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Research paper

Farm diversity and resource use efficiency: Targeting agricultural policy interventions in East Africa farming systems

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ABSTRACT

This paper aimed to provide empirical evidence on the links between farm diversity and resource use efficiency. Using farm typology and stochastic production frontier approaches, we grouped households into those pursuing similar livelihood strategies and assessed their resource use efficiency. At 60% coefficient of similarity, we identified three distinct farm types – Farm-specialised, Diversified and Off-farm specialised. Significant ($p < 0.01$) differences across farm types were observed for, the proportion of income from farming, farmed area, and land use patterns, confirming these as good indicators for distinguishing between farm types. Over 50% of surveyed households were categorised as Diversified and Off-farm specialised, and mainly pursued off-farm livelihood strategies. Farm-specialised households pursued mainly farm-based activities and earned higher net incomes compared to other farm types. However, they exhibited technical inefficiency in the use of labour and fertiliser compared to other farm types. Access to extension and commercial orientation showed significant ($p < 0.01$) positive effect on technical efficiency for Farm-specialised households. Results have implications for policies and programmes aimed at improving agricultural productivity. There is need to focus support on interventions that make a significant contribution to farm efficiency, in particular, extension services and market access. Agricultural programmes are likely to be successful if they are targeted to households reliant on agriculture, while, off-farm households could be oriented towards off-farm agri-enterprises such as processing and marketing.

1. Introduction

Agriculture development is considered the engine for economic growth in Sub Saharan Africa, and a key determinant in the region's efforts to reduce poverty in the immediate years ahead. However, productivity in the sector lags considerably behind that of other continents, as well as the region's potential (AGRA, 2013). East African countries (Kenya, Uganda, and Tanzania) in particular still remain below the 6% per annum growth rate targeted by the African Union in the Maputo Declaration (2003), under the Comprehensive Africa Agriculture Development Program (CAADP) (World Bank, 2013). African governments have implemented a number of development programmes and strategies aimed at improving agricultural productivity, though they have often generated weak responses. For example, large variability in outcome of fertiliser use efficiencies has been reported in some African countries that have implemented agricultural input subsidies (Baltzer and Hansen, 2012; Chibwana et al., 2010). Similarly, government-led extension and advisory services in many African countries have been criticised for their failure to address the diverse farmers' needs and demands (Benin et al., 2007; Kristin, 2008; Swanson and Rajalahti, 2010). Further, programs promoting sustainable land use management practices in Africa have had mixed results, attributed to socio-economic and ecological variability within farming systems (Giller et al., 2011). A big question of concern to policy makers, therefore, remains on how to target investments to maximize rural growth taking into consideration the vast diversity of development attributes.

Some studies have suggested targeting interventions based on development domains based on some of the key elements that determine comparative advantage of different rural livelihoods, including agricultural potential, access to markets, and population density (Chamberline et al., 2006; Omamo et al., 2006). Targeting

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interventions based on development domains can guide commodity investment at a national level but does not provide insight into how best to reach diverse farm households. Other studies have suggested geographical targeting based on development pathways, and directing interventions across sites that are comparable (Kristjanson et al., 2012; Pender and Ruben, 2004). However, this approach has also been countered by other studies that have indicated that differences between households are greater than the differences between regions (ICRA, 2012), implying that rural households are heterogeneous irrespective of their geographical localities. Much of the diversity of smallholder farmers has been attributed to differences in farmer socio-economic characteristics, ecological variability, agronomic strategies, and farmers' livelihood diversification strategies (Oumer and de Neergaard, 2011; Pender and Ruben, 2004; Tittonell et al., 2010; Tittonell et al., 2005). These factors, in turn, may affect farmers' ability to pursue better use of available resources to increase farm productivity, and meet their main goal of food self-sufficiency (Tittonell et al., 2011). Similarly, diversity of smallholder farmers implies that they may respond differently towards any development support or policy initiative. Better knowledge of farm diversity and farm efficiency is therefore important to understanding processes driving agricultural productivity and for targeting policy interventions for enhanced sustainable production and resource use efficiency (Tittonell et al., 2011).

Farm typology offers a framework for analysing technical issues in agricultural production, developing a range of relevant solutions adjusted to the needs and means of different types of farms (Landais, 1998). Farm typology approach has been used in various previous studies on farm typologies for example in the Netherlands (Mandryk et al., 2012), Ethiopia (Oumer and de Neergaard, 2011), Kenya and Uganda (Tittonell et al., 2005) and France (Landais, 1998). These studies, however, have largely been focused on describing links between farm diversity and technology adoption, livelihood strategies, and poverty dynamics, with no focus on resource use efficiency. In parallel, studies on the efficiency of farmers in Africa are vast, but much work in this area is on efficiency indices and little has been done to analyse the determinants of inefficiencies under farm heterogeneity. Mutoko et al., 2014 assessed farm diversity and resource use efficiency, with a specific focus on implications for sustainable land management in Western highlands of Kenya.

Building on farm typology work, this paper aimed to provide empirical evidence on the links between farm diversity and resource use efficiency. Specifically, the study; i) analysed farm diversity and livelihood strategies, ii) characterised farms based on diversity of farming activities and livelihood strategies, and iii) assessed agricultural production and resource use efficiency comparing different farm types. The novel contribution to literature from this study is the analysis of resource use efficiencies of different farm types. The study also expands the current knowledge of specific socio-economic factors that influence the technical efficiency of farms. This also contributes to the identification of intervention options to address both agricultural production and sustainability concerns of rural households taking cognizance of farm heterogeneity and livelihood strategies.

Results are based on a dataset collected by IITA and ZOA International from 500 households in West Nile zone in Uganda. West Nile zone covers an altitude range from 600 m to 1700 m and four contrasting agro-ecologies that represent about 70% of the key landscape features in East Africa (Garrity et al., 2012), illustrating the diversity of smallholder production systems in East Africa on one hand, and efficiency of different farm types on the other.

2. Methodology

2.1. Study area

The study covered five districts (Arua, Koboko, Moyo, Nebbi, and Zombo) in West Nile zone in Uganda. Average rainfall in the zone is 1259 mm with high variability, from about 800 within the Lake Albert basin to about 1500 mm over the western parts (Zombo), with good to moderately rated soils. Most of the agricultural production occurs in a single rainy season of about 8 months, from late March to late November with the main peak from August to October and a secondary peak in April/May (GOU, 2010). Farmers enjoy the advantages of cross-border trade with Democratic Republic of Congo (DRC) and/or South Sudan. The road network is fairly well developed especially in Nebbi because of tourist activities in the nearby Murchison Falls National Park and recent oil exploration in the Albertine Rift.

There are four major livelihood zones in West Nile (FEWSNET, 2010); i) Highland ranges, Coffee and Banana zone (Zombo and part of Arua); ii) Tobacco, Cassava and Sorghum zone (Arua, Koboko, Moyo, and Yumbe); iii) Simsim, Sorghum and Livestock zone (Nebbi, Gulu, Amuru, and Kitgum); and iv) Lowland Cattle zones (Nebbi). The zones are differentiated by key livelihood strategies, ranging from perennial mixed cropping in the highland areas to annual crops, livestock, and fishing in the mid to lowland livelihood zone. According to Garrity et al. (2012), close to 70% of the rural poor in Sub-Saharan Africa reside in five farming systems − Highland Perennial, Maize-Mixed, Cereal Root and Tuber Crops, Agro-pastoral, and Highland Mixed Farming Systems. The diversity in farming systems in West Nile zone represents these five major farming systems in East Africa region, and thus provides a good case study for assessing farm diversity and associated production efficiencies and generating recommendations that are relevant to the region.

2.2. Data used

This study used data from a survey of 500 households; undertaken as part of the baseline study under the Agri-Skills for You (AS4Y) Programme in March 2014. IITA and ZOA international collected the data. The sampling frame for the baseline comprised households in the target programme districts. Selection of respondent households was by simple random sampling. The survey collected information on household composition, livelihoods strategies, farming activities (including crops grown), production output and prices applied for various crop outputs, land use patterns and livestock ownership. Further information was obtained on food production, food consumption, and sales. Household incomes from various sources − cropping, livestock, trading and other off-farm activities were recorded to determine the most important income sources for households in the study area.

2.3. Data analysis

2.3.1. Farming systems analysis

In order to capture diversity among farms in the zone, we constructed farm typologies (Tittonell et al., 2010). Descriptive statistics were used to summarize selected variables important for the characterization of the farming households. We tested data for multicollinearity using variance inflation factors and endogeneity of explanatory variables in the production function using Durbin-Wu-Hausman test (Maddala, 2001).

We subsequently employed multivariate techniques, involving principal component analysis (PCA) and cluster analysis (Köbrich et al., 2003), to assign farm households into clusters based on predominant livelihood activities they engaged in both on the farm and off-farm. The variables used in the PCA included; farm size (hectares), cropped share (% of cultivated area), the share of total income by income source, availability of labour both on-farm and off-farm, production orientation (% of farm produce sold), and participation in community groups. These variables have been theoretically and empirically linked with determining the performance of agricultural enterprises, for example (Bongers et al., 2015; Mandryk et al., 2012; Mutoko et al., 2014; Tittonell et al., 2005). We used the identified factors (those with factor loading ≥ 0.7) to run hierarchical clustering of the farms to derive farm