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Agrotechnology

Research Article

Review on Prospects of Precision Livestock farming in Ethiopia

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ABSTRACT

Livestock sector holds large share of contribution to the bio-economy and overall food production by increasing crop productivity through manure and animal traction power supply. Integrating livestock into the circular bio-economy can be enhanced by increasing the not only the edible products and direct sources of services from livestock but also share of by-products or waste that humans cannot eat in the livestock feed ration or by recycling and treating nutrients and energy from animal waste. Precision Livestock Farming (PLF) is potentially one of the most powerful avenues for developments interventions in the livestock sector in particulars as well as the national development at large amongst a number of interesting new and upcoming technologies that have the potential to revolutionize the livestock farming industry. It is used to boost farm profitability, efficiency and sustainability by improving the breeding, nutritional, environmental and other management aspects of various livestock species. The challenge and the success of farming lie in how precisely we can intensify our farming practices in the long run.

Keywords: Innovation; Livelihood; Livestock farming; Precision; Prospect

INTRODUCTION

Innovation and technical change still remain potentially critical drivers of social and economic transformation in the agriculture-based economies of many developing countries [1]. It is widely argued that, achieving agricultural productivity growth will not be possible without developing and disseminating improved agricultural technologies that can increase productivity to smallholder agriculture farm [2]. Ethiopia has large livestock population with diverse genetic resources, and agro-ecologies suitable for different kinds of Livestock production. The total livestock population for the country is estimated to be about 59.5 millions of cattle, 30.2 million goats, 30.7 million sheep, 2.16 million horses, 8.44 million donkeys, 0.41 million mules, and about 1.21 million camels. Out of 59.5 million female cattle constitute about 55.5 percent and the remaining 44.5 percent are male cattle. From the total cattle in the country, 98.20 percent are local breeds and the remaining 1.62 percent and 0.18 percent are hybrid and exotic breeds, respectively [3]. The country produces over 3.8 billion litres of milk and ~1 million tonnes of beef per year valued at USD 2.5 billion and USD 5.1 billion, respectively [4]. The country has been earning foreign currency by exporting meat and live animals mainly cattle, sheep, camels and goats [5]. Livestock production in Ethiopia has been mainly smallholder subsistence farming with animals having multipurpose use and being managed in a traditional way [6]. The country's livestock sector is increasingly challenged by limited availability of land and water resources, and climate change. Livestock contribute to improve the nutritional status and income gain of the people by providing meat, milk, eggs, cheese, butter and commodities, such as live animals, hides and skins for home use and export; and avert risks in times of crop failures [7]. Despite the huge numbers, the current contribution of livestock to the producers and to the national economy at large is limited in proportion to its size. It has increasingly been unable to meet the demands of livestock originated food products for the rapidly growing population [8].

The livestock industry plays very important economic, social and cultural roles for households to improve income and wellbeing of the farm family. The economic contribution of the livestock sector could be improved substantially if the sector better integrated into improved technologies and practices. Keeping livestock is an important risk reduction strategy for vulnerable communities, as animals can act as insurance in times of need and provide a means of income diversification to help deal with times of stress [9]. The emergence of new technologies and their use in animal husbandry, which has given rise to Precision Livestock Farming (PLF), appears to be a possible lever for the sustainable development of livestock farming systems [10]. Agricultural productivity and improved

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Received: September 10, 2019; **Accepted:** December 21, 2020; **Published:** December 28, 2020

Citation: Adane A (2020) Review on Prospects of Precision Livestock farming in Ethiopia. Agrotechnology 9: 201. doi: 10.35248/2168-9881.20.9.201.

livelihood remained low as a result not only of the lack of appropriate technologies and the lack of access to those technologies, inputs, credit and access to markets and rural infrastructure, but also because of gaps in information and skills that prevented rural producers from effectively utilizing and adopting technologies [11]. Sources of agricultural knowledge include scientific research and indigenous knowledge. After the creation, sourcing or accumulation of knowledge, the knowledge has to be disseminated to users to support the innovation process. Information and Communication Technology (ICT) can play a critical role in facilitating rapid, efficient, and cost effective knowledge management. The main aim of this review is to review the innovation capacities, generation and utilization of technologies, capacities and entrepreneurship skills of livestock value chain actors.

Prospects of precision livestock faring in Ethiopia

Ethiopia has a comparative advantage in live animals and meat export due to its large livestock population and geographical location. However, the sector remains small in volume and earning when compared to the country's resource potential and aforementioned comparative advantages. Precision livestock farming is the aspect of precision agriculture that focuses on improving livestock farming operation through the drafting and development of various software and hardware technologies for automated tracking, monitoring, disease detection, record keeping, feed management, and other livestock farming operation [12]. Precision Livestock Farming (PLF) is defined as the use of information and communication technologies for improved control of fine-scale animal and physical resource variability to optimize economic, social, and environmental aspect of farm performance [13]. It enables to have better food hygiene, traceability, welfare and environmental benefits [14]. Agricultural innovation involves interaction among multiple actors along the commodity value chain and beyond [15]. Current advancements in science and technology play great role in promoting the livestock sector [16]. ICT tools found to have lots of potential for driving innovation in livestock sector through the interaction and sharing of digital information by multiple stakeholders [17]. The shift in national policy towards more market-based economy facilitate private entrepreneurs to respond to the increasing demand of livestock products and services through increased investment in livestock production and product processing. Organized training programs on precision farming and digital technologies would raise awareness of precision agriculture with farmers and equip farmers with the digital skills required to access digital resources [18].

Precision livestock farming technologies can help farmers to improve livestock production potential and quality of product in a sustainable manner. Computerized management system allows us to have all sorts of unbiased and real time data that will get summarized into meaningful, actionable insights. Data-driven decision making leads to better, more efficient, and timely decisions that will advance the productivity of livestock herds. Artificial insemination is recognized as the best biotechnological technique for increasing reproductive capacity. However, due to numerous technical, financial, infrastructural and managerial problems its applicability in Africa has not yet matched that of its success in the developed countries [19]. Improvement of the quantity and value of livestock products need high potential for adoption technologies by enhancing the potential for investment in the sector through public private partnership and promotion of appropriate policies for value addition. Artificial insemination and preservation of semen are the main technologies that are used extensively. Reproductive technologies can also be used to control reproductive diseases if procedures and protocols are accurately followed Madan, 2005 [20]. Digital culture in production and advanced technologies are useful for more rational use of resources, higher profit margins, and greater productivity in every production sector of agriculture. The use of digital tools and instruments can enhance the sustainability of agriculture through more rational use of chemical inputs and the consequent reduction of their impacts on social, cultural, economical and environmental system of the large public.

Livestock innovation and inclusive value-chain development scenario

Livestock production is considered to be an important pathway out of poverty for the rural poor in developing countries. According to Madan, 2005, innovation is a process by which new ideas and methods are transformed into practices. Drucker defined innovation as the act that endows resources with a new capacity to create wealth [21]. Innovation System refers to the network of organizations, enterprises and individuals focused on bringing new products, new processes and new forms of organization into economic use, together with the institutions and policies that affect the systems' behavior and performance [22,23]. Fagerberg et al., describe invention as the first occurrence of an idea for a new product or process, while innovation is the first attempt to put the invention into practice and commercialization [24]. The innovation-systems approach assumes that learning in networks leads to learning by all individual chain actors. The more diverse the actors better the opportunities to combine complementary capabilities. Interaction and learning depend on actors' physical distance, the institutional environment that shapes trust-based relationships, and actors' capacity to absorb new ideas. Livestock value chain is understood to include all the actors and activities from production to consumption, and the dynamic interaction between actors involved in a livestock value chain [25]. This encompasses the two most important approaches these are inclusiveness – ensuring economic and social inclusion for all food systems actors, including smallholder farms, women and youth and sustainability – minimizing negative environmental impacts, conserving scarce natural resources, saving biodiversity loss and strengthening resiliency against future shocks. Sustainable intensification is generally defined as producing more output from existing resources while minimizing pressure on the environment [26]. Sustainable intensification of livestock production involves the use of technologies in breeding (crossbreeding and selection), feeding (planting multipurpose fodder trees and use of agro-industrial by-products) and animal healthcare (vaccination and anti-parasitic medicaments).

Innovation approach focuses on knowledge generation and use at a particular stage of a value chain, while the value-chain approach is more about value creation and market opportunities and linkages throughout the a chain. Recent studies of agricultural innovation pointed out the utility of the value-chain concept as unit of analysis and focus of interventions aimed at stimulating innovation and developing innovation capacity [27]. Livestock innovations imply improving processes and products from the holistic knowledge of the system. In the livestock sector, innovation is the successful deployment of good ideas and techniques into practice on farms. Relevant innovation capacities reside in networks and partnerships, in organizations, and in individuals [28]. Farmers need to innovate

in their system; governments need to innovate in the specific policies they implement to support family farming; producers' organizations need to innovate for a better response to the needs of family farmers; the researchers and extension advisors need to innovate shifting from a research driven process predominantly based on technology transfer to an approach that enables and rewards innovation done by smallholders themselves. Le Gal et al., noted that knowing how an innovation can be generated and diffused to the large mass of the public (commercialization) is recognized to be another key factor in the success or failure of the innovation [29]. For innovation thinkers, innovation of different kinds (technical, institutional, etc.) follows a nonlinear process and uses multiple sources of knowledge from different sources.

Determinants for livestock production technology utilization and adoption

Technologic developments provide more efficient, cost effective and fast solutions for producers to get on time process using management and direct manipulation possibilities. The main technology is electronic recording, milking, heat detection, auto-weighing, genetic improvement, feeding, barn optimization, and health issue monitoring and recording, livestock housing and equipment designs. Understanding the emergence of innovation systems is at the heart of research analyzing technological change [30]. Technologies need to be understandable and usable to achieve widespread adoption by farmers. The automation of animal husbandry and integration of on-farm systems and processes have a key role to play in facilitating the process of meeting each of important challenges for competitive market. Advanced information management is increasingly an essential component of profitable livestock production. This is achieved through various measures like effective disease forecasting, rapid and accurate disease diagnosis, modern therapeutic measures, modern livestock management systems, modern financial management system [31].

Technology acceptance and uptake is complex and influenced by a variety of factors such as socio-demographics (age, education), financial resources and farm size, with these variables having different effects on adoption. Limited adoption was attributed, among other factors, to farmers' limited knowledge of technologies and low technical support provided to them, low government priority given to fodder compared to staple crop technologies, and limited availability of fodder seeds [32]. The type of technology influences adoption decisions as there are varying costs associated with different technologies and some technologies may be more familiar to farmers. Tey and Brindal studied the adoption factors for PA and classified the factors found into seven categories; socioeconomic factors, agro-ecological factors, institutional factors, information factors, perception factors, behavioral factors and technological factors [33]. Small farmers do not know about the benefits of using technology and they also have a lack of skills in using technology. Availability of household labour, household's education attainment, better endowment of physical assets, availability of financial capital and access to information facilitate adoption of agricultural technologies [34,35].

Innovative livestock production and rural livelihood improvement

Livestock contribute to food security and nutrition, livelihoods, national economic development and the overall well-being of people. Accelerating and scaling up innovation in livestock sector can trigger the transformation needed to respond to feeding a growing and increasingly population, climate change impacts and achieve the sustainable development [4]. The growing demand for animal source foods will provide major business opportunities for cattle farmers, who will invest to increase herd sizes and improve productivity. Livestock goods and services also figure as intermediate inputs into activities such as manufacturing and transport provision within Ethiopia. The livestock sector has an enormous contribution to national economy and generating income to farmers, creating job opportunities, ensuring food security, providing services, contributing as asset, social, cultural and environmental values, and sustain livelihoods [36,37]. Technologies in animal husbandry make the production more cost-effective, socially and environmentally friendly and sustainable [38]. Food security is becoming an increasingly important issue in Ethiopia. Empowerment of women in the livestock sector is fundamental to achieving gender equality as well as essential for increased productivity and enhanced household health and nutrition. The essential roles of women in livestock raising, commodity processing and trading along with their roles in household food choices mean that innovations to improve engagement and empowerment of women are can be supported to have co-benefits with overall health and nutrition outcomes. Livestock helps on food supply, family nutrition, family income, asset savings, soil productivity, livelihoods, transport, agricultural traction, agricultural diversification and sustainable agricultural production, family and community employment, ritual purposes and social status [39]. The new emerging technology have allowed people to incorporate modern and advanced solutions that not only improve the productivity of the agricultural sector but also reduce costs, save time, improve the health and safety of the producer, increase product quality, and reduce losses within and out of the field. Household income from livestock activities has not changed notably with respect to today for smallholders, agro pastoralists and pastoralists, because of the weak economy and significant challenges in accessing productive inputs.

CONCLUSION

Livestock farming is playing a significant role supporting the livelihoods of smallholder farmers with multiple purposes. Livestock provide basic products, such as milk, meat, egg and hides and skin. Livestock products and by products provide the required animal protein contributing to the improvement of nutritional status. Precision livestock production enables to maximize the efficiency and effectiveness livestock production while maintaining farm sustainability. The habit of advanced livestock production technology and packages adoption and utilization is in infant stage. It is sound to improve the productivity, product quality, health and welfare of animals and to support traceability across the entire livestock production chain. To amplify the livestock production among livestock producers and to tackle food shortage and decreasing livelihoods, it is inevitable for livestock farmers to adopt and use multipurpose and advanced livestock production technologies and practices.

REFERENCES

1. United Nations Development Program. Making new technologies work for human development. Oxford University Press, Oxford. 2001.
2. Asfaw S, Shiferaw B, Simtowe F, Lipper L. Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. Food Policy. 2012;37(3):283-295.

3. Central Statistics Authority (CSA). Agricultural sample survey. Livestock and livestock characteristics. Volume II. Addis Ababa, Ethiopia. 2016.

4. Food and Agriculture organization (FAO). Africa sustainable livestock 2050: Livestock production systems spotlight cattle sectors in Ethiopia. 2018.

5. Asfaw N, Shahidur R, Berhanu G. Livestock production and marketing. Development strategy and governance division, International food policy research institute-Ethiopia strategy support program II, Ethiopia. 2011.

6. Ministry of agriculture. Livestock growth strategy and action. Addis Ababa University, Ethiopia. 2013.

7. Gebre Mariam S, Amare S, Baker D, Solomon A, Davies R. Study of the Ethiopian live cattle and beef value chain. International Livestock Research Institute (ILRI), Nairobi, Kenya. 2013.

8. Asresie A, Zemedu L. Contribution of livestock sector in Ethiopian economy: A review. Adv Life Sci Technol. 2015;29:79-90.

9. Thornton PK. Livestock production: recent trends, future prospects. Philosophical Transactions of the Royal Society B. 2010;365(1554):2853-2867.

10. Berckmans D. Precision livestock farming technologies for welfare management in intensive livestock systems?. Rev Sci Tech. 2014;33(1):189-196.

11. Miriam AM, Johann FK Ferdinand HM. Agricultural rural innovation and improved livelihood outcomes in Africa. Proceedings of the Forum on the Development Southern Africa. 2011.

12. Lima E, Hopkins T, Gurney E, Shortall O, Lovatt F, Davies P, et al. Drivers for precision livestock technology adoption: A study of factors associated with adoption of electronic identification technology by commercial sheep farmers in England and Wales. Plos One. 2018;13(1):1-17.

13. Eastwood CR, Chapman DF, Paine MS. Networks of practice for co-construction of agricultural decision support systems: Case studies of precision dairy farms in Australia. Agricultural Systems. 2012;32:25-48.

14. Banhazi TM, Babinszky L, Halas V, Tscharke M. Precision livestock farming: Precision feeding technologies and sustainable animal production. J Agric Biol Eng. 2012;5(4):54-61.

15. Sumberg J. Systems of innovation theory and the changing architecture of agricultural research in Africa. Food Policy. 2005;30(1):21-41.

16. Nigussie E. Livestock and livelihoods: Role of advances in animal breeding and biotechnology. Biotechnol Food Res. 2011.

17. Jespersen LM, Hansen JP, Brunori G, Jensen AL, Holst K, Mathiesen C, et al. ICT and social media as drivers of multi-actor innovation in agriculture–barriers, recommendations and potentials. European Commission, Directorate-General for Research. 2014.

18. Roberts K, McIntosh G. Use of mobile devices in extension and agricultural production-A case study. 16th Australian agronomy conference. Capturing opportunities and overcoming obstacles in Australian agronomy. 2012.

19. Van Arendonk JA. The role of reproductive technologies in breeding schemes for livestock populations in developing countries. Livestock Science. 2011;136(1):29-37.

20. Madan ML. Animal biotechnology: Applications and economic implications in developing countries. Rev Sci Tech Off Int Epiz. 2005;24(1):127-139.

21. Drucker P. Innovation and entrepreneurship. Routledge. 2014.

22. Hall A, Janssen W, Pehu E, Rajalahti R. Enhancing agricultural innovation: How to go beyond the strengthening of research systems. World Bank, Washington DC. 2006.

23. Hall M. Innovation in Africa: Speech on the conference hosted by Trust Africa. CODESRIA and the United Nations institute for economic development and planning. 2010.

24. Fagerberg J, Mowery D, Nelson R. The oxford handbook of innovation. Oxford University Press, New York. 2006.

25. Rich KM, Ross RB, Baker AD, Negassa A. Quantifying value chain analysis in the context of livestock systems in developing countries. Food Policy. 2011;36(2):214-222.

26. Pretty J, Toulmin C, Williams S. Sustainable intensification in African agriculture. Int J Agric Sustain. 2011;9(1):5-24.

27. World Bank. Enhancing agricultural innovation: How to go beyond the strengthening of research systems. Agriculture and Rural Development Department. Washington, DC. 2007.

28. Ayele S, Wiled D. Science and technology capacity building and partnership in African agriculture: Perspectives from Mali and Egypt. J Inter Develop. 2005;17(5):631-646.

29. Le Gal PY, Dugué P, Faure G, Novak S. How does research address the design of innovative agricultural production systems at the farm level?. A Review Agric Syst. 2011;104:714-728.

30. Hekkert MP, Negro SO. Functions of innovation systems as a framework to understand sustainable technological change: Empirical evidence for earlier claims. Technol Forecasting Soci Change. 2009;76 (4):584-594.

31. Food and Agriculture organization of the United Nations (FAO). ICT uses for inclusive agricultural value chains, Rome. 2013.

32. International Fund for Agricultural Development (IFAD). Technical agreement grant: Enhancing livelihoods of poor livestock keepers through increasing use of fodder. Rome. 2006.

33. Tey YS, Brindal M. Factors influencing the adoption of precision agricultural technologies: A review for policy implications. Precision Agriculture. 2012;13(6):713-730.

34. Knowler D, Bradshaw B. Farmer's adoption of conservation agriculture: A review and synthesis of recent research. Food policy. 2007;32(1):25-48.

35. Larson DF, Gurara DZ. A conceptual model of incomplete markets and the consequences for technology adoption policies in Ethiopia. World Bank. 2013.

36. Solomon A, Authority EL. Livestock marketing in Ethiopia: A review of structure, performance, and development initiatives. ILRI (aka ILCA and ILRAD). 2003.

37. GebreMariam S, Amare S, Baker D, Solomon A. Diagnostic study of live cattle and beef production and marketing: Constraints and opportunities for enhancing the system. ILRI and IFPRI, Addis Ababa University, Ethiopia. 2010.

38. Almeida CM, Santos F, Ferreira AC, Lourinha I, Basto MC, Mucha AP. Can veterinary antibiotics affect constructed wetlands performance during treatment of livestock wastewater?. Ecoll Engineer. 2017;102:583-588.

39. Moyo S, Swanepoel FJ. Multifunctionality of livestock in developing communities. The role of livestock in developing communities: Enhancing multifunctionality. The Technical Centre for Agricultural and Rural Cooperation (CTA) and University of the Free State. 2010.