



Integrated crop-livestock management practices, technical efficiency and technology ratios in extensive small-ruminant systems in Ghana



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ABSTRACT

This paper evaluates the performance of smallholder farmers in three districts of the forest-savannah transition agroecological zone of Ghana and examines the effect of integrated crop-livestock management practices (ICLMPs) on the productivity and technical efficiency of production of small-ruminant outputs of farmers. Using farm-level data collected from a sample of 510 farmers from the Atebubu-Amantin, Nkoranza South and Ejura-Sekyedumase districts, a metafrontier production function model is used to estimate the mean technical efficiencies of farmers in each district and their metatechnology ratios. Small-ruminant outputs of the farmers were significantly influenced by the inputs, herd size, capital, labor, feed and veterinary expenses, in at least one of the three districts and for the metafrontier function. Furthermore, the small-ruminant outputs were significantly and positively influenced by the use of pigeon pea, ash or neem, improved pasture and storage of crop residue. The efficiency of production of small ruminants was affected by ICLMPs such as the use of tetracycline, use of ash or neem, and storage of crop residue in one or more of the three districts. The technical efficiency of the crop-livestock farmers was also influenced by their age, gender and education, by their participation in projects, obtaining off-farm income, market information and access to extension advice in one or more of the three districts. The results indicate that there are significant differences in small-ruminant production technologies across the three districts and that the production technology in Nkoranza South district is superior to the ones in use in the other two districts. The results underscore the need for investments in research and extension in developing and disseminating relevant ICLMPs and complementary training that leads to more efficient small-ruminant production and, consequently, increased farm income.

1. Introduction

Livestock production systems have gone through rapid changes due to human population growth, urbanization and increasing incomes with their attendant changing lifestyles. Consequently, growth in the demand for meat products is expected to reach 85% in developing economies by 2020 (Food and Agriculture Organization, 2005). This demand is expected to enhance domestic livestock production in developing countries by increasing the incomes and livelihoods of smallholders. Unfortunately, this is not the case for smallholder livestock producers in Ghana who account for about 17% of agricultural gross domestic product (Ministry of Food and Agriculture, 2010). In recent decades, the production of small ruminants (sheep and goats) has increased among rural households in Ghana for a number of reasons. They are a good source of income for farmers and, thus, have an important role in reducing poverty and improving the general wellbeing of rural households (Devendra, 2001; Devendra and

Chantalakhana, 2002; Lebbie, 2004; Peacock, 2005; Dossa et al., 2008). In addition, these small ruminants exhibit high feed conversion efficiency compared with swine, cattle and poultry (Peacock, 2005).

In Ghana, there is relatively less initial capital outlay in terms of production inputs and investments in housing and other resources for starting and continuing production of small ruminants than for other livestock (Devendra, 2001). Besides, other traits such as a short production cycle, fast growth rate, high roughage-to-feed conversion efficiency, and high tolerance to diseases make them desirable (Peacock, 2005). The high marketability and high birth rate per year also accounts for the increased preference for the production of these animals (Lebbie, 2004). In a related development, small-ruminant production has been perceived as an income-diversification strategy where sheep and goats are kept as capital stock and also for contingencies (Amankwah et al., 2012; Baah et al., 2012). Chevon and mutton are major sources of household meat and have sociocultural significance that enhances their value across the country because they

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are used for traditional festive occasions such as marriages, naming ceremonies and festivals (Baah et al., 2012).

In spite of the growing significance of small ruminants to rural households and the entire economy, the growth of the domestic ruminant livestock industry has been impeded by a number of challenges. Adzitey (2013) identified lack of improved breeding stock, diseases and inadequate feed and fodder. Others include poor marketing and lack of credit facilities, an appropriate grassland policy, adequate research and effective extension programs (Duku et al., 2011; Ministry of Food and Agriculture, 2010). As pointed out by the Ministry of Food and Agriculture (2010), this has resulted in generally low sheep and goat productivity. As a consequence, sheep and goat farmers are faced with high transaction costs that prevent them from participating actively in the markets (Rooyen and Tui, 2009; Udo et al., 2011; Amankwah et al., 2012).

Productivity could be enhanced through the use of new technologies and by promoting efficiency-enhancing, integrated crop-livestock management practices (ICLMPs). As part of the government's efforts to promote the production and enhance the productivity of small ruminants among rural farm households in Ghana, a number of livestock development interventions have been implemented. These include the National Livestock Services Project (1993–1999) and the Livestock Development Project (2003–2009) (Udo et al., 2011; Food and Agriculture Organization, 2005). A more recent intervention is the Sustainable Intensification of Integrated Crop-Small-Ruminant Project in West Africa (Western and Central African Council for Agricultural Research and Development (CORAF/WECARD), 2013), which aims to increase agricultural productivity to reduce poverty and enhance food security through sustainable crops and sheep and goat production. These programs focus on reducing poverty by improving small-ruminant productivity through research and technology. However, the impact of the interventions on productivity and market participation has not been substantial (Ministry of Food and Agriculture, 2010). Given that efforts have been made through which technologies and interventions have been developed, it is imperative to examine whether the low productivity in small-ruminant systems could be attributed to inefficiency. This will allow productivity to be differentiated by districts and decide whether district disparities could account for variability in productivity.

In this paper, a metafrontier production function model is used to evaluate the performance of small-ruminant farmers in the Atebubu-Amantin (A-A), Nkoranza-South (N-S) and Ejura-Sekyedumase (E-S) districts of Ghana. The objectives are to: (i) obtain indicators of technical efficiency for individual farmers relative to their own district and to the whole region; (ii) estimate mean metatechnology ratios and investigate whether differences in performances across districts are due to the inherent production environments; and (iii) examine the effect of ICLMPs on productivity and efficiency. The ICLMPs are technologies introduced to farmers through a number of livestock development projects, as discussed above. Thus, examining the effects of these technologies on productivity and efficiency of small-ruminant systems is essential. This will assist policymakers to identify which of these technologies are worthy of further promotion among the farmers to increase small-ruminant productivity and efficiency for improving income security and food security among poor farm households in Ghana. The results of our analysis demonstrate the need to improve productivity and efficiency through adoption of better management practices.

The rest of the paper proceeds as follows. Section 2 reviews relevant efficiency studies on small-ruminant livestock. Section 3 discusses the methodology, which includes a description of the study area, the survey procedures and data; the analytical framework for the analysis of the technical efficiencies of production of the farmers in the three districts involved; and the empirical model for the analysis. Section 4 presents and discusses the empirical results. Conclusions and policy implications are presented in Section 5.

2. Review of efficiency studies on small-ruminant livestock

Examining technical efficiency of production¹ in agriculture is important in guiding the design of better informed policies for increased food production and enhanced food security (Thiam et al., 2001; Abdulai and Tietje, 2007; Asante et al., 2014; Ogundari, 2014). Efficiency studies on livestock production have largely focused on beef cattle and dairy industries (Hadley, 2006; Gaspar et al., 2009; Fleming et al., 2010; Barnes et al., 2011; Samarajeeva et al., 2012; Sobczyński et al., 2013; Mugeru, 2013; Otieno et al., 2014), with very few of them focused on the small-ruminant sector but mostly in developed countries (Shomo et al., 2010; Galanopoulos et al., 2011; Kipserem et al., 2012; Villano et al., 2012; Theodoridis et al., 2013).

Examining the factors that influence technical inefficiency of production is essential to identify relevant factors for policy to enhance small-ruminant production. However, studies on the determinants of technical inefficiencies in livestock production have been limited to household-level characteristics, institutional factors such as extension, research, access to veterinary services, and other factors (Rakipova et al., 2003; Latruffe et al., 2005; Ortega et al., 2007; Theodoridis et al., 2013; Otieno et al., 2014; Qushim et al., 2014). Given the link between livestock and crop production (Amankwah et al., 2012), and the significant role of integrated crop-livestock farming in ensuring food security and reducing poverty in Sub-Saharan Africa, evaluating the role of ICLMPs on the productivity and technical efficiency of sheep and goat production is essential. To our knowledge, these sets of factors have not been explored in the literature.

The production of sheep and goats in Ghana is prevalent across the forest-savannah transition and guinea savannah agroecological zones (Ministry of Food and Agriculture, 2013). However, for the districts within each of these zones, the microclimatic conditions are distinct and, hence, are expected to affect the productive efforts in sheep and goat systems differently. Subsequently, given that variations in performance are evident among farmers, the conditions under which farmers operate are also subject to other biophysical and environmental limitations. For instance, in small-ruminant systems, the availability and the quality of pasture and fodder may be influenced by the agroclimatic conditions.

The relevance of regional heterogeneity on agricultural production and productivity has long been acknowledged (Bravo-Ureta et al., 2007; Boshraadi et al., 2008; O'Donnell et al., 2008; Barnes et al., 2011). As advised by Battese et al. (2004) and O'Donnell et al. (2008), farms operating under different technologies, defined by different stochastic frontier production models, are not directly comparable. Villano and Boshraadi (2010) pointed out that making such comparisons across districts may result in incorrect inferences about technical inefficiency and lead to inappropriate policy decisions. To make such comparisons, the metafrontier production function model, initially proposed by Battese and Rao (2002) and extended by Battese et al. (2004) and O'Donnell et al. (2008), is employed. The metafrontier approach allows technology gaps to be distinguished from technical inefficiency, thus, providing the basis for comparison of inefficiency under a common overall technology set.

Applications of the metafrontier approach to livestock are not numerous (Moreira and Bravo-Ureta, 2010; Barnes et al., 2011; Otieno et al., 2014), but very few studies involve small-ruminant systems (Villano and Boshraadi, 2010; Villano et al., 2012). This paper adds to the sparse empirical literature on the metafrontier approach in small-ruminant production by applying it to examine differences in technical efficiencies across three districts of Ghana.

¹ The term “technical efficiency of production” is used to measure the ability of individual farmers to obtain maximum production, given their existing resources and technology.

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