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Agricultural innovations and food security in Malawi: Gender dynamics, institutions and market implications

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ABSTRACT

The main objective of this paper was to analyze the driving forces that enhance farm households' decision to adopt agricultural innovations and the implications of these decisions on household food security. Maize variety diversity, soil and water conservation and improved storage or combinations of these accounted for 98% of agricultural innovations followed by the farmers in the study area. Using data from 892 randomly sampled households obtained from six districts of Malawi, the research employed a maximum simulated likelihood estimation of a multinomial endogenous treatment effect model to account for unobservable heterogeneity that influences technology adoption decision and maize productivity. Results revealed considerable heterogeneity in the choice of agricultural innovations practiced by smallholder farmers ranging from none to all practices within their fields. For instance 24% adopted improved maize varieties and storage; 14% improved maize, soil and water conservation, 14% improved maize only and 36% practiced all the technologies while 12% practiced none. In addition, the results showed that spouse's education, marital status, religion and informal networks are important factors in shaping women's participation in agricultural technology choice decisions. Exposure to production shocks such as drought, access to input and output markets, land size and gender of the plot manager of the plots explained the variation in farmers' propensities to adopt agricultural innovations. Respondents from drought prone areas, with small land size had higher incentives to adopt all the agricultural technologies as risk minimizing strategies. Conversely, farmers from high potential regions with bigger land sizes and higher asset and crop diversity indexes were less likely to adopt these agricultural innovations. Overall, adoption of improved maize and storage technologies resulted in significant increase in maize output per unit area though it may be important for researchers and policy makers to understand the social and institutional settings in which the technology is targeted, to benefit both men and women farmers equally.

1. Introduction

Technology change has been widely acknowledged as a critical component of agricultural development and economic growth specifically in countries with agro-based economies and large concentration of agricultural households among the poor such as Malawi (World Bank, 2008; Diao et al., 2010). Agricultural technologies can provide a potential means of increasing crop production, improving household food security and subsequently raising incomes of farmers. Agricultural innovation involves the continuous use of new and existing knowledge emanating from diverse sources within and outside research domains to improve food production and household welfare (Spielman, 2005; Hall, 2010). Agricultural innovations which include adoption of improved agricultural practices, crop varieties, inputs and associated products such as crop insurance, have the potential to improve household food security and contribute to economic growth among the poor particularly in southern Africa. Agricultural innovations are facilitated by diverse interactions between men and women; shaped by institutions, practices, behaviors and social relations that direct scientific research and technological change and the ultimate socio-economic goal (World Bank, 2008). It is also important to note that economic capacities and incentives are gender differentiated in ways that affect food availability and access, resource allocation, labor productivity and welfare within the household (World Bank, 2005; Quisumbing and McClafferty, 2006). According to FAO (2011) gender inequalities constrain women more than men in competitiveness and entrepreneurship. These gender differences have implications on agricultural research and innovation in terms of flexibility, responsiveness and dynamism. It is recommended that improving access to requisite resources (such as land, seed and fertilizer) for rural women to the same extent as men would increase agricultural production by 20% (Bardisi et al., 2007; DFID, 2007). Thus understanding the dynamic processes of technology change related to gender and agriculture innovation is fundamental in order to enhance faster and sustained agricultural growth, particularly in subSaharan Africa where gender disparities

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tend to be greatest among the poor (Mason and King, 2001). The social dynamics around different activities and roles that poor communities engage in to address their economic needs through agricultural production systems shows the gender dimension of agricultural innovation. More importantly the interrelationships emanating from social dynamics of a society form a significant component of social capital that drives technological improvements and adoption. Paucity of literature on gender related agricultural innovations and its implications for increased food production is widely acknowledged (Kakooza et al., 2005; Nompumelelo et al., 2009; Meinzen-Dick et al., 2011; World Bank, 2008; Blake and Hanson 2005). Given the inter-causal relationships that exist between men and women in the different activities of the agricultural production cycle, there is need for planners, policy makers, implementers and researchers to focus both on men's and women's roles in agricultural activities simultaneously rather than as separate entities. A policy tool that addresses these diverse challenges, while maximizing on the available innovative opportunities for men and women, will be very useful.

Food security is commonly defined as a situation "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Thus, the nutritional dimension is integral to the component of food security (FAO, 2009).It is important to understand the multidimensionality of the food insecurity issue in search of effective, and comprehensive solutions which are vital for improving nutrition. Food security is a fundamental need for individuals to realize both their maximum physical and intellectual potential. It is the basis for the well-being of individuals and households and for human capital formation and, thus it is vital for economic development. Food insecurity has serious, long-lasting economic consequences at the micro and macro levels. Malnutrition and illness reduce household income earning ability; perpetuate poverty, and slow economic growth through direct losses in productivity from poor physical and mental performances and indirect losses from reduced working and cognitive capacity and related deficits in schooling, and losses in resources due to increased health care costs. Even transitory food insecurity can cause irreversible health impairments, particularly in children, limiting the development potential of future generations (World Bank, 2006). Household food security is dependent on agricultural production, food imports and donations, employment opportunities and income earnings, intra-household decision-making and resource allocation, health care utilization and caring practices. Household food security also depends on the characteristics of the decision maker and gender roles, information and education, cultural and social customs (Thomas and Frankenberg, 2002; Tanumihardjo et al., 2007; WHO/FAO, 2003). Hence, there is need to understand how agricultural innovations can be leveraged for improving food security given the complex social and institutional environment under which these innovations occur in Malawi. The objectives of this paper are to identify the pathways and the extent to which agricultural innovation contributes to household food security in a complex social and institutional environment.

2. Methodology

2.1. Conceptual framework

Smallholder farmers in Malawi produce and consume a number of maize and legume varieties. Their decision about crop combinations and varieties to grow, agricultural technologies to implement, and the amount of land to allocate to each crop and variety can be explained by household economic theory (Becker, 1965; Sadoulet and de Janvry, 1995). In this theory, due to imperfect input and output markets, a household acts as a unified unit of production and consumption of goods and services with the aim to maximize expected utility. Market imperfections directly influence farm household's investment and production decisions. For example capital market imperfections limit households to their savings and already accumulated capital assets such that low resource endowed smallholder farmers are not able to invest in capital-intensive technologies. Similarly imperfect rural labor market structure, information asymmetry and high transaction cost imply that only larger households are able to invest in labor-intensive technologies (Pender and Kerr, 1998). In many developing countries including Malawi output markets for food grains are highly seasonal and underdeveloped. Empirical evidence show that when output markets are highly imperfect or thin it discourages technology investments. Farmers will opt for technologies that improve food supply and access stability. In such situations, non-separable household models that partially or fully incorporate input and output market imperfections are suitable for modeling household decisions and resource allocation. Our theoretical framework mainly draws from Becker (1965) and Sadoulet and de Janvry (1995). In our model, households are assumed to rely primarily on agriculture. They maximize utility in a specific period t, U_t, which is assumed to be a concave. Utility depends on the consumption of agricultural commodities (c_a), manufactured goods (c_m), leisure (c_l), subject to household characteristics affecting preferences (z_h)

$$\max U(c_a, c_m, c_l \mid z_h). \tag{1}$$

The farm household utility function is subjected to three constraints, a convex, continuous production function, assuming that quantity of maize produced (q_a) depends on the selected agricultural technology x_j, family labor input available (l), agricultural knowledge(k_a) acquired through experience or observing other neighboring farmers using the selected technology, and fixed inputs such land and capital (z_f)

$$g(q_a, x_j, k_a, l \mid z_f) = 0. \tag{2}$$

It is through the production function that households are differentiated as innovating households (i.e. those that adopt modern technology or not). Adopting modern technology represents picking a production plan that represents a production possibility set that maximizes output associated with $q_a, x, l \in Q$. The second constraint relates to household's labor allocation into agriculture, off-farm activities and leisure which cannot exceed the household endowment (l). Finally, the household has a standard budget constraint such that the total household expenditure, measured using market prevailing prices should be less than the net income from agriculture, off farm income generating activities, other income sources (e.g remittances and pensions) and net savings.

Becker (1965) laid the foundation for household models while Sadoulet and de Janvry (1995) extended the model to make it a producer, worker and consumer model. This earlier work did not discuss the role that technology could play in altering the outcomes of farm output and eventually household utility. We attempt to indicate that given an isoquant $Q = f(x_i, \ldots, x_j) = \{x \in \mathbb{R}_+{}^n : x \in V(q)$ and $x \notin V(q') \forall q' > q\}$, when a new technology becomes readily available, the farm household will attempt to adjust adoption behavior of other technologies in such a way that

$$\frac{\partial f(x)}{\partial x_i} dx_i + \frac{\partial f(x)}{\partial x_j} dx_j = 0. \tag{3}$$

Hence, the household will substitute the technologies in such a way that their technical rate of substitution becomes

$$\frac{dx_j}{dx_i} = -\frac{\frac{\partial f(x)}{\partial x_i}}{\frac{\partial f(x)}{\partial x_j}}. \tag{4}$$