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Assessing Capabilities and Skills for Delivery of Quality Solar Drying Technologies in the Kenyan Market

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Introduction

Postharvest loss (PHL) presents a threat to food and nutrition security (FNS) and sustainable livelihoods in sub-Saharan Africa (SSA) and reducing it is a key target in the Sustainable Development Goal target 12.3, which aims to "halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" (FAO, 2020). Previous estimates in SSA indicated that roughly 37 percent or 120–170 kg/year per capita of food is lost (FAO, 2011). In Kenya, it is estimated that horticultural losses have been reported to be as high as 50 % (Ridolfi et al; 2018). Like in many developing countries, solar drying in Kenya is considered a cost-effective and sustainable technology option for reducing PHL, but also presenting opportunities for value-addition as part of expanding agribusiness in the country. Despite the increasing significance of solar drying technology in the food sector, their full potential has not been realized due to several challenges. These include poor designs, intermittent nature of solar energy and generally varying and sub-optimal performance of the different technologies available in the market (Mujuka et al., 2020; Ndirangu et al, 2020; Romuli et al., 2019;).

These challenges are linked to lack of minimum performance standards and guidelines for solar dryer technologies, as many developing countries, including Kenya have no clear institutional, legal, and regulatory frameworks that govern fabrication, including the use of necessary materials and marketing of solar dryers (Tchanche et al.,2009; Amankwah-Amoah, 2019; Ndukwu et al., 2023).

Key messages

- There is an expanding solar drying technology ecosystem evidenced by the number of emerging fabrication SMEs and other input actors in response to the increasing demand in the market. These present opportunities for accelerating agri-processing enterprise and industrialization that needs be exploited further.
- While the SMEs possess skills and capacities, there are critical gaps which can be enhanced through training and technical support and other capabilities strengthening approaches coupled with supportive incentives for further development and growth of the sector with a focus on enhancing quality of the technology in the market.
- Capabilities and skill gaps impact the fabricators' delivery of quality outputs resulting in low production levels, wastage of material due to errors, low uptake, and limited growth of their enterprises.
- Lack of guiding quality standards of solar drying technologies in Kenya is affecting growth of the market.

Additionally, there has been emergence of many local small and medium enterprises (SMEs) fabricating solar dryers as part of the growing productive use renewable energy technologies, but studies indicate gaps in requisite technical capabilities and skills to design and deliver quality products in the market. Considering the initial high investment costs for the technology, the lack of quality standards, potential capacity gaps is enlarging the information asymmetry on the value for money related to the technology, which may negatively impact performance of the technology that ultimately affects the agri-enterprise positioning in the market and potential to grow, including limiting access to appropriate financing (Tchanche et al., 2009; Amankwah-Amoah 2019; Udomkun et al.,2020; Ndukwu et al.,2023). According to Mohammed et al. (2020), there has been little effort to analyse and assess the solar dryers' fabrication ecosystem including status of the market orientation, including market development, marketing and distribution channels, skills, capacity and innovation, quality assurance and standardization of materials and the final product. This is a bottle neck to wide-scale adoption of solar drying technology in Kenya.

This brief summarizes findings of a rapid assessment study that was conducted to understand the capacity gaps and needs of fabricators involved in delivering solar dryers in Kenya. Data was collected from six small and medium fabrication enterprises (SMEs) to understand the nature of their business, current skills and capacities and gaps and the challenges and opportunities in the solar dryers' business ecosystem. Informed by the findings, we outlined recommendations for policy and practice that can stimulate and promote quality in the solar drying technologies market.

Summary of key findings

Business overview of the SMEs

Results showed that the interviewed enterprises that are majorly young, registered businesses, have been in existence for less than 10 years. Most were 5 years and less with only one established in 2016 (seven years old) (Table 1). Based on the number of employers, all are characterized as small enterprises, with the largest one having twenty-two staff.

The businesses are established in different parts of the country. Most of them had a diversified offering of products besides fabrication of solar dryers, including irrigation systems, dam liners, greenhouses, water pumps, energy saving briquettes and one was involved in processing, packaging, and distribution of assorted dried food products

Table 1: Fabricators business overview

Fabricator	Year of establishment	No. of Employees	No. of solar dryers sold in 2022	Estimated annual turnover from sales of dryers (KES)
SME 1	2017	10 Permanent/5 Casual	5	3 million
SME 2	2017	4 Permanent/7Casual	13	4.4 million
SME 3	2018	4 Permanent	34	Not for profit making on solar dryers
SME 4	2016	4 Permanent/6Casual	8	4.8 million
SME 5	2017	22 Permanent	15	5 million
SME 6	2018	5 Permanent/5Casual	33	16 million

*SME =Small & Medium Enterprise; Ltd = Limited

A total of 108 dryers were fabricated in the year 2022 by the six (6) SMEs, with the range of low (5) and high (34) (Table 1).

Analysis of fabricators' skills and capacities

Sources for skills and capacities

Interestingly, most (70%) fabricators obtained their skills through apprenticeship, working with other fabricators or were self-taught. Only a small portion learned through formal institutions. The skill sets they noted to have include design and installation (mechanical design, forming, and shaping), fabrication (blueprint reading, and welding), assembly, business development, structural engineering & design, material selection, marketing, and customer service.

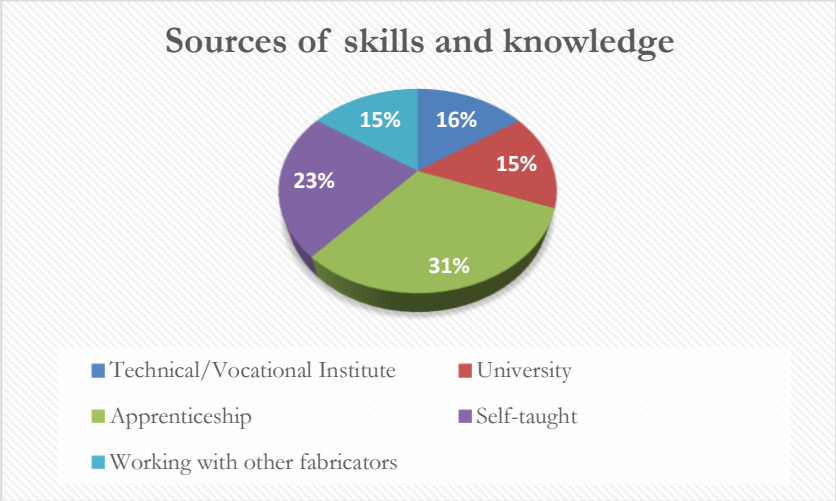

Figure 1: Sources of fabricators' skills

Gaps and demand for skills

The SMEs highlighted various existing gaps in their skills and capacities (Figure 2)., the skills that are highly in demand and other skills deemed critical for effective delivery. The demand for the listed skills is guided by current market and customer demands for improved accessibility and affordability of dryers.

Skills & capacity gaps	• Design, construction, trouble shooting • Automation of processes • Sourcing for more funding for outreach programs, training and payments of recurrent overhead costs • Conceptual and design, installation and costing skills • Design of modern cost-effective dryers • Implementing a mass production line
Highly demanded skills	• Automation of processes for increased efficiency • Reduced cost of production • Enhanced mass production lines to improve market supply • Expertise in project costing • Material selection and identification • Use of local materials and sourcing for funding
Other needed skills	• Support the design of dryers that meet industry quality and standards • Develop improved and energy-efficient (hybrid) solar dryers • Create dryers that are easy for farmers to install, acquire, and operate

Figure 2: Status of skills and capacities

The gaps in skills and capacity impacted their businesses in various ways including low productivity and production wastage of material due to trial and error, low uptake of their products, and challenges with access to finance. All these resulted in their inability to meet market demand, including meeting quality expectation hence affecting their profitability and growth prospects.

Trends in Solar Dryers Technology and the Expanding Innovation Ecosystem

The findings show that there is a transition in technological developments and innovations in the solar dryers' ecosystem over the last few years. The evolving scope of products and technological advancements shows that solar drying sector in Kenya is rapidly growing which is informed by growing need for enhanced energy efficient dryers (Kiplagat et al.,2011; Ndirangu et al.,2020), the need to reduce downtime drying capacities and minimizing environmental footprint. When asked about their sources of information that stimulate innovation the fabricators noted clients (based on their specifications), research (on materials, industry needs and available technologies), use of online platforms (YouTube, journal articles, google search engine), field days and user testing and prototyping.

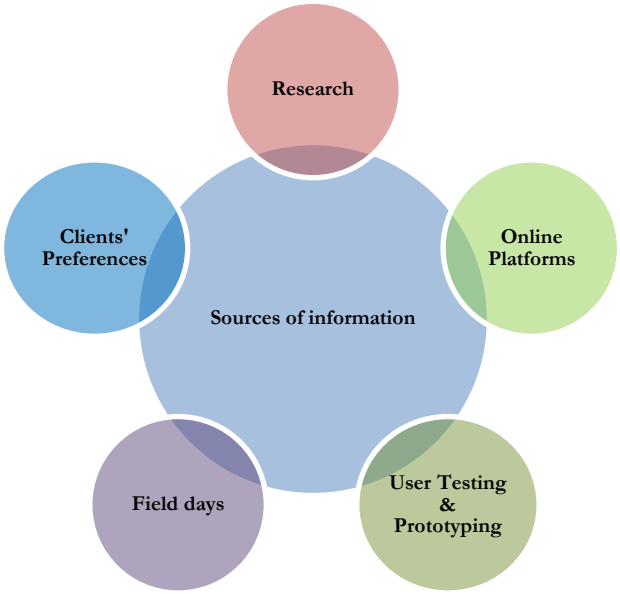

Figure 3: Sources of information

There is a growing ecosystem of interested actors and stakeholders supporting the solar drying sector which include but not limited to international and development organizations, national government institutions, county governments and financial institutions. The growth is essentially demonstrated by the increasing number of investments and programs, initiatives and projects geared to support and promote technology. Some of the support provided include capacity building, financing, marketing, information dissemination, networking, protection of intellectual property etc. The fabricators point to emerging innovation trends which include among others:

- Increasing demand for hybrid solar dryers with alternate energy sources such as biomass to provide more reliable and consistent source of heat for the drying process for increased energy efficiency, reduction of downtime drying capacity and minimize environmental footprint.
- Integration of automated controls and monitoring systems to improve efficiency and accuracy, optimize drying process and reduce production (labor) costs.
- Mobile solar dryers are being developed for use in remote or rural areas where access to electricity is limited. These systems can be transported to the site and set up quickly, providing a reliable source of drying heat without the need for fossil fuels.
- Remote monitoring and control: Remote monitoring and control systems are being used to monitor and control the drying process from a distance This can include the use of sensors to measure temperature and humidity, and automated systems to adjust airflow and temperature as needed.
- Customization is becoming more common in drying technologies, as companies seek to tailor their processes to specific materials or products. Incorporating flexible designs and adjustable settings can help accommodate a wide range of products and drying conditions.

Gaps in Standards and Regulations of Solar Dryers Technology in the Market

Presently, there are no Kenyan national specification and/or guidelines related to standards of solar dryers to guide design, types of acceptable materials and marks to assure quality of the technology marketed. However, there is a standard that governs the fabrication of metallic products which can be borrowed in some components. There is therefore need for institutional, legal, and regulatory framework to guide fabrication, certification, and marketing of solar dryers in Kenya to curb the cases of low-quality and substandard dryers entering the Kenya's market. This will assure customers who are acquiring these capital-intensive assets but also enhance the quality of dried food products that is growing in the market.

Policy Recommendations

We recommend strengthening of the solar drying innovation ecosystem through support for development of training and capabilities strengthening programs for fabricators to enhance their delivery of quality products through collaborative engagement with industry, research and technology developers to innovation that is best fit and affordable for the market.

There is need to develop specifications and standards as part of the enabling environment to enhance delivery of quality solar dryers and dried food products in the market.

All actors (government agencies, NGOs, development partners and private sector) that are intervening to support acquisition of solar drying technology by farmers need to ensure they are of sufficient quality to guarantee performance as part of support for agribusiness development.

Appropriate interventions and strategies to reduce food loss require an integrated value chain approach and the coordination of a wide diversity of actors, including multidisciplinary researchers, policymakers, private sector, financiers among others.

There is need for a policy framework and platform to engage the industry that can outline the barriers that need to be unlocked to stimulate growth in solar drying Agri-enterprises to exploit the opportunities presented by this subsector in stimulating inclusive Agri based-industrialization.

References

Amankwah-Amoah, J. (2019). Technological revolution, sustainability, and development in Africa: Overview, emerging issues, and challenges. Sustainable Development, 27(5), 910-922. https://doi.org/10.1002/sd.1950

FAO (2011). Global Food losses and Food Waste – Extent, Causes and Prevention. Rome: UN Food and Agriculture Organization.

FAO. (2020). The State of Food Security and Nutrition in the World. https://doi.org/10.4060/ca9692en

Kiplagat, J., Wang, R., & Li, T. (2011). Renewable energy in Kenya: Resource potential and status of exploitation. Renewable and Sustainable Energy Reviews, 15(6), 2960-2973. https://doi.org/10.1016/j.rser.2011.03.023

Mohammed, S., Edna, M., & Siraj, K. (2020). The effect of traditional and improved solar drying methods on the sensory quality and nutritional composition of fruits: A case of mangoes and pineapples. Heliyon, 6(6), e04163. https://doi.org/10.1016/j.heliyon.2020.e04163

Mujuka, E., Mburu, J., Ogutu, A., Ambuko, J. (2019). Returns to investment in postharvest loss reduction technologies among mango farmers in Embu County, Kenya. Food Energy Security. https://doi.org/10.1002/fes3.195

Ndirangu, S. N., Ronoh, E. K., Kanali, C. L., Mutwiwa, U. N., and Kituu, G. M. (2020). Design and performance evaluation of a solar-biomass greenhouse dryer for drying of selected crops in western Kenya. Agricultural Engineering International: CIGR Journal, 22(3): 219-229

Ndukwu, M., Ibeh, M., Okon, B. B., Akpan, G., Kalu, C., Ekop, I., Nwachukwu, C. C., Abam, F., Lamrani, B., Simo-Tagne, M., Ben, A. E., Mbanasor, J., and Bennamoun, L. (2023). Progressive review of solar drying studies of agricultural products with exergoeconomics and econo-market participation aspect. Cleaner Environmental Systems, 9, 100120. https://doi.org/10.1016/j.cesys.2023.100120

Ridolfi C, Hoffmann, V and Siddhartha Baral, S (2018) Post-Harvest Losses in Fruits and Vegetables: The Kenyan Context. IFPRI Review. https://t.ly/OuY2a

Romuli, S., Schock, S., Nagle, M., Chege, C. G. and Müller, J. (2019). Technical Performance of an Inflatable Solar Dryer for Drying Amaranth Leaves in Kenya. Appl. Sci, 9, 3431 https://doi.org/10.3390/app9163431

Singh, P., Shrivastava, V., and Kumar, A. (2018). Recent developments in greenhouse solar drying: A review. Renew. Sustain. Energy Rev. 82, 3250–3262 10.1016/j.rser.2017.10.020

Tchanche, B.F., Mohamed, E.S., and Papadakis, G. (2009). Solar energy: a solution to energy poverty in Africa. Proceedings of the ISES Solar World Congress, Renewable Energy Shaping Our Future, Johannesburg, South-Africa

Udomkun, P., Romuli, S., Schock, S., Mahayothee, B., Sartas, M., Wossen, T., Njukwe, E., Vanlauwe, B. and Müller, J. (2020). Review of solar dryers for agricultural products in Asia and Africa: An innovation landscape approach. Journal of Environmental Management, 268, 110730. https://doi.org/10.1016/j.jenvman.2020.110730

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