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Economy Analysis of the Determine of Rice Farming System

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Abstract

In sub-Saharan African countries, rice is grown through different rice farming systems (RFSs). Despite the growing interest of policymakers and significant research in ensuring sustainable rice production, little is known about the factors that underline the choice of the different RFSs. This study empirically examines key determinants of RFSs choice with Côte d'Ivoire, a case study, where three rice production systems are distinguished. Considering that farmers can make multiple choices, we use a Multivariate Probit model. Data were collected from 588 rice farmers randomly sampled in seven rice areas. The results show that the determinants of the choice of RFSs vary from one production system to another. More specifically, land tenure, presence of an irrigation system, intercropping system, access to extension services, membership in a rice farmers' organization, access to credit, paddy rice marketing, rice farm size, farming experience, off-farm income, gender, and household size influence the choice of the different RFSs. Our results suggest increasing investment in irrigation infrastructure, strengthening technical and organizational support to rice farmers, and defining guidelines for the intercropping system.

Keywords: Agricultural systems; Sustainability; Rice farmer preference; Multivariate probit model.

Introduction

In sub-Saharan Africa (SSA), in addition to being a food commodity of strategic significance for food security and social stability, rice is a food crop that generates income and contributes to poverty alleviation. Therefore, in SSA countries, rice is a pivotal commodity to achieve the two first goals of the Sustainable Development Goals (SDGs) entitled "No poverty" (SDGs 1) and "Zero hunger" (SDGs 2). Rice consumption in this region is increasing faster than any other food commodity, and the rice demand growth rate is the fastest one in the world (Arouna, Fatognon, et al., 2021). The rapid growth of the population and the change in dietary preferences are the main reasons for the rising demand for rice. However, local rice production in SSA is failing to meet the increasing demand of the population (Arouna, Devkota, et al., 2021). This makes SSA countries, including Côte d'Ivoire, major rice importers to fill the gap in rice consumption demand. In Côte d'Ivoire, despite the new commitment of policymakers in the aftermath of the 2007 to 2008 global food crisis, the local rice production struggles to keep pace with national consumption demand. The productivity level of paddy is commonly pointed at as one of the reasons. Although the country's average paddy yield (2.79t/ha) in 2020 was slightly higher than that of the entire SSA region (2.28 t/ha), it remains low compared to the world average (4.61t/ha in 2020; FAOSTAT, 2022). Paddy rice production in Côte d'Ivoire, like in SSA countries, is mainly grounded on three Rice Farming Systems (RFSs) (Dossou-Yovo et al., 2020; Futakuchi et al., 2021; Tanaka et al., 2017). The Rainfed Upland Rice Farming (RURF), the Irrigated Rice Farming (IRF), and the Rainfed Lowland Rice Farming (RLRF). In RURF, rice is cultivated without soil surface flooding, under crop rotation systems with other crops (Saito et al., 2018). Shifting cultivation and slash-and-burn cultivation of fallow land or new clearings are carried out with rudimentary tools. Upland rice farms are exposed to climatic hazards We carry out this study in the context of Côte d'Ivoire. The RFSs mentioned above all contribute to local rice production and are essential for producers' livelihoods. These rice producers are smallholder farmers estimated at two million (NRDS, 2012). They practice family agriculture with rice plots averaging around 1 ha (Ouattara et al., 2020). Rice farming constitutes a reliable source of food and economic activity for these smallholder farmers. The determinants of the choice of RFSs remain poorly understood in SSA countries in general, and particularly in Côte d'Ivoire, despite the implementation of policies to boost rice production in this region (Arouna, Fatognon, et al., 2021; Demont, 2013). Through this study, we contribute to this gap by empirically examining the key determinants of the choice.

Literature Review

The existing literature regarding the choice of cropping systems and practices in general shows that several factors determine farmers' decisions. These earlier studies, which have been carried out for the most part in developing countries, can be broadly grouped into two parts. One strand of studies has analyzed the determinants of the choice of crop varieties, while a second strand has analyzed the determinants of the choice of crops and cropping adaptation strategies in response to climate change. In line with the first strand, Greig (2009) investigated crop choice factors and assessed decision-making between subsistence and commercial farmers in Tanzania. The results showed that seasonality, water availability, machinery availability, crop marketability, and potential profit determine the choice of crops. Moreover, the author found that commercial farmers were more oriented toward the economic aspects of the crop, while subsistence farmers were more oriented toward the taste of the crop. In Ethiopia, Asrat et al. (2010) used the random parameter logit model to identify farmers' preferences for major cereal varieties (teff and sorghum). The results revealed that yield stability and environmental adaptability are significant attributes for the choice of crop varieties. Furthermore, the authors reported that resource endowments such as land and livestock, farming experience, and access to extension services influence farmers' preferences of crop variety. Using the Seemingly Unrelated Regression

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model, Yang et al. (2017) reported that ethnicity, farmland altitude average, labor productivity, family size, and yield are factors that influence the planting of two rice varieties (red rice and hybrid rice) in Yuanyang county, Yunnan Province. For their part, Appau et al. (2020) applied the multinomial logit model to investigate the determinants of Tobacco In accordance with the second strand, Doumbia and Depieu (2013) found that faced with the challenges of climate change, rice farmers in the rainfed upland rice system choose other rice varieties or other food crops (cassava, maize, yam, or plantain) at the expense of rice crop in the Center-West of Côte d'Ivoire.

Theoretical and analytical framework

The theoretical background of this study relies on the neoclassical microeconomic theory. This theory postulates that economic agents make their decision to maximize their utility. Therefore, the random utility model is used to conceptualize the choice of rice production system that a rice farmer makes. We postulate that the choice of producer between (j) choices procures the latter with a certain level of utility (Uij). Considering that they have the choice of planting rainfed upland, rainfed lowland, and irrigated rice (j = 1, 2, and 3), the rational producer chooses the production system that maximizes his utility. More exactly, a rice farmer chooses the production system 1 rather than 2, if and only if U U i i 1 2 > . Following Tarekegn et al. (2017), the utility (Uij) is decomposed into deterministic (Vij) and random (ε ij)

U V ij = +ij ij ε .

Discussion

In Côte d'Ivoire, rice is cultivated in both upland areas (rainfed upland rice) and lowland areas (rainfed lowland rice and irrigated rice). Therefore, understanding the determinants of the choice of these different production systems is essential for sustainable rice production in the country. The results of the econometric analysis show that, overall, the determinants of the choice of RFSs vary from one cultivation system to another. However, the econometric approach cannot justify this variation. To do so, we refer to previous research and economic theory. In the following discussion, emphasis will be placed on the differences that have come out from these findings. The significant influence or relevance of environmental factors (land and water) in the choice of RFSs can be explained by the fact that land and water resources are the primary production factors in agriculture. On the one hand, in SSA countries such as Côte d'Ivoire, the galloping urbanization and the high demographic growth reduce farmlands, notably in upland areas. Therefore, the availability of farmland is key for rice farmers, and they must make their choice of the RFS by considering the endowment of farmland. The MVP results show that rice farmers who own land are more likely to grow rainfed upland rice and are less likely to grow rainfed lowland rice. In other words, all other things being equal, if there is farmland in upland areas, rice farmers choose RURF to the detriment of RLRF. This choice of landholder rice farmers could be stemmed from the fact that the work in the lowlands is tougher (laborious) than in the uplands. Indeed, for the production of rainfed lowland rice farmers must transform the land themselves (i.e., clearing, ploughing, making the drainage channels, etc.) for the production of rice. Thus, landowners prefer to exploit upland areas and rent the lowland areas to landless farmers. Likewise, studies elsewhere found that land endowments influence the choice of crops (Asrat et al., 2010; Ozaki & Sakurai, 2020). In rice farming, Ozaki and Sakurai (2020) found that the availability of upland influences significantly and positively upland rice production in Madagascar. On the other hand, rice farmers are also concerned with the availability of water. Rice crop is a water-intensive crop (Nawaz et al., 2022; Thapa & Rahman, 2021). Accordingly, water sources (hydro-agricultural dam, diversion from river, tube wells) are important in rice farming. Based on the econometric results, rice farmers are more likely to choose IRF and less likely to choose the other two production systems (RURF and RLRF) in the presence of an irrigation system. This result signifies that ceteris paribus, in the presence of irrigation infrastructure, irrigated rice production can gain momentum at the expense of the two other production systems in Côte d'Ivoire. The irrigation system allows rice farmers to control water, thereby alleviating the problems of drought and flood that are inherent threats in the other two production systems. In the same way, studies of Greig (2009), Kinuthia et al. (2018), Buisson and Balasubramanya (2019), Ozaki and Sakurai (2020), and Thapa and Rahman (2021) found that water availability, particularly irrigation systems, is a key determinant of the choice of crops in Tanzania, Kenya, Tajikistan, Madagascar, and Nepal, respectively. Ozaki and Sakurai (2020) reported that the presence of irrigation in lowlands influence significantly and negatively the choice of upland rice production. On their part, Thapa and Rahman (2021) reported that in the presence of irrigation systems that have good water delivery systems, farmers choose rice crop over the other crops.

Conclusion

Rice is an essential food crop for food security, income generation, and poverty alleviation in SSA countries. Therefore, this crop is the target of policymakers through agricultural development policies in these developing countries. As this food crop is grown through different production systems in SSA countries, including Côte d'Ivoire, the study of the determinants of the choice of RFSs is fundamental for sustainable rice production in such countries. This research paper examined key determinants of the choice of RFSs, with Côte d'Ivoire a case study. The empirical results showed that the following variables significantly determined the choice of RFSs in Côte d'Ivoire: extension services, FBOs, land tenure, presence of irrigation system, access to credit, farming experience, marketing of paddy rice, intercropping system, size of rice farm, off-farm income, gender, and household size. On the one hand, these agronomic guidelines could allow farmers to increase the yields of the different crops concerned by the intercropping system. On the other hand, agronomic guidelines could help improve soil quality and reduce climate risks, thus ensuring sustainable agriculture.

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