Unlocking The Full Potential Of Agricultural Transformation In LDCs: The Role Of Traditional And Emerging Technologies

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Abstract

Unlocking the full potential of agricultural transformation in least developed countries (LDCs) is crucial to achieve SDG 2. Persistent challenges such as poverty, climate change, and inadequate infrastructure contribute to food insecurity in these regions. Emerging technologies hold great promise to address some of these persistent challenges, but there is a need to assess effectiveness and relevance of such technologies in the context of LDCs. The Technology Needs Assessments (TNAs) play a pivotal role in identifying specific needs and recommending appropriate technological solutions, ensuring that technology adoption is tailored to the unique conditions of each LDC. Evidence-informed and comprehensive strategies for technological adoption, encompassing capacity building, strategic investments, and a thorough assessment of the most appropriate technologies, are needed to support sustainable progress and meet future food demands by 2050.

Despite significant progress in the recent decades, the least developed countries (LDCs) still face critical challenges in meeting the Sustainable Development Goal 2 (SDG2), which aims to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. Persistent barriers such as poverty, conflict, climate change, and inadequate infrastructure hinder progress towards this goal and LDCs continue to struggle with high levels of food insecurity and malnutrition. SDG targets 2.1 - end hunger and ensure access by all people to safe, nutritious and sufficient food all year round - and 2.2 - end all forms of malnutrition - are still very far from being achieved.

As of 2022, over 270 million people in LDCs suffer from severe food insecurity (increasing from 185 million in 2015, when the SDGs were endorsed), and more than 51 million children are moderately or severely stunted. These figures underscore the urgent need for action to enhance agricultural productivity, particularly considering the projected doubling of the population in LDCs by 2050. With the LDCs population reaching 1.6 billion people by 2050, sustainably increasing food production will be critical to reduce food insecurity. Indeed, FAO estimates that global agricultural production would have to increase by almost 50 percent by 2050 (FAO, 2017). Moreover, LDCs are disproportionately affected by climate change and environmental degradation, which further exacerbate these challenges, disrupting agricultural activities and increasing the risk of food shortages.

Sustainable increases in agricultural productivity are also crucial for increasing farmers' income, given agriculture's prominence as the primary sector of employment in LDCs (54% of total employment) (ILO, n.d.), and sustain economic growth. Agriculture represents, on average, over 18 per cent of value added as a percentage of GDP (World Bank Open Data, n.d.) . Low productivity in agriculture is indeed a major reason for the persistence of poverty in most LDCs (UNCTAD, 2015). The recent pandemic and related economic downturn, together with increasing political instability and conflicts, added to the LDCs' vulnerability due to these countries' high dependence on international trade to secure access to food and disruptions in the agri-food supply chains. Despite the key role of increased productivity in the process of structural transformation and as a precondition for industrialization and development, public expenditure to support farmers and the agricultural sector is still very low, 4.2%(UNSDG, n.d.), in LDCs.

However, increasing productivity alone is insufficient; a holistic approach encompassing a reduction of food loss and waste, alongside enhancing accessibility and quality of food in a sustainable manner, is imperative. For instance, it is estimated that globally up to one third of the food produced for human consumption is wasted. In LDCs, food loss usually takes place primarily during the production and post-harvest stages of the supply chain.

Limited agricultural productivity and significant food loss often stem from deficient infrastructure and limited access to technology, including for transportation, storage, handling, distribution, processing and preservation. Science, technology and innovation play a key role in transforming agri-food systems. Technology is widely used in all stages of the agricultural supply chain, from production to post-harvest handling, storage, processing, and value addition. Well-known examples include soil health management techniques, advanced plant breeding methods, efficient irrigation systems, eco-friendly pest

management strategies, cold storage facilities, and modern processing units. However, despite the wide availability of mature agricultural technologies, their adoption in LDCs remains limited and constrained by various factors, including inadequate infrastructure, financial constraints, limited awareness of existing solutions and lack of knowledge on their application.

The 45 least developed countries are countries that suffer from structural impediments, low income, poor infrastructure, weak productive capacities, low-level of technological development, and low performance in social indicators. Challenges such as unreliable electricity, limited internet connectivity, inadequate transportation networks, skills gaps, and insufficient financial resources hinder technological development in these countries. Even profitable technologies may not diffuse widely due to credit constraints, market-related obstacles, and ineffective information dissemination systems, particularly attributable to inadequate agricultural extension services. Nonetheless, with the growing population and the need for more sustainable food production, the urgency of equitable technology access and adoption has never been more pronounced.

Role of Traditional Technologies

Agricultural technologies and innovations can be classified based on the enhancements they offer, including yield increase, cost reduction, risk mitigation, quality enhancement, environmental protection, and shelf-life extension (Sunding & Zilberman, 2001). Technologies can mitigate various food security challenges by increasing food availability, enhancing food accessibility, improving quality and nutritional value, and reducing uncertainty and food instability. For example, genetic modification of plant varieties is used to increase tolerance to drought, herbicides, diseases, or pests, and for higher yields; technologies are being applied for a more sustainable use of fertilizers to increase productivity without compromising soil conditions; low-cost and affordable drills, renewable energy-powered pumps, technologies for desalination and improved water efficiency are needed to make water available and ensure crop productivity. A reduction in post-harvest loss and waste through storage, refrigeration, transport and agro-processing innovations can ensure improved access to food, while biofortification can improve quality and nutritional value. Precision agriculture and early warning systems can help reduce uncertainty and food instability (UNCTAD, 2017).

Opportunities of Emerging Technologies

Lately, new technologies and innovations have emerged with the potential to deliver transformative results in agriculture and help address some of the prevailing challenges in this sector. From precision agriculture to modern biotechnology and drones, these innovations promise enhanced efficiency in food production and distribution, alongside reductions in food waste and increased shelf life of food products. Despite their potential, it is imperative to evaluate the appropriateness, effectiveness and relevance of emerging technologies within the context of LDCs.

A recent report indicates that even high-impact emerging technologies with the earliest maturation timelines will require another decade or more to reach maturity. These include, for example, real-time satellite imagery, positioning systems, and autonomous Geographic Information Systems (GIS). Most emerging technologies with significant potential, such as artificial general intelligence, synthetic biology, aerial robotics, and the internet of food will take another twenty years to mature (Alexandrova-Stefanova et al., 2023) . Most of the emerging technologies which promise to have transformative effects of food systems are still in the research and development or demonstration phases in developed countries. For instance, nanomaterials for food packaging, promising for addressing food loss and waste challenges, are projected to reach their full potential only by 2042, significantly beyond the Sustainable Development Goals (SDG) timeline.

Reality suggests that traditional technologies will still play a significant role in achieving increased food production, value addition along the chain, and reduction of food loss in the LDCs. For example, genetic modification for increased productivity can be achieved either through more conventional cross-breeding approaches, which continue to be of relevance for stallholder farmers which are the majority in LDCs, or through more modern biotechnology, which presents access challenges in LDCs and still requires substantial capacity building efforts, not only in terms of knowledge, but also regulatory and legal for environmental safety.

Given the array of mature technologies already available for adoption in the LDCs, understanding specific needs and potential applications in each context is crucial. Context-specific application of technologies is essential for identifying appropriate and effective means of technology transfer, ensuring the sustainability of applied solutions. The UN

Technology Bank's Technology Needs Assessments (TNAs) serve as key policy tools to identify the priority sectors or economic activities in LDCs that require technological inputs and recommend appropriate technological solutions. Agriculture has consistently emerged in completed TNAs as a focal area for the majority of LDCs, emphasizing the importance of prioritizing enhanced access to mature technologies to address prevailing gaps.

Unlocking the full potential of agricultural transformation in LDCs requires a comprehensive strategy for technological adoption, encompassing capacity building, strategic investments, and a thorough assessment of the most appropriate technologies to drive sustainable progress. While prioritizing the transfer of mature technologies, which allow for a clearer understanding of potential risks and benefits, it is essential to simultaneously speed up efforts to build innovation capabilities in LDCs. This will facilitate a more rapid adoption of emerging technologies as they diffuse. A strategic mix of both mature and emerging technologies is critical for sustainable agricultural development in LDCs. Investments in capacity-building initiatives and fostering an enabling environment for innovation are urgently needed, with an emphasis on areas which can deliver gains at a higher speed and lower cost, such as climate-smart agriculture, precision agriculture, and digital technologies for data access and exchange.

Conclusions

In conclusion, three key priorities emerge to leverage the potential of science, technology and innovation for SDG 2 in LDCs: firstly, designing and fostering sustainable food systems through innovation rooted in context-specific needs assessments; secondly, identifying the appropriate optimal mix of mature and emerging technologies based on the specific context; and thirdly, continuing to build innovation capacities to prevent LDCs from further lagging behind as the technological frontier advances.

References

Alexandrova-Stefanova, N., Nosarzewski, K., Mroczek, Z. K. Z. K., Kolos, N., & Wan, J. (2023). Harvesting change: Harnessing emerging technologies and innovations for agrifood system transformation. FAO; CIRAD; https://doi.org/10.4060/cc8498en

FAO. (2017). The future of food and agriculture: Trends and challenges. Food and Agriculture Organization of the United Nations.

ILO. (n.d.). ILO Modelled Estimates (ILOEST database). ILOSTAT. Retrieved April 25, 2024, from https://ilostat.ilo.org/resources/concepts-and-definitions/ilo-modelled-estimates/

Sunding, D., & Zilberman, D. (2001). Chapter 4 The agricultural innovation process: Research and technology adoption in a changing agricultural sector. Handbook of Agricultural Economics, 1, 207–261. https://doi.org/10.1016/S1574-0072(01)10007-1

UNCTAD. (2015). Transforming rural economies. United Nations.

UNCTAD. (2017). The role of science, technology and innovation in ensuring food security by 2030. https://unctad.org/system/files/official-document/dtlstict2017d5_en.pdf

UNSDG. (n.d.). Retrieved March 16, 2024, from https://unstats.un.org/sdgs/dataportal/database

World Bank Open Data. (n.d.).. Retrieved March 17, 2024, from https://data.worldbank.org