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Intensification and intrahousehold decisions: Fertilizer adoption in Burkina Faso

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ABSTRACT

In most West African countries, agricultural production is a complex process that involves multiple household members managing land and sharing agricultural inputs. We develop an intrahousehold decision-making model to illustrate how technology adoption can influence bargaining processes on farms in harsh agricultural environments of West Africa, where staple food production by extended families is organized collectively under the leadership of a senior head. The head, who assumes primary responsibility for household food security, also allocates fields to members who manage production individually. Drawing on this and the intrinsic complementarity of labor and fertilizer as divisible inputs, we test the nature of the linkage between fertilizer use on collective and individual plots by applying bivariate probit and tobit models to nationally-representative, panel data from Burkina Faso. We find evidence of input sharing, though bargaining is inadequate to sustain efficient allocation of fertilizer. Plot manager characteristics that influence bargaining power, such as literacy, gender, age, contact with extension, and membership in farmer organizations differ between collectively- and individually-managed plots—confirming the differential status of household members in technology adoption. Agroforestry practices are strongly and positively associated with fertilizer use, regardless of plot manage type. Programs aimed at increasing use of modern agricultural inputs should consider impacts on bargaining positions within the household. Providing inputs to women and young men will increase their influence on other decisions, which may lead to greater equity within the household. It may also enhance efficiency in production, since currently, inputs are not allocated efficiently within the household.

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1. Introduction

Collective organization of farm production by extended family households is a social norm in the dryland farming systems of West Africa, including most regions of Burkina Faso. Often, households that span multiple generations and encompass several nuclear families farm together under the management of a senior male head or his designate. Historically, in this harsh environment, with limited equipment and few modern inputs, family groups may have averted hunger through effective pooling of their land and labor. Chayanov (1991), Fafchamps (2001)

and others have invoked risk and uncertainty to explain various forms of collective farming, and a recent empirical analysis by Ouedraogo (2016) supports this viewpoint for dryland production in Mali.

Today, extended family households in this region farm a mixture of collectively and individually managed fields. While individual plots proliferate, production on large collective fields continues to serve as the basis for family food security on many farms. Some researchers suggest that the head's strategy is to encourage hard work on these fields by granting "private" plots as rewards to family members (Fafchamps, 2001; Guirking & Platteau, 2014). Intensification, including the adoption of modern inputs such as fertilizer, may also explain individualization of production processes as a consequence of management diseconomies (Gray & Kevane, 2001; Guirking & Platteau, 2014).

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The unitary model of household decision-making is ill-suited to exploring technology adoption in this context. The unitary model, which assumes a single or altruistic welfare function among family members (Becker, 1981)¹, has been challenged in development research for decades (e.g., Folbre, 1984; Haddad, Hoddinott, & Alderman, 1994; Jones, 1983; van Koppen, 2009). Several types of models have been proposed as alternatives to the unitary model, each emphasizing heterogeneous preferences and unequal status among household members. Cooperative models, which are based on game theory, specify bargaining options that are exogenous to the household and thus amenable to policy instruments (Manser & Brown, 1980; McElroy & Horney, 1981). Collective models are a special case of cooperative models (Chiappori, 1992), in which no decision-making mechanism is specified but decisions are assumed to be Pareto efficient based on sharing rules that are empirically identifiable. Non-cooperative models provide a framework for testing Pareto efficiency (Doss, 1996).

Testing a cooperative model with 1980s data from Burkina Faso, Udry (1996) rejected Pareto-efficiency of farm production based on systematic yield differentials among plots. More recently, also in Burkina Faso, Kazianga and Wahhaj (2013) demonstrated that yields on the collective plots managed by household heads were higher than those managed individually, explaining this result by “the social institution that places a particular obligation on the head of the household” (2013: 540). Following a specification similar to Udry’s (1996), Ouedraogo (2016) found more intensive use of labor, and higher productivity, on collective as compared to individual plots in Mali. By contrast, in a higher rainfall region of Mali, Guirkinger, Platteau, and Goetghebuer (2015) concluded that plots managed by individuals had higher productivity than those managed collectively by heads, especially for cash crops.

In none of these studies did authors explicitly examine linkages between input use on collective and individual fields. Direct outcomes of intrahousehold negotiation include the allocation of modern inputs, like fertilizer, among household members. Yet, intrahousehold bargaining models are largely absent from the literature on technology adoption (Doss, 2013). One noteworthy exception is the work by Von Braun and Webb (1989), who concluded that the introduction of centralized pump irrigation in the Gambia led to a transfer of the rice crop from women’s individual fields to the collective fields farmed by men on behalf of the household. Lilja, Sanders, Durham, De Groote, and Dembélé (1996) in Mali also found that the introduction of new technologies in cash crops grown on collective plots increased women’s compensation for labor on those fields, reducing the male-female wage differential. Applying a programming model representative of conditions in southwestern Burkina Faso, Lawrence, Sanders, and Ramaswamy (1999) concluded that the impact of adopting farm technologies (as compared to household technologies) on women depended on the type of intrahousehold decision-making process—and was more favorable with bargaining behavior.

Here we develop a conceptual model that illustrates how technology adoption is affected by intrahousehold bargaining and enables us to test econometrically the nature of the linkage between input use on collective and individual fields. We apply probit and tobit models to data collected during three cropping seasons (2009/10, 2010/11 and 2011/12) under the Continuous Farm Household Survey (*Enquête Permanente Agricole* (EPA) of Burkina Faso. We employ the Mundlak-Chamberlain device to address time-invariant unobserved effects that may be related to household decision-making. The significance, direction, and mag-

nitude of the regression coefficients reveal information about the negotiations between the head who manages collective fields on behalf of the extended family and individuals who have been allocated plots to meet their personal needs.

Our findings have importance for development policy. When family resources are managed both individually and collectively, the relative bargaining position of family members affects the intended and unintended outcomes of policies and programs (Haddad & Kanbur, 1992; Jacoby, 2002; Smith & Chavas, 2007; Doss, 2013). For example, Smith and Chavas (1997) concluded that male-favored bargaining in Burkinabe households restricted the positive effects of rising income on the physical well-being of women. Here, using fertilizer as a case in point, we demonstrate how the diffusion of new technologies could be affected by the bargaining positions of household members. We highlight fertilizer adoption for two reasons. First, despite its low average use in Burkina Faso relative to other countries, fertilizer is fundamental for enhancing productivity and is the most widely adopted modern input. Second, fertilizer is a divisible input that can be readily allocated among plots. Our model can be easily adapted to the study of various intrahousehold bargaining processes in agricultural production, including husband-wife and intergenerational decision-making, and extended to other types of farm technology.

Next, we highlight pertinent contextual features of the farming system. The presentation of the theoretical model follows. Section 4 summarizes the empirical strategy. Results are discussed in Section 5, and conclusions are drawn in Section 6.

2. The Burkinabe farming context

Over two-thirds of the Burkinabe population depends on agriculture as their primary source of livelihood (World Bank, 2016). Hence, agricultural intensification is crucial for increasing household incomes. Production of rainfed cereals, such as sorghum, millet, and maize, account for over 70% of total cultivated land (INSD, 2014). Needing less moisture, millet and sorghum are well-adapted to drylands and are cultivated throughout the country. Both cereals play an important role in achieving food security, since they constitute the basis of the diet for a vast majority of Burkinabe (DGPER, 2012). In contrast, maize is grown only in the wetter zones of the country. Cotton, the main country’s export, is also produced in the wetter zones, where it is typically grown in rotation with maize and millet or sorghum. Households growing cotton have benefited for years from a vertically-integrated and highly institutionalized cotton sector, which provides them with fertilizer on credit for cotton and cereal crops (Theriault & Serra, 2014).

Social norms in most of Burkina Faso are patriarchal and patrilineal. The senior male head has ultimate responsibility for ensuring the household’s food security, supervising the use of household labor and inputs on the major collective fields planted to cereals and cotton. Harvests from collective fields are shared as meals consumed together by the patriarch, who ‘holds the keys’ to the family granaries and distributes their content. Sales revenues serve to purchase common goods, such as ceremonial expenses or taxes (Becker, 1996; West, 2010). Each household member contributes to labor on collective fields, and has a strong incentive to do so because the head is obliged to provide public goods in return (Kazianga & Wahhaj, 2013).

Alongside the collective field, the head may also allocate plots among individual members of the household according to both norms and negotiation. Following patrilocal norms, on marriage, women join the family of their husband and gain the right to cultivate a plot, on which they grow crops needed for food prepara-

¹ Another assumption that would be consistent with a unitary model would be a dictatorial welfare function.

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