47). Fertilizer use in the Mekong River Delta has generally increased over time. However, none of the farmers interviewed cited low fertilizer quality as a reason for intensive fertilizer use.<sup>23</sup>

**Product choice.** Farmers' choice of retailer appears to depend on the provision of sales credit and the assortment of products. Distance to the retailer is less critical, as retailers usually deliver fertilizer to their paddy fields. Farmers are not interested in whether the retailer has the certificates required by Decree 108. Major brands (producers and trademarks) are well known, and farmers have preferences and loyalty to certain brands.

**Quality assessment and social learning.** Farmers' beliefs about product quality are based primarily on their own experience. Many farmers believe that they can infer fertilizer quality by observing crop growth, leaf color changes, granular texture, solubility, and country of origin for

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<sup>23</sup> Several studies have argued that increased fertilizer use in the Mekong River Delta is due to reduced soil fertility caused by the continuation of triple cropping (Tong, 2017; Tran et al., 2018). However, a recent study using a representative household survey found no correlation between the continuation of triple cropping and increased fertilizer use or reduced yields (Tsukada et al., 2023).

imported products. Of course, the accuracy of their quality assessments is questionable.<sup>24</sup>

Importantly, beliefs about fertilizer quality are also updated through social learning. Farmers share information with each other. Local extension workers occasionally recommend specific brands to farmers. Cooperatives also recommend or even specify some brands when farmers engage in contract farming. In particular, some farmers share feedback on their quality perceptions with retailers through regular communication and complaints. These retailers respond to consumer feedback by switching to other producers or products.

## 5. Discussion and conclusion

### 5.1. Implications of three initiatives

Based on in-depth interviews, we found the following facts related to the governance of fertilizer quality: government control through regulations and inspections; producer reputation building through branding, warranty, and dealer certification; and farmer learning through quality assessment, information exchange, feedback to retailers, and retailer competition through product assortment. We discuss the implications of these initiatives.

***Government control.*** Government control is a primary and direct intervention. Regulations consist of standard quality disclosure rules, including licensing and certification, mandatory quality labeling, and random inspections (Dranove and Jin, 2010). During our interviews, we found that producers and retailers comply with the regulations.

Meanwhile, several issues remain to be addressed. Regulations need to be better organized, as rules on sampling protocols, inspection procedures, and penalties are currently complex and scattered across different decrees. The agencies responsible for fertilizer management have not been unified and remain uncoordinated. In addition, such complicated policies can be further complicated by frequent policy changes. The various government agencies can better coordinate initiatives, collect information on violations, and effectively communicate inspection results to the market. They can also increase the coverage and frequency of inspections, improve

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<sup>24</sup> See Ashour et al. (2019) and Michelson et al. (2021) on how farmers evaluate quality and its inaccuracy. In our context, some farmers determine that fertilizer granules that do not dissolve immediately are of low quality. However, slow-release fertilizers are intentionally designed to dissolve slowly and release nutrients gradually.

compliance on the government side, and eliminate corruption by falsifying inspection results.

**Branding.** Producers use two main strategies to build and maintain higher reputations. Warranty is a well-known measure to commit and signal high quality under asymmetric information (Grossman, 1981). Authentic dealer certification is valuable in preventing counterfeiting because counterfeiting dealer certification is more complex than imitating packaging and logos.<sup>25</sup> The example of dealer certification by Binh Dien Fertilizer Joint Stock Company described in Section 4.1 helps agents to signal their close relationship with the producer and their knowledge.

**Learning and reputation building.** Farmers try to assess fertilizer quality based on observations. An important contextual difference between Vietnam and SSA is that Vietnamese farmers have more experience with rice cultivation and related fertilizer use; therefore, they are expected to infer fertilizer quality better.

The hierarchical social-learning process, in which retailers accumulate farmers' fertilizer quality ratings and decide on product assortments, may eliminate "bad" products from the market faster and more effectively than farmers' individual learning by more accurately evaluating quality signals due to the law of large numbers (Bold et al., 2017). This hierarchical social learning also differs from ordinary decentralized social learning, in which each farmer decides which product to use based on the information shared within social networks. In hierarchical social learning, retailers accumulate and aggregate a larger number of signals from farmers, allowing them to make more accurate quality inferences than individual farmers. Retailers thus play the role of a centralized information "expert" in detecting product quality and eliminating low-quality products from the market by deciding which product to sell (Biglaiser, 1993; Biglaiser and Friedman, 1994).<sup>26</sup>

## 5.2. Policy implications

Vietnam's experience offers several lessons for other countries. First, the government should implement the "standard" regulatory package of licensing, certification, mandatory quality labeling, and random inspections. Learning from farmers' experiments alone that the fertilizer is unprofitable can be slow and uncertain if nutrients are only moderately diluted, which could create

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<sup>25</sup> Producers can easily verify and detect dealers who falsify a dealer's certification. Consumers can also check that the dealer is certified by reviewing the published list of certified dealers.

<sup>26</sup> Moreover, government inspection results also provide reliable signals.



an equilibrium in which low-quality products persist in the market (Bold et al., 2017). Inspections are essential to eradicate the problem. These regulations must be enacted and implemented through sufficiently frequent and intensive inspections. This requires a specific administrative capacity.

When such administrative capacity is limited, the role of market initiatives becomes more relevant. The Vietnamese case suggests that reputation building is possible through entrepreneurial efforts such as warranty and certification of authentic dealers. Competition among producers can help farmers identify poor-quality fertilizers by comparing products (Björkman Nyqvist et al., 2022).

Government regulations complement market initiatives. Quality standards, labeling requirements, and third-party inspections strengthen producers' reputations and signaling. It is also critical for consumers to be able to verify producers' quality claims, as trademarks identify each product but do not reveal the quality. Governments should also support the protection of intellectual property rights, such as trademarks, to prevent counterfeiting.

Accelerating the quality of learning can also help build a reputation. One primary approach is to increase the frequency of on-site inspections. Accepting inspection requests from farmers can speed up detection, as suspicious products are more likely to be requested for testing.<sup>27</sup> Training and dissemination of information on quality detection methods to farmers, facilitated by extension officers, can be helpful in promoting self-learning.

As new fertilizer producers, distributors, and retailers continue to enter the market, it is also critical to require appropriate skills and facilities, and to provide technical assistance and training. In Vietnam, the government requires these entities to have relevant education, knowledge, skills, and facilities, and to obtain and renew certificates and licenses, while providing training to fertilizer retailers.

#### 5.4. Limitations and directions for future study

Given the scope and descriptive nature of our approach, we do not make causal claims about the effectiveness of the observed initiatives. Rigorous evaluations of specific policies, such as those for the e-verification programs, are needed (Gillgan et al., 2019). Nevertheless, the

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<sup>27</sup> Requested testing, in which anyone can request nutrient testing at a low cost, was introduced in prewar Japan (Matsumoto and Sakane, 2017). Producers and retailers demanded testing for signaling purposes, while buyers (mostly farmers' associations) demanded quality verification.

initiatives studied here are standard and have been implemented in many developed countries. While a thorough comparative study is warranted, we believe that a combination of direct government control and market initiatives is essential. In this regard, the results of Mano et al. (2023) are suggestive. They find that although there is large variation in actual nutrient content between samples and between nutrients within a sample, nutrient labels are on average reliable in the Mekong River Delta, even for the unbranded fertilizers. Given that quality cannot be maintained by reputation for unbranded products, this suggests that regulation plays a critical role in controlling quality.

Future studies could examine policies that induce and support market initiatives under limited administrative capacity, typically in developing countries. Frequent inspections, their announcement, and third-party quality testing services (Saenger et al., 2014) are potential candidates for such policies.

The case of SSA remains a puzzle. Recent studies argue that the problem lies in the farmers' persistent misperception of fertilizer quality despite its good quality. Future studies are expected to clarify whether fertilizer quality is indeed good and, if so, how the quality problem was solved when social learning is dysfunctional (because farmers have misperceptions about quality) and the government regulation is ineffective (Michelson et al., 2021).

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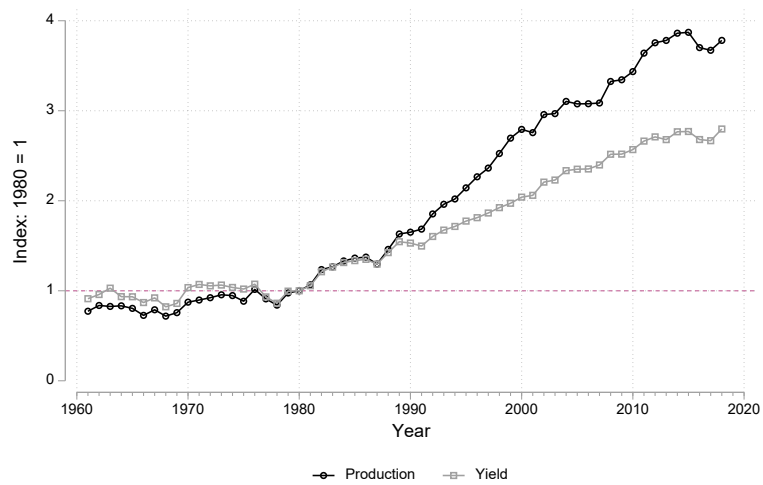
**Table 1.** Newspaper reports of low-quality or counterfeit fertilizers

Reference	The ratio of low quality/fake fertilizer	Evidence	Information source
Công (2009)	435 (47.18%) out of 922 fertilizer products did not meet the standards.	In 2008, 4434 fertilizer producers and distributors were inspected in 22 southern provinces.	Aggregate (incomplete) data from 22 provinces
Quang (2010)	419 (48.8%) out of 859 sample fertilizers did not match the ingredients on the package, especially 58% of the inorganic fertilizers (mainly NPK).	In 2009, the sample tests were conducted in 17 southern provinces.	Aggregate data reported by 17 provinces
Nguyễn (2013)	Up to 41% of sampled fertilizers did not match the labeled ingredients in all three factors of NPK.	In 2011, sample tests were conducted on several producers and distributors nationwide.	Ministry of Industry and Commerce
Khánh (2017)	69 (over 40%) of 158 sample fertilizers did not match the labeled ingredients.	In 2014, 158 sample fertilizers were tested in Tra Vinh Province.	Department of Industry and Commerce of Tra Vinh Province
Minh (2018) Phan (2018)	306 (21.5%) out of 1420 sample fertilizers and pesticides were in violation.	In the first quarter of 2018, 1420 fertilizer and pesticide products were inspected nationwide.	The National Steering Committee 389
Hoàng (2019)	12 (24%) out of 50 sample fertilizers did not meet the ingredients listed on the package, and two products were counterfeit.	In the first half of 2019, 50 sample fertilizers were inspected in Long An Province.	The Department of Market Management of Long An Province

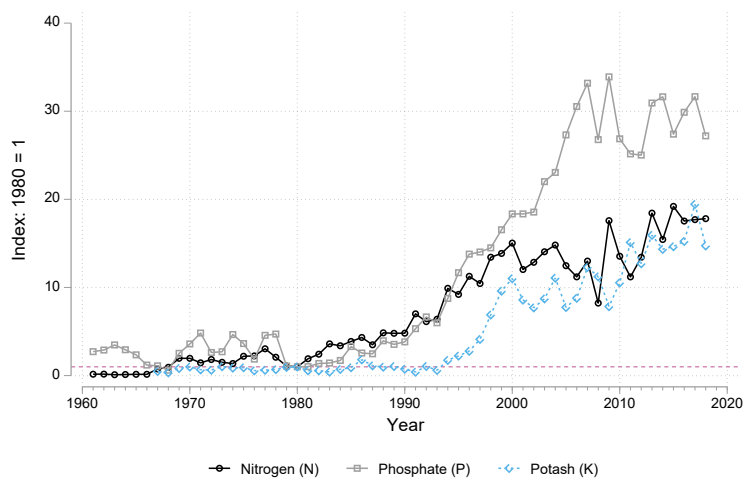
Source: Prepared by the authors.

**Table 2.** Main licenses and certificates for fertilizers

License/Certificate	Required for	Requirements
Distribution permit (công nhận lưu hành)	Fertilizer distributor	Issued by the Department of Plant Protection (Cục Bảo vệ thực vật) of the Ministry of Agriculture and Rural Development (MARD) (hereafter referred to as MARD-DPP). The approval is valid for five years and must be re-approved three months before expiry. Field tests are required before approval and the test procedure is specified in detail. The tests may only be conducted by organizations that meet certain conditions and are accredited by the MARD-DPP.
Fertilizer producer license (Giấy chứng nhận đủ điều kiện sản xuất phân bón)	Fertilizer producer	Issued by MARD-DPP. All producers must meet the specified criteria for production facilities and personnel.
Fertilizer retailer certificate (Giấy chứng nhận đủ điều kiện buôn bán phân bón)	Fertilizer retailer	Issued by the Sub-Department of Plant Protection, Department of Agriculture and Rural Development at the provincial level. The requirements for the retailer certificate include certain sales facilities and the requirement that a person in charge of selling fertilizers must obtain the <i>fertilizer specialist certificate</i> .
Fertilizer specialist certificate (Giấy chứng nhận bồi dưỡng chuyên môn về phân bón)	Sales manager of a fertilizer retailer	Complete a 3-day training course unless they have a specific educational background in horticulture, plant protection, soil, fertilizer, or agronomy.
Fertilizer sampling certification (Giấy chứng nhận tập huấn lấy mẫu phân bón)	Sampling specialist	Complete a 5-day training course.



(a) Paddy production and yield (1980 = 1)

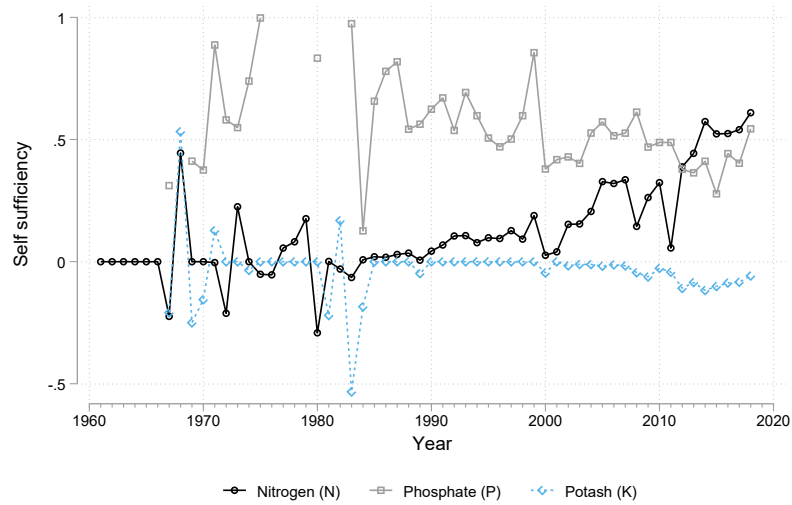


(b) Fertilizer use (1980 = 1)

**Figure 1.** Trend of paddy production, yield, and fertilizer use in Vietnam

*Source:* FAOSTAT.

*Note:* Fertilizer use indices are calculated based on the amount of nitrogen (N), phosphate (P<sub>2</sub>O<sub>5</sub>) and potassium (K<sub>2</sub>O) applied per cropland area (kg/ha). 2.3. Fertilizer market and distribution channels



**Figure 2.** Fertilizer self-sufficiency

*Source:* FAOSTAT.

*Note:* Fertilizer self-sufficiency is defined as the difference between agricultural use of fertilizer and fertilizer imports divided by agricultural use, where agricultural use and imports are reported in quantity (tons).

## Appendix

### Appendix A.

**Table A1.** Major fertilizer producers in Vietnam

Name of company	Main products and capacity (thousand ton/ year)	Brand	Established Year
Vinachem Group			
Habac Nitrogenous Fertilizer & Chemicals Company Limited	Urea (500)	Ha Bac	1959
Binh Dien Fertilizer Joint Stock Company	NPK (1050)	Dau Trau	1973
Ninh Binh Nitrogenous Fertilizer Ltd. Company	Urea (560)	Ninh Binh	2011
Southern Fertilizer Corporation	NPK, Superphosphate, Organic (450)	Con O	1976
Van Dien Phosphate Corporation	FMP (300), NPK (150)	Van Dien	1963
Lam Thao Phosphate and Chemical JSC	NPK (750), Superphosphate (750)	Lam Thao	1962
Ninh Binh Phosphate Fertilizer Joint Stock Company	FMP (300), NPK (200)	NIFERCO	1977
Can Tho Fertilizer & Chemical Joint Stock Company	NPK (300)	Co Bay	1977
DAP-VINACHEM Joint Stock Company	DAP (330)	DAP	2008
DAP2-VINACHEM Joint Stock Company	DAP (330)	DAP Lao Cai	2008
PVN Group			
PETROVIETNAM Fertilizer and Chemicals Corporation	Urea (800)	Phu My	2003
PETROVIETNAM Ca Mau Fertilizer Joint Stock Company	Urea (935)	Ca Mau	2011
Other			
Five Star International Group	NPK (300)	Nam Sao	1999
General Materials Biochemistry Fertilizer Joint Stock Company	NPK (360)	Hoa Sinh (HIS)	2005
Baconco Group	NPK (200)	BACONCO	1996
Japan Vietnam Fertilizer Company	NPK (350)	JVF	1995

*Source:* Website of each company (accessed on March 14, 2023), Bạch (2021).