Department of Animal Science

AGRICULTURAL TECHNOLOGIES OFFER SUSTAINABLE SMALLHOLDER CHICKEN PRODUCTION EFFICIENCY

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Enhancing smallholder chicken production and productivity is an integral component of agricultural development strategies in sub-Saharan Africa, in part because smallholder chicken production plays an integral role in the livelihoods of rural and resource-poor households across sub-Saharan Africa. Smallholder production accounts for roughly 80 percent of the poultry in the region (Akinola and Essien, 2011; FAO, 2020). Livestock in general is an important asset to many people across sub-Saharan Africa, contributing to household incomes, employment, food security and nutrition, as well as supplying social, cultural and environmental values (Wong et al., 2017). The demand for livestock products is steadily increasing due to population growth and rising income levels, and this increase is projected to exponentially grow in the coming decades (FAO, 2018). How the livestock sector responds to this growing demand for animal source food will have important implications on public health, livelihoods and the environment (FAO, 2022). Production technologies will play a major role in the sustainability of poultry production in developing countries; however, utilization of agricultural technologies in the context of developing countries remains seriously underdeveloped.

Smallholder farmers and agricultural technologies

In most developing countries, village chicken production produces the largest proportion of chicken products consumed by rural and urban households, and these products have added cultural and religious values. In addition, village chicken production is an integral part of the farming system that converts low-quality feeds and household wastes into high-quality protein and supplies manure for crop production (Birhanu et al., 2021). Despite the enormous contribution of the poultry sub-sector to household livelihood and overall wellbeing, the level of production and productivity remains very low (Scanes, 2007). Therefore, potential contributions from this sub-sector to household food security, income, and overall growth and development of society remain unrealized, in part because the production of indigenous chickens faces many challenges. In East Africa, for example, the poor productivity of birds, a shortage and the poor quality of feeds consumed by village chickens, frequent disease outbreaks and inappropriate housing were identified as major constraints to production (Mapiye et al., 2008; Dana et al., 2010; Mekonnen et al., 2010; Magothe et al., 2012; Okeno et al., 2012; Bwalya, 2014; Mahoro et al., 2017).

As a result, limitations in access to production technologies such as improved breeds, quality feeds, vaccines, input and output markets, institutional support, technical support, access to Extension services and trainings, and financial capital constrain the sector. Improvements in production technologies can shift production functions towards increased quantity and quality of outputs while maintaining the level of inputs (Jin et al., 2010). Improving production and productivity of the poultry sector requires an integrated intervention that includes improving management practices and enhancing the productivity of genotypes (FAO, 2014; Wong et al., 2017). Extension services are critical to smallholder success and must provide local trainings and opportunities to improve management practices and allow smallholders access to production technologies that can enhance their knowledge and increase productivity. This will require greater attention on training Extension personnel that work with smallholders in rural outlying areas. The need for women Extension personnel is extremely great, particularly in poultry, where women smallholder farmers often care for the chickens.

Given that smallholders have limited access to productive resources, technologies and markets, it is imperative to consider productivity improvements through modern technologies and the use of available inputs and technologies. Compared with a technological change approach, sometimes a productivity change using current technologies with better input allocation or modern technologies with available inputs could better contribute to economic and environmental sustainability (Birhanu et al., 2021). Improvements to village chicken productivity should follow a comprehensive approach, including consideration of technological change, improvements to the efficiency of the production process, and enhancing other institutional and market-related factors (FAO, 2014). However, improved efficiency should be the primary driver of productivity growth and economic development, as it can successfully benefit impoverished populations in developing countries (Barbier, 2020).

Improved efficiency must be carefully managed and considered from multiple angles. Historically, introduction of improved/exotic genetics into smallholder, extensive chicken production models has not been competitive in sub-Saharan Africa due to management issues, high feed costs and disease rates. While many sub-Saharan African countries have access to exotic germplasm, these birds are often poorly adapted to these countries' low-input poultry management systems. In addition, most sub-Saharan African countries cannot produce the large quantities of feed grain needed to support intensive chicken production, making commercial layer and broiler lines not the best option for smallholder producers in the tropics. It has been suggested that smallholder farmers in sub-Saharan Africa need tropically adapted, improved breeds that are dual purpose and require only modest management conditions (Kumaresan et al., 2008; Dana et al., 2010).

Understanding smallholders' technology acceptance

Understanding smallholder farmers' perception of the acceptance and use of newly introduced agricultural technologies is challenging due to smallholders' constraints, production objectives, livelihood strategies and access to information and services (Llewellyn and Brown, 2020). Sustained adoption is a multi-staged process that includes initial awareness of the technology, adoption, evaluation, and sustained adoption or rejection of the technology (Weersink and Fulton, 2020). Weersink and Fulton (2020) identified the advantages of the technology, technology trialability, and social, cultural, and personal influences as the three critical factors that affect adoption.

For example, regarding exotic commercial lines of chickens compared to tropically adapted dual-purpose breeds, dual-purpose breeds have the following benefits for smallholder production: Like local breeds, they are more able to produce eggs and meat simultaneously (Mueller et al., 2020); they have good scavenging ability (Spencer, 2013); they are easily adaptable to diverse agro-ecosystems, and they are docile, mobile and easy to manage at the village level (McDougal, 2019). Dual-purpose breeds also have lower protein requirements and are less susceptible to common diseases (Birhanu et al., 2022). In addition, conventional and non-conventional feeds can be used without affecting their performance, making them more suitable for smallholder production. Also, these breeds have higher productivity than local indigenous breeds, which helps smallholder producers better achieve their production goals (Mueller et al., 2020). It appears that technical, economic, social and environmental feasibility of production technologies seems the most important considerations for sustained adoption and use of the technologies at the smallholder level.

Sustainability

For recent innovations and new technologies (such as tropically adapted improved dual-purpose chickens (TAIC)) to be sustainable, they must first be found feasible to smallholder farmers. Birhanu et al. (2022) argue that demonstrating an innovation's economic, social, technical, and ecological viability and enhancing access to efficient input and output markets are vital for sustained agricultural technology adoption at the smallholder level. These researchers, working in Ethiopia, Nigeria and Tanzania, found that most smallholders prefer TAICs to indigenous breeds, and TAIC-based production enhances producers' consumption and income production goals. In addition, adopting these breeds generates higher economic gains, is socially viable, is technically feasible and has manageable environmental risks. However, it was noted that sustained adoption required delivery models, capacity building, marketing and financial models, and integrated risks reduction strategies, and each of these required smallholder assistance from Extension personnel or other information outlets. In other words, recent innovations and new technologies can work at the smallholder level but require training and educational assistance from Extension services to be successful, indicating the importance of trained Extension personnel, particularly women Extension service providers with poultry background/training, to assist women smallholder farmers at the local level.

There are constraints to the feasibility of the TAIC production system. For example, from a technical feasibility standpoint, commercial TAICs have limited ability to reproduce themselves, and a sustainable supply of replacement stock is a challenge at the smallholder level. With help from the African Chicken Genetic Gains (ACGG) project, public-private partnerships have been implemented to facilitate the continual supply of replacement stock to smallholder farmers. Poultry feed is often the major constraint for semi-intensive or intensive production at the smallholder level. TAIC-based production needs a better and more readily available feed supply than local indigenous chickens. However, scavenging ability of TAICs and lower protein requirement (compared to exotic breeds) help to minimize feed cost and creates opportunities to use locally available feeds in rural areas.

Another constraint is smallholder knowledge and skill. While most smallholder farmers may have adequate experience in indigenous chicken management, sustained adoption of improved breeds requires further knowledge and training. Birhanu et al. (2022) indicated that during their baseline assessment only 10.6 percent (10.9 percent in Ethiopia, 2.4 percent in Nigeria and 18.3 percent in Tanzania) of the total respondents reported receiving Extension or training services in the previous 12 months. This indicates the serious existing gaps in Extension programs and services at the smallholder production level. Integrated and innovative Extension approaches such as videos, mobile phones, peer-to-peer learning opportunities and other digital Extension systems should be considered possible options to deliver training and advisory services (Naika et al., 2021; Silvestri et al., 2021). The Extension component requires careful thought and consideration, with particular attention paid to the training of women smallholder farmers. This is of critical importance because in many areas across sub-Saharan Africa, women are the caretakers of the chickens and are therefore the ones that need the additional knowledge and training to be successful.

Environmental situation

The environmental situation with semi-intensive TAIC or intensive exotic commercial chickens is much different than traditional extensive indigenous chicken production. Environmental risks associated with indigenous chicken production is marginal due to small bird numbers at any one site, limited manure concentration and the use of mainly scavengeable feed sources. Semi-intensive or intensive production models may lead to a higher concentration of waste as increased numbers of birds may be confined to a house for part of the day and throughout the night. Once again, this suggests the need for a greater presence of Extension personnel to integrate improved manure management strategies into intensive and semi-intensive production models to reduce environmental threats and enhance sustained adoption of technology advances.

One other important environmental issue that must be addressed and that is receiving greater attention today by researchers, program development personnel and policymakers where intensive and semi-intensive production is concerned is the increasing risk of losing the genetic diversity of indigenous chicken breeds as intensive-style production becomes more broadly adopted. Genetic diversity can buffer populations against infectious diseases, and populations with high genetic diversity are more resistant to infections than homogeneous populations (Reed and Frankham, 2003; Springbett et al., 2003). Local indigenous African chicken populations are highly genetically diverse and are heterogeneous (Kitalyi, 1998). Local African chickens may harbor genes responsible for disease resistance and may be appropriate in the changing environmental conditions caused by climate change (Gondwe and Wollny, 2007). However, despite the well-known genetic diversity of local African chickens, little has been done to investigate their genetic potential for disease resistance through artificial selection (Mpenda et al., 2019). The absence of involvement or active participation of the government and other stakeholders in genetic improvement at the rural level is another factor which limits the development of the indigenous chicken value chain (Mujyambere et al., 2022).

Due to the vast potential of indigenous African chickens, the exploration of strategies for improvement supported by additional details on their genetic variability and adaptation to different management conditions is greatly needed. It is believed that 33 percent of indigenous chicken breeds are facing extinction (Hoffmann, 2009; FAO, 2007). Therefore, as a critical first step toward breed conservation and future breeding strategies, it is fundamental to create an inventory of indigenous chickens. The FAO has initiated a program for the characterization and conservation of indigenous breeds in the hope of conserving the genetic material of these unique breeds (FAO, 2007). Conservation strategies are generally grouped into in-situ and ex-situ strategies. In-situ conservation is characterized by traditional production systems where breeds are maintained in their environment on farm, while ex-situ conservation involves maintaining breeds outside their traditional production systems using technological advances such as cryopreservation (Asmara et al., 2017). Most poultry genetic resources are preserved in-situ in the living population; however, this method has challenges such as pathogen epidemics or natural calamities. Ex-situ conservation of chickens is practiced by commercial poultry companies through the collection of frozen semen, while indigenous breeds are fully preserved by way of in-situ populations (Assan, 2015). Protecting and preserving the vast array of indigenous African chicken genetics in an ex-situ conservation system is vital to preventing the disappearance of critical poultry genetic diversity and avoiding an irreplaceable environmental loss.

Summary

Village chicken production supports the livelihoods of many smallholder farmers across sub-Saharan Africa, even though the sector is widely known for low production and productivity. This could be the result of a lack of technical efficiency and inadequate technological progress in the village chicken production system. This highlights the need for improved agricultural technologies at the smallholder level and technically trained Extension personnel — particularly women smallholder farmers who are most often caretakers of the chickens — in numbers large enough to adequately provide support to the smallholder farmer population. The adoption and dissemination of agricultural technologies is a complicated process that involves multiple dimensions and trade-offs. Technical, economic, social and environmental factors are all in play, and sustained adoption of agricultural technologies depends on establishing integrated innovations and other input delivery systems, aligning technologies with existing resources and production practices, demonstrating the profitability and financial viability of agricultural technologies under smallholders' current management systems, integrating smallholders' preferences and addressing their production goals, and minimizing production, marketing and environmental risks. Research and development should focus attention on building the capacity of smallholder farmers in various production and marketing activities, with increased attention to the empowerment of women along the value chain. A higher level of production efficiency could be achieved through a sizable and strategical investment in capacity building through Extension training services and creating enhanced input delivery and output marketing systems.

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