Study on the Effect of Chemical Fertilizer Reduction on New Agricultural Operation Subject

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Abstract. This study explains the cause and development of chemical fertilizer reduction, summarizes that the agricultural operating entities of chemical fertilizer reduction mainly consist of the traditional smallholders and new agricultural operation entities. And concludes the existing three feasible routes for reducing chemical fertilizer use: production end, consumption end and operation mode from the aspects of the traditional smallholders. This research also illustrates the advantages of chemical fertilizer reduction of new agricultural operation entities based on profit maximization, ecological consciousness and technological advantages, and analyzes the possibility of its driving effect on surrounding smallholders from various perspectives.

Keywords: Chemical Fertilizer Reduction; New Agricultural Operation Entities; Driving Effect.

1. Introduction

Since the reform and opening up, China’s grain production has achieved remarkable results. Grain output increased from 304.765 million tons to 663.843 million tons, an increase of 117.82%. At the same time, the area sown with grain decreased from 120,587 hectares to 116,064 hectares (Source: China Statistical Yearbook (1978) and China Statistical Yearbook (2019).), indicating a significant increase in land yield per unit area. Agricultural factor input such as chemical fertilizer and pesticide, agricultural technology and agricultural machinery adoption are the main reasons (Zhu, 1999; Xiao et al., 2004; Hu et al., 2006; Huang et al., 2010). Among them, fertilizer input is an important driving factor for yield growth (Kong et al., 2018). However, the excessive application of chemical fertilizer is serious in China. The amount used increased by 511.27% from 8.84 million tons in 1978 to 54.036 million tons in 2019 (Source: China Statistical Yearbook (1978) and China Statistical Yearbook (2019).), far exceeding the increase in grain production. At the same time, the current per-mu chemical fertilizer application amount of 325.65kg is far higher than the internationally recognized safe upper limit of 225kg/hm². This will not only bring about environmental problems such as soil acidification, water and air pollution, but also waste agricultural resources and increase production costs (Ji et al., 2018), leading to crop reduction (Shankar & Neeliah, 2005; Chu et al., 2012; Yang et al., 2016). In addition, with the transformation of agricultural development stage and the improvement of residents’ consumption ability and level, the contradiction between green consumption preference and the supply of green agricultural products has become increasingly prominent (Wei, 2017). Therefore, excessive fertilization will also be detrimental to agricultural supply-side reform and agricultural modernization (Kong, 2016). To this end, the Central Committee of the Communist Party of China and The State Council issued the Rural Vitalization Strategic Plan (2018-2022) in 2018, advocating reducing the amount of chemical fertilizer and pesticide application and actively guiding farmers to apply fertilizer scientifically. In 2021, the No. 1 central document proposed to continuously promote the reduction and efficiency of chemical fertilizers and pesticides, promote green agricultural development, and promote rural revitalization and agricultural modernization.

At present, the existing literature mostly studies the ways to realize the reduction of fertilizer based on farmers’ own agricultural production decisions. For example, insufficient cognition of scientific fertilization by small farmers leads to excessive application (Qiu et al., 2014; Li et al., 2015). However, the important role of the emerging agricultural entities in promoting the reduction of chemical fertilizer application has been neglected. In addition to the traditional small-scale farmers, new agricultural business entities (hereinafter referred to as “new entities”) such as large specialized households, family farms, farmers’ professional cooperatives and agricultural enterprises are widely
emerging. In theory, the new entities are engaged in specialized, large-scale and mechanized agricultural production and management, and have a high level of ecological consciousness, which is conducive to scientific fertilization and fertilizer reduction (Cai & Du, 2016). At the same time, the new entities have a demonstration and driving effect on the surrounding farmers, which helps to promote scientific fertilization among farmers to a certain extent (Abdoulaye, 2005; Wang & Du et al., 2020). However, whether the new entities can effectively promote the reduction of chemical fertilizer needs the support of empirical data. Based on this, this paper uses the Data of China Household Financial Survey (CHFS) in 2015 to explore the effect and mechanism of the new entities in promoting fertilizer reduction. This can not only provide a theoretical basis for cultivating and developing new types of agricultural business entities, but also provide a path reference for promoting fertilizer reduction and improving ecological environment to realize rural revitalization.

2. Literature Review

The reduction of chemical fertilizer application and the realization of agricultural sustainable development goal depend on the change of agricultural operation entities’ decisions on the amount of chemical fertilizer application. The agricultural operation entities mainly include traditional peasant households with small-scale operation and emerging new agricultural operation entities with moderate-scale operation. Existing researches mainly discuss the possible ways to promote the realization of fertilizer reduction from the factors that affect the fertilizer application decision of traditional smallholders, and mainly study from the following three perspectives. The first perspective is from the individual characteristics at the production end. To begin with, small-scale farmers apply fertilization mainly based on agricultural production experience. They subjectively believe that the amount of fertilizer application is positively correlated with the yield, so they tend to use excessive fertilizer with the risk aversion psychology (Qiu, 2014). Secondly, small-scale farmers are witnessing a trend of aging labor force and generally have a low level of education, lacking the cognitive ability of scientific fertilization and farming and hardly using any environment-friendly and other new agricultural technologies (Chu, 2012). Thirdly, in order to increase income sources, small-scale farmers are generally engaged in part-time jobs, and the distraction of energy may lead to lax land management (Yang & Fan, 2018). At the same time, farmers’ willingness to invest in sustainable agricultural production and their awareness of ecological and environmental protection are weakened, which may lead to farmers’ misuse of chemical fertilizers. The second perspective is the consumer side. Green consumption of agricultural products is becoming a new trend (Wei, 2017), which puts forward higher requirements on input of agricultural production factors. At present, the insufficient supply of green and healthy agricultural products provides large profit space for green organic agricultural products, which helps to encourage farmers to apply fertilizer scientifically and reduce the input of chemical fertilizer to produce green agricultural products. The third perspective is the mode of production and operation. Traditional smallholder’s agricultural management mode usually presents a dispersive and small-scale characteristic. This feature easily leads to excessive input of agricultural factors per unit of land, which is not conducive to the reduction of chemical fertilizer (Liang et al., 2020b).

In contrast, as the new production end of agricultural products, the new entities in agricultural production is gaining more and more attention. First of all, the characteristics of the new entities have certain advantages in scientific fertilization, which is embodied in the following aspects. The first advantage is its profit maximization goal. New entities with large-scale production and management have a strong motive to pursue profits (Li et al., 2015). The cost and benefit will be fully considered in the decision of the amount of pesticide and chemical fertilizer, which is helpful to the rational application of chemical fertilizer. The second advantage is their ecological awareness and cognitive ability. New entity operators already had preliminary ecology consciousness. They are more educated and therefore have better learning ability, and are more likely to adopt environmentally friendly new agricultural production technologies (Cai et al., 2016). The third advantage is their technology. New entities are engaged in specialized agricultural production and management, making full use of talents.
in agricultural science and technology (Wang et al., 2020) and agricultural technology. They have a strong ability to distinguish the quality of fertilizer and the ability to formulate a fine fertilization program, so as to be able to scientifically and rationally fertilizer. The fourth advantage is market perception. In order to pursue profit maximization, the new entities are more sensitive to the market supply and demand of green organic products. A more accurate perception of the demand for green agricultural products makes it possible for new entities to engage in the production of green agricultural products and thus reduce the amount of chemical fertilizer (Huang, 2014; Kong and Zhou, 2020).

Moreover, new entities may also have an important influence on the fertilizer application decisions of surrounding farmers. First, the scientific fertilization management mode of the new entities may have a demonstration effect on the surrounding farmers. For example, higher ecological consciousness of new entities operators and the spilt effect of human capital are conducive to farmers’ learning and imitating production behaviors of new entities to promote fertilizer reduction (Liang et al., 2020a). In addition, studies have found that the participation of farmers in cooperatives has a significant positive impact on their green ecological production behaviors (Xiao & Du, 2015). High quality farm trials have a demonstrative and promotive effect on the reduction of chemical fertilizer use by farmers (Abdoulaye, 2005; Wang & Du, 2020). Large farms also help surrounding farmers to reduce the amount of chemical fertilizer (Cai et al., 2016; Lay et al., 2018). Based on a Zambian study on the impact of large farms on farmers’ fertilizer inputs, Lay et al. (2018) found that farmers living in villages without large farms applied significantly more fertilizer than farmers living in villages with large farms. Lay et al. (2018) also pointed out that this might be related to the agricultural factor subsidy project proposed by the Zambian Government, but did not explain in detail nor study the possible reasons. Second, the specialized and large-scale agricultural production and operation mode of new entities can realize large-scale operation by driving surrounding farmers to rent land (Huang & Yu, 2010; Wang et al., 2015; Zhang et al., 2017; Zhang et al., 2018). This in turn helps to reduce the usage amount of chemical fertilizer (Xiang et al., 2012; Zou & Zhang, 2019). New entities are engaged in large-scale agricultural production and operation, which, to a certain extent, can drive elite farmers to rent land and expand the operation scale. For example, Lay et al. (2018) found that large farms can drive surrounding farmers to expand the scale of land operation, which promotes land concentration from inefficient farmers to elite farmers, helping to achieve large-scale agricultural operations. For farmers engaged in large-scale production and management, the amount of chemical fertilizer input is usually more reasonable. Studies have found that farmers’ renting land and moderately expanding their business scale is conducive to the release of agricultural production factors. This practice can also improve the usage efficiency of factors, thus helping to achieve chemical fertilizer reduction (Xu et al., 2014; Li et al., 2015; Leaf, 2016; Zhu, 2017; Zhang & Luo, 2020). Third, the mechanized production and operation mode of new entities also has a certain demonstration effect on the surrounding farmers, which can drive the surrounding farmers to increase the input of agricultural mechanization, thus helping to realize the reduction of chemical fertilizer. New entities such as cooperatives can promote the dissemination and application of new agricultural production knowledge, technologies and varieties among farmers (Fischer & Qaim, 2012; Abebaw, 2013; Wang et al., 2019; Chen, 2020). Moreover, in the process of mechanized production and management, fertilization is easier to be under quantified and standardized control. This can ensure the evenness and accuracy of the application amount, improve the utilization efficiency of chemical fertilizer and maintain the soil fertility, which is contributive to the reduction of chemical fertilizer (Shen et al., 2011; Ji, 2018; Zhang & Luo, 2020). Fourth, new entities have the dual characteristics of production demand and service supply (Li et al., 2020). By participating in and cultivating the outsourcing market for productive services and developing agricultural socialization services, they can provide farmers with services such as agricultural machinery rental, production technology training or agricultural labor force sharing. This can promote farmers to participate in the socialized division of labor in agricultural production and adopt agricultural production outsourcing services, so that farmers can enjoy the scale economies effect of productive services (Luo, 2017). This practice
helps to further promote chemical fertilizer reduction (Yang et al., 2020), and also facilitates the organic connection between small farmers and modern agriculture (Zhang & Luo, 2018).

3. Limitations and Prospects

At present, the existing literature provides many references for the follow-up study of chemical fertilizer reduction, but there are still directions to expand as follows. First, most of the existing studies focus on the characteristics of small farmers to explore feasible ways to promote chemical fertilizer reduction. However, the amount of chemical fertilizer used depends on the input decision of agricultural entities. In addition to the traditional small-scale farmers, new agricultural entities gradually play a bigger role in agricultural production and operation. However, few studies have discussed the possible ways to realize the reduction of chemical fertilizer from the perspective of new agricultural entities. Second, few literatures have examined the possible role of family farms and specialized farmer cooperatives in the process of chemical fertilizer reduction. However, new agricultural entities mainly include major professional households, which are large specialized households, family farms, farmer specialized cooperatives and agricultural enterprises, and their roles in the process of chemical fertilizer reduction may be significantly different. There are few literatures comparing and analyzing the difference of the chemical fertilizer reduction effect of different new entities. Third, existing literatures mostly start from the characteristics of new entities, such as technical advantages, risk awareness and knowledge level. The existing literature provides a possible theoretical explanation for the contribution of new entities to chemical fertilizer reduction, while the mechanism of new entities’ promoting chemical fertilizer reduction needs to be further studied.

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