Factors affecting the adoption of fertilizers by rice farmers in Côte d’Ivoire

Akinwumi A. Adesina
West Africa Rice Development Association, Bouake, Côte d’Ivoire (present address: International Institute of Tropical Agriculture (IITA) B.P. 2008, Yaounde (Messa), Cameroon)

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Abstract

This paper analyzed the factors that affect the adoption of chemical fertilizers by rice farmers in Côte d’Ivoire using a Tobit model. The results show that the major factors that positively influence farmers’ use of fertilizers in rice fields are cultivation of lowlands, use of mechanization, farm size, land pressure and availability of non-farm income. Factors found to negatively affect the use of fertilizer in rice fields are the distance of the field to the village, distance of the village to the major market, and if the cultivator is a female. The paper concludes with strategies for targeting soil fertility interventions on farmers’ rice fields.

Introduction

Soil infertility and low use of chemical fertilizers have been cited as two major factors limiting productivity growth of agriculture in most of Sub-Saharan Africa (Bationo and Mokwunye, 1991; Vlek, 1990). Studies of soil nutrient balance across countries in Sub-Saharan Africa show evidence of widespread nutrient mining leading to severe nutrient deficiencies across agro-ecological zones (Smaling et al., 1993). In particular, several nutrient disorders (both deficiency and toxicity) have been identified for rice lands in West Africa (Kang, 1973), including deficiencies in nitrogen, phosphorous and iron in the uplands (Agboola and Fube, 1983), potassium deficiency in leached oxisols and Ultisols, and zinc deficiency in lowlands (Kang and Okoro, 1976). In lowland rice systems, it has been shown that the addition of varying levels of phosphorous, potassium and zinc can be used to ameliorate the serious effects of iron toxicity. The importance of fertilizers for sustainable productivity increases in rice in West Africa is evident. Rice production has been growing at the rate of 4.1% since 1970, but with most of the production growth coming from bringing new lands into cultivation. Area expansion has grown at the annual rate of 2.4% compared to only 1.5% annual yield growth since 1970. Such expansion, particularly into marginally productive upland areas, may lead to soil nutrient mining or degradation unless efforts are made to increase the use of organic and inorganic fertilizers to replenish soil nutrients.

Fertilizer use in sub-Saharan Africa remains very low averaging less than 10 kg of fertilizer nutrients ha⁻¹ (Vlek, 1990). Macro-level constraints to fertilizer use in sub-Saharan Africa include: thin fertilizer markets that preclude socially profitable domestic investments in fertilizer production (Vlek, 1990), high import prices (Andre, 1989), extremely high marketing costs and irregularity of supply due to very poor road infrastructures and physical distribution facilities (Daramola, 1989; Vlek, 1990) and the recent drastic elimination of fertilizer subsidies that is worsened by a lack of adequate credit facilities for farmers (Vlek, 1990; Thompson and Baanante, 1989). It is, therefore, important to identify the factors that affect the adoption of fertilizers by farmers so as to better target fertilizer-based interventions. Very few studies have quantitatively examined the determinants of farm-level fertilizer use in West Africa (Daramola, 1989; Fatusi, 1976; Matlon, 1994). No study has yet investigated the determinants of fertilizer use within rice-based cropping systems in Côte d’Ivoire.
The objective of this paper is to determine the factors that affect farmers’ adoption and use intensity of chemical fertilizers in rice production systems in Côte d’Ivoire. This study differs in two ways from the only article on fertilizer adoption in West Africa so far published in this Journal (Daramola, 1989). First, it uses detailed plot-level data. Daramola (1989) and the earlier work by Falusi (1976) focused only on socio-economic characteristics of farmers (e.g., age, education, membership in farmer associations, contact with extension agents, access to credit, etc.) and overlooked critical farm-level and field-specific factors that condition fertilizer adoption and use. Ignoring plot-specific factors limits the usefulness of results from adoption studies for orienting agronomic and soil fertility research to better target soil fertility decline on farmers’ fields (Posner and Crawford, 1992; Matlon, 1994). Our access to both detailed plot-level, household-level, and community-level socioeconomic factors permits us to consider critical ecosystem and other plot-specific factors and spatial issues that affect fertilizer use within rice-fields of farm-household members. Second, the earlier studies used Probit models which treated the fertilizer adoption decision as a dichotomous choice (i.e., either the farmer adopted or did not adopt fertilizers). Tobit model, which has the advantage of permitting the derivation of the probabilities of adoption and expected level of use intensity of the technology (Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1996) is applied in this paper.

Materials and methods

Survey

Data for this study were collected from a random sample of 120 rice farm households in 22 villages located in humid-forest (Gagnoa area), forest-savanna (Touba area) and savanna (Boundiali area) agro-ecological zones, respectively, of Côte d’Ivoire. Study villages and households were selected based on a detailed macro-level characterization of rice farming systems in Côte d’Ivoire (Becker and Diallo, 1992). The villages also constitute key sites where detailed biophysical characterization (e.g., agronomic, hydrologic, cropping systems, weeds, diseases, insects, etc.) is being carried out by the West Africa Rice Development Association. Cropping systems in the study villages covered all major types of rice ecosystems, including rainfed uplands, lowlands, and irrigated lowlands. Overlaid on these ecosystems are the methods of tillage used by farmers: hand-tillage, oxen tillage and tractorization. Field-level data were collected during 1992 and 1993 on the use of fertilizers on all plots cultivated by every member of the farm-households. A total of 186 rice fields was monitored. Data collected included: the type and quantity of fertilizers applied, methods of application, timing of application, labor requirements, type of field on which fertilizer was applied (i.e., family or individual fields), gender of the plot owner, farmers’ assessments of the soil fertility status of the field (scaled as “very good”, “average” and “poor”) and the distance of the field to the village or homestead. In addition, crop yields were measured at harvest.

The two major types of fertilizers used by farmers are urea and NPK. None of the rice fields of villages in the Gagnoa area of the humid-forest zone received chemical fertilizers in the survey year. This may be due to the fact that farmers in this area are predominantly upland rice farmers who cultivate rice primarily for subsistence, and rely on traditional crop fallow rotation as the primary means of maintaining soil fertility. In the Touba villages, chemical fertilizer use in rice varied with the type of rice-ecosystem. Of 15 improved lowland fields sampled (i.e., lowlands with good water control), 93% received NPK and 87% received urea. Of 35 upland rice fields, 86% did not receive any fertilizers. These were all traditional upland rice systems where farmers grow traditional varieties. The remaining 14% that received fertilizers were all improved upland rice systems on which farmers cultivate improved varieties. All of the 10 cotton fields received chemical fertilizers. The data showed that farmers growing soybeans in this area apply fertilizer (exclusively NPK) to that crop. In the Boundiali villages, cotton also plays a very important role as a cash crop. Of the 30 cotton fields, 100% received NPK while 80% also received urea. Only 16% of the 55 rice fields received fertilizers. All were improved lowlands, of which 33% and 11% received NPK and urea, respectively.

Analytical model

For the analysis we used the Tobit regression model. This model (for details see Madalla, 1983) has found several empirical applications in the adoption literature (Shakya and Flinn, 1985; Adesina and Zinnah, 1993). The model framework used in this paper is given below.