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# **Characteristics of Improved Oil Palm Production Technologies disseminated by Fatuma Mwasa AgriTecH in Western Tanzania: ‘‘A Farmer’s Perspective’’**

# **Abstract**

**Aims:** This study aims at describing the characteristics of improved oil palm production technologies that have been disseminated by Fatuma Mwasa Agricultural Technology Transfer Hub (AgriTecH) in Tabora and Katavi regions in the Western parts of Tanzania. **Study Design:** The study employed a cross-sectional mixed-methods research design involving quantitative and qualitative methodologies.

**Place and Duration of Study:** The study was conducted in the selected regions of Western Tanzania namely Tabora and Katavi from June, 2024 to August, 2024.

**Methodology:** A semi-structured questionnaire was used to collect quantitative data from a sample of 120 respondents, while focus group discussions and key informant interviews were employed to obtain qualitative data

**Results:** The study revealed that the majority of the farmers believed that the disseminated technologies are environmentally friendly (94.2%), boost oil palm productivity (92.5%), cost-effective (91.6%), can be easily applied (90.0%), resource-efficient (89.2%) and are not constrained by the infrastructures (76.7%).

**Conclusion:** Based on the findings of the study, it was recommended that TARI keep up its good work of offering services and products which are client-oriented. Furthermore, TARI Headquarters should keep providing AgriTecH with financial, material and human resources to enable them to carry out the intended operations efficiently.

**Key words:** Characteristics, Oil Palm Production Technologies, Dissemination, AgriTecH

**INTRODUCTION**

Improved agricultural technologies refer to all enhanced procedures and innovations which contribute to increasing agricultural productivity, resulting in significant increases in farm income and ensuring food security (Jain *et al.,* 2009; Challa & Tilahun, 2014). The ability to produce and deliver what consumers desire is being enhanced by improved technologies, and that people are exercising their influence either directly as consumers or indirectly as stewards of the environment where food and fibre products are produced (Keulen, 2007, as cited by Alex, 2021). Improved agricultural technologies include new crop varieties, soil and soil fertility management, pest management as well as irrigation and water management (Loevinsohn *et al.*, 2013). Alex (2021) identified agro-machinery for value addition, post-harvest handling and labour reductions as some of the additional agricultural technologies which are currently receiving attention as they contribute to increasing agricultural productivity. The improved agricultural technologies are aimed at improving agricultural productivity, ensuring food security as well as increasing the farm income (Wossen *et al.,* 2017; Ayenew *et al.,* 2020; Mendola, 2007; Tambo & Wünscher, 2016; Kolapo & Kolapo, 2021; Teka & Lee, 2020; *Farquharso et al.,* 2013; Alex,2021; Gollin *et al.,* 2018; Ogundari & Bolarinwa, 2018; Stewart *et al.,* 2015).

The improved agricultural technologies are developed by different public or private research and academic institutions (Alex, 2021). Tanzania Agricultural Research Institute (TARI), as one among the sources of improved agricultural technologies in the country, is responsible for coordinating and conducting agricultural research and coming up with different improved agricultural technologies and then disseminating them to farmers, extension staff and other stakeholders. TARI uses different extension approaches to disseminate these improved agricultural technologies to the beneficiaries. Agricultural Technology Transfer Hub (AgriTecH) is among the approaches used for the dissemination of improved agricultural technologies. AgriTecH is an organised facility that facilitates the dissemination of improved agricultural technologies to farmers, extension workers and other agricultural stakeholders (TARI, 2020). Currently, TARI has established eight AgriTecHs in each zonal agricultural show ground. These AgriTecHs were established for the following objectives: (i) To ensure that the dissemination of agricultural technologies and innovations extend beyond one Agricultural show event; (ii) To establish one stop centre for training and accessing agricultural technologies and innovations to end users; (iii) To enhance collaboration with public and private stakeholders in technology dissemination; and (iv) To establish shops for sale of seeds and value-added products and by-products (TARI, 2020).

Although these improved agricultural technologies are available, their adoption rates by smallholder farmers are low (Lantican *et al.,* 2016; Bold *et al.,* 2017). The low adoption rates might be attributed to the low level of farmers’ awareness of the technology characteristics. In Sub-Saharan Africa (SSA), low levels of adoption of improved agricultural technologies have been partially blamed for the region's low agricultural productivity when compared to other parts of the world (Walker & Alwang, 2015; Yitayew *et al.,* 2021). This, in turn, has implications for the region's progress towards food security (Issahaku & Abdulai, 2019). Thus, this study attempts to describe the characteristics of the improved oil palm production technologies disseminated by the AgriTecH according to farmers’ perspectives.

The present study focuses on Fatuma Mwasa AgriTecH as one among the eight AgriTecHs established by TARI in the country. It is located in the Fatuma Mwasa Agricultural Show grounds at Ipuli in Tabora Municipality. AgriTecH is in charge of disseminating improved agricultural technologies in the Western Zone of Tanzania (TARI, 2021). Administratively, the centre operates under the supervision of the two TARI Centres, which are TARI Tumbi and TARI Kihinga. TARI Tumbi has a national mandate for conducting and coordinating agroforestry research and research on other crops, including oil palm, cereals, root and tubers, legumes, and horticulture. However, TARI Kihinga is mandated nationally to carry out and coordinate oil palm research. These centres provide personnel, capacity development, and improved technologies, all of which are critical assets for AgriTecH’s operations. In addition to the technologies from the centre’s mandate areas, AgriTecH provides technologies from other TARI centres, including improved seeds/seedlings of various crops, good agronomic practices and value-added products. It disseminates improved agricultural technologies to beneficiaries through various extension methods, such as demonstration plots, farmer field days, exhibitions, and mass media. In the process of technology dissemination, Fatuma Mwasa AgriTecH collaborates with different stakeholders, including private agricultural enterprises, academic institutions and local government authorities. Although it disseminates various improved agricultural technologies, the current study focuses on the improved oil palm production technologies. The oil palm production technologies disseminated include improved oil palm seedlings (tenera), criteria for selecting oil palm field, land preparation methods, nursery management practices, transplanting techniques, irrigation methods, pruning techniques, fertilizer application methods and pest control methods.

Characteristics of improved agricultural technology refer to the attributes or features that distinguish technologies designed to enhance agricultural practices and outcomes, such as increased efficiency, productivity, and sustainability. The characteristics of a technology are among the important determinants for the adoption of that particular technology (Farquharson *et al.,* 2013; Alex, 2021). As Jones (1989) and Rogers (2003) observe, perceptions of the characteristics of technology impact their use. Studies show that the degree of technology adoption depends on various factors, one of which is the adopter's perception of the characteristics of the technology (Zebua *et al.,* 2019). Thus, it is crucial to comprehend how the characteristics of technology impact their use. Understanding the characteristics of technologies is very significant because it helps identify their strengths and limitations, guiding stakeholders in promoting their adoption, tailoring extension services, and aligning them with development goals such as food security, income generation, and environmental sustainability.

Various scholars used different approaches to describe the characteristics of improved agricultural technologies disseminated in the social system. Farquharson *et al.* (2013) and Mannan *et al.* (2015) relied on the five attributes of innovation/technology as stated by Rogers (2003), namely trialability, complexity, compatibility, observability and relative advantage. Zamzami (2021) and Alex (2021) made a slight modification to the five innovation attributes as proposed by Rogers (2003) by replacing the relative advantage with relative profit and observability with quality when identifying the characteristics of improved agricultural technologies in Indonesia and Uganda, respectively. Mgumia *et al.* (2015) used the three technology characteristic categories, namely physical features (physical product and knowledge of application), economic features (excludability, rivalry/subtractability and appropriability) and the level of sophistication in analysing the characteristics of improved agricultural technologies in Tanzania. The current study will use 11 statements which were obtained from literatures, informal meeting with farmers and agricultural extension officers regarding their perception on characteristics of the improved agricultural technologies.

On the other hand, the focus of many studies on improved agricultural technologies is inclined towards the adoption of improved agricultural technologies (Adams & Jumpah, 2021; Ruzzante *et al.,* 2021; Wordofa *et al.,* 2021; Businge *et al.,* 2024; Norton & Alwang, 2020; Okonji & Awolu, 2020; Mottaleb, 2018; Feyisa, 2020; Lasway *et al.,*2020; Manguia *et al.,* 2021;Yokamo,2020; Daniso, 2022; Yitayew *et al.,* 2022; Gagoitsiwe & Keba, 2019; Kumar *et al.,* 2018; Kabunga & Bizimungu, 2018; Ogundari & Bolarinwa *et al.,* 2018; Udimal et *al.,* 2017; Isibor & Ugwumba, 2014; Wainaina *et al.,* 2014; Akudugu *et al.,* 2012; Mwangi & Kariuki,2015) and the impacts or contribution of improved agricultural technologies to agricultural productivity, income and improvement in the farmers’ welfare in general (Andrea & Mishili, 2023; Hawas & Degaga, 2023; Dhehibi, 2022; Habtewold & Heshmati, 2023; Hailu *et al.,* 2021; Asfaw *et al.,* 2012; Awotide *et al.,* 2012; Oyewole *et al.,*2023) with limited studies on characteristics of the improved agricultural technologies (Alex, 2021; Adiyoga, 2021; Zamzami *et al.,* 2021; Mgumia *et al.,*2015; Farquharson *et al.,* 2013). Furthermore, none of the latter described the characteristics of improved oil palm production technologies. Thus, this study attempts to fill this knowledge gap.

The rest of the article is structured as follows: in the next section, the methodology of the study is described. Next, results are presented and discussed. In the final section, conclusions based on the findings are presented.

**Methodology**

The study was carried out in Tabora Municipality, Urambo and Kaliua Districts in Tabora region and Tanganyika District in Katavi region, located in the Western zone of Tanzania. Tabora and Katavi regions were selected because they are ecologically conducive for oil palm production and are among the regions which are served by Fatuma Mwasa AgriTecH. According to the 2022 National Census, Katavi and Tabora Regions have the populations of 1,152,958 and 3,391,679 people, respectively. Katavi Region is situated between Latitudes 5° 15' and 7° 03' South and Longitudes 30° and 33° East. Rainfall in the area ranges from 700 to 1,300 millimetres per year. On the other hand, Tabora Region is located between latitudes 4° and 7° south of the Equator and receives an average of 1,010 millimetres of precipitation annually.

The study employed a mixed-methods research design involving both qualitative and quantitative research methods. The use of mixed research methods facilitates triangulation, which improves validity and depth of the results. Oil palm farmers were the population of interest in this study. Both men and women farmers were included in the study to determine gender contribution in the oil palm production. Thirty farmers were selected from each district using the purposive sampling technique, making a total of 120 oil palm farmers.

The selection procedure focused on farmers who are actively engaged in AgriTecH activities, such as attending training sessions, asking for guidance on oil palm production, and putting the disseminated technologies into practice. This strategy ensured that the sample included individuals who were knowledgeable about the disseminated technologies and had relevant experience that aligned with the research objectives.

In addition, the District Agriculture, Livestock, and Fisheries Officer (DALFO), AgriTecH Staff and Ward Agricultural Extension Officers (WAEO) were selected as Key Informants in this study due to their expertise and experience in the dissemination of improved agricultural technologies. Four Focus Group Discussions (FGDs) were conducted with the oil palm farmers in the study area, one in each district, and eight KIIs involving the DALFO and the WAEO, two from each district. The selection of FGD participants based on their involvement in oil palm production and their familiarity with AgriTecH dissemination activities. To ensure diversity, each FGD had six participants, including women, men, young people and the elderly, to collect a range of viewpoints. The participants in FGDs included oil palm farmers who did not take part in the survey to prevent survey overlap. The FGDs were moderated by a trained facilitator familiar with the study objectives to ensure a neutral and productive discussion environment.

The discussions were facilitated by a standardized checklist that focused on respective subjects, specifically the characteristics of the disseminated oil palm technologies. The primary data were collected from 120 respondents using a semi-structured questionnaire with the KOBO Collect v2022.3.6 software, which enables responses to be entered directly into a digital format. This minimizes errors resulting from manual data entry, thereby streamlining data administration and guaranteeing data accuracy.

To describe the characteristics of the improved oil palm production technologies disseminated by AgriTecH the study used 11 statements which were obtained from literature, informal meetings with farmers and agricultural extension officers regarding their perceptions on characteristics of the improved agricultural technologies. Among the 11 statements six statements were positive and five statements were negative (Masanja et al 2024). Prior data analysis all negative statements were converted to positive statements. Respondents were asked to express their perception on the statements regarding technology characteristics on five-point Likert scale whereby, SD = strongly disagree (1), D = Disagree (2), N = Neutral (3), A = Agree (4), SA = Strongly Agree (5). Then, data were subjected to descriptive statistics such as frequency count and percentage. The collected quantitative data were arranged, coded, and cleaned in MS excel and then imported into SPSS version 27 for further analysis.

Content analysis was used to analyse qualitative data from KIIs and FGDs. The data were coded and similar patterns were categorized to cast experiences and perspectives of farmers. The categories developed were then validated by an expert review to make sure they appropriately reflected farmers' experiences and viewpoints. Content analysis was utilized to delve into particular issues regarding the characterization of improved oil palm production technologies disseminated by the AgriTecH (Xu & Zammit, 2020).

# **Results and Discussion**

# **Socio-economic characteristics of respondents**

Results in Table 1 indicate that males made up the majority (83.3%) of the respondents, similarly, a sizable majority (95.8%) of the respondents were married, and a large portion (59.2%) had only finished primary education. Besides, the majority (96.7%) of the respondents are engaged in farming, and 72.5 per cent have more than ten years of experience in farming. Although maize was the most important crop grown by 91.7per cent of the respondents, a recent move towards oil palm cultivation (68.3%) indicates diversification driven by market and regulatory changes.

**Table 1: Socio-economic characteristics of the respondents**

|  |  |  |  |
| --- | --- | --- | --- |
| **Socioeconomic characteristics** | **Category** | **Frequency** | **Percent** |
| Sex | Female | 20 | 16.7 |
|  | Male | 100 | 83.3 |
| Marital status | Single | 5 | 4.2 |
|  | Married | 115 | 95.8 |
| Level of education | No formal education | 2 | 1.7 |
|  | Primary Education | 71 | 59.2 |
|  | Secondary education | 25 | 20.8 |
|  | Tertiary/college education | 22 | 18.3 |
| Occupation | Government employee | 14 | 11.7 |
|  | Farmer | 116 | 96.7 |
|  | Local leader | 6 | 5.0 |
|  | Business/trade | 18 | 15.0 |
|  | Others (religious leader, plumber, carpenter) | 4 | 3.3 |
| How many years have you been engaged in agricultural activities? | Less than 3 years | 10 | 8.3 |
|  | 3 to 5 years | 8 | 6.7 |
|  | 6 to 10 years | 15 | 12.5 |
|  | More than 10 years | 87 | 72.5 |
| For how long have you been growing oil palm? | Less than 3 years | 82 | 68.3 |
|  | 3 to 5 years | 12 | 10.0 |
|  | 6 to 10 years | 5 | 4.2 |
|  | More than 10 years | 21 | 17.5 |
| Crops other than oil palm | Maize | 110 | 91.7 |
|  | Tobacco | 40 | 33.3 |
|  | Sweet potatoes | 17 | 14.2 |
|  | Rice | 64 | 53.3 |
|  | Others such as beans | 55 | 45.8 |

### **Source: Adam *et al.* (2025)**

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# **Identification of Improved oil palm production technologies disseminated by Fatuma Mwasa AgritecH**

Table 2 presents the respondents' distribution according to the technologies that have been disseminated by Fatuma Mwasa AgriTecH. Farmers identified various oil palm production technologies, which are disseminated by AgriTecH. These include transplanting (92.5%), land preparation (87.5%), site selection (85%), fertilizer application (75.0%), pruning (66.3%), irrigation (64.2%), nursery management (60.8%), pest and disease control (59.2%) and other improved technologies such as weeding techniques and improved planting material (54.2%). The percentage indicates the frequency by which a particular technology was mentioned by oil palm farmers.

**Table 2: Distribution of the respondents based on the Identified improved oil palm production technologies disseminated by AgriTecH**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Category** | **Frequency** | **Percent** |
| Technologies disseminated | Site selection | 102 | 85.0 |
|  | Land preparation | 105 | 87.5 |
|  | Nursery management | 73 | 60.8 |
|  | Transplanting | 111 | 92.5 |
|  | Irrigation | 77 | 64.2 |
|  | Pruning | 80 | 66.3 |
|  | Fertilizer application | 90 | 75.0 |
|  | Pest and disease control | 71 | 59.2 |
|  | Others such as improved varieties and weeding techniques | 65 | 54.2 |
|  |  |  |  |
|  |  |  |  |

# **Farmer’s perception of the characteristics of improved oil palm production technologies disseminated by the AgriTecH**

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The following part presents how oil palm farmers perceived the characteristics of the oil palm production technologies disseminated by the AgriTecH.

# **3.3.1 Easily applicable**

The findings in Table 3 showed that the majority (90%) of the respondents agreed that they can easily use technologies promoted by AgriTecH. This high rating implies that smallholder farmers can easily apply the innovations from the AgriTecH in agricultural production activities. Farmers are more inclined to embrace technology when they see how it fits in with their current situation. According to Buadi *et al.* (2013), among other factors, the rate of adoption is highly influenced by favourable impressions since farmers choose technology that is simple to incorporate into their everyday tasks. This finding is supported by the remarks from a male oil palm farmer during FGD when he said;

*‘‘… It is possible to apply oil palm production technologies we learned at the AgriTecH in our fields because AgriTecH staff provided detailed information and practical demonstration on every technology disseminated, including holes preparation, transplanting, intercropping, weeding, pruning, irrigation, fertilizer application as well as pest and diseases control. Through the practical demonstration on the AgriTecH demonstration plots is easy for us to remember and practice in our oil palm fields…’'*

*(Male Oil palm farmer during FGD at Usisya village on 02 July, 2024)*

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# **3.3.2 Resource-efficient technologies**

Results in Table 3 indicate that the majority (89.2%) of the surveyed respondents concurred that the available technologies at AgriTecH guarantee effective use of farm resources. This implies that AgriTecH is known for the dissemination of resource-efficient solutions that utilize the scarce farm resources including seeds/seedlings, fertilizers, pesticides and farm machinery. Similar findings are reported by Li (2010), who found that Chinese farming techniques disseminated by ATDC in Nigeria saved up to 30per cent of the seeds in rice production. The use of resource-efficient technologies enables farmers to maximize their agricultural productivity while avoiding the wastage of agricultural inputs.

**Table 3: Distribution of the respondents based on characterization of technologies disseminated through AgriTecH**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Statement** | **Strongly Agree** | **Agree** | **Neutral** | **Disagree** | **Strongly Disagree** |
| Oil palm producers can use the technologies offered by AgriTecH | 49 (40.8%) | 59 (49.2%) | 12 (10.0%) | 0 (0.0%) | 0 (0.0%) |
| AgriTecH offers resource-efficient technologies | 50 (41.7%) | 57 (47.5%) | 13 (10.8%) | 0 (0.0%) | 0 (0.0%) |
| AgriTecH offers technology that boosts oil palm productivity | 62 (51.7%) | 49 (40.8%) | 9 (7.5%) | 0 (0.0%) | 0 (0.0%) |
| AgriTech offers technologies that are not constrained by infrastructure | 60(50%) | 32 (26.7%) | 4 (3.3%) | 24 (20.0%) | 0 (0.0%) |
| AgriTecH provides environmentally friendly technologies | 32 (26.7%) | 81 (67.5%) | 7 (5.8%) | 0 (0.0%) | 0 (0.0%) |
| AgriTecH offers cost-effective technologies | 16 (13.3%) | 94 (78.3%) | 5 (4.2%) | 4 (3.3%) | 1 (0.9%) |

# **Technologies boost oil palm productivity**

The results in Table 3 show that the majority (92.5%) of the farmers accepted that improved oil palm production technologies disseminated by the AgriTecH have a significant contribution to increasing oil palm productivity. This might be attributed by the adoption of improved oil palm production technologies including a high yielding oil palm seedlings (tenera) with a potential of producing 4-5 Tons of edible oil per hectare as compared to 1.6 Tons per hectare from the local cultivars. The findings are in conformity to the findings from a study by Mgendi *et al.* (2019) who reported the significant increase in rice productivity from 0.8–4.5 t/ha to 9–12 t/ha when using Chinese hybrid rice disseminated by ATDC in Tanzania. Similarly, Li (2010) noted that Chinese cultivation techniques disseminated by ATDC in Nigeria increased rice productivity up to 18 percent compared with the local technologies. Mannan *et al.* (2015) underline that agricultural technologies are crucial in enhancing output by improving farming efficiency and minimizing losses. The increase in agricultural productivity has a significant impact on farmers and the national at large by ensuring food security and an increase in income at the farmer and national levels.

# **Technologies not constrained by infrastructural limitations**

The results in Table 3 reveal that the majority (76.7%) of the respondents thought that improved oil palm production technologies do not face some infrastructural limitations that will limit their application in the field. This implies that the nature of the disseminated technologies fits well with the farmer’s settings. This finding conforms to the remarks from a female oil palm farmer who was quoted as saying:

*‘‘… We can use the technologies disseminated by AgriTecH without any infrastructural limitations because they were developed with a consideration of our farming conditions..…’'*

*(Female Oil palm farmer during FGD at Magele Village on 03 July 2024)*

In contrast one male oil palm farmer claimed,

*‘‘… It is difficult for farmers to establish tenera seedlings by themselves because it requires the use of seed germinators to maintain the required temperature at the first three months in order to facilitate seedlings development. This made us rely on TARI as the source of supply for improved oil palm seedlings… ’' (Male farmer …*

# **Environmentally friendly technologies**

The findings in Table 3 show that the majority (94.2%) of farmers agreed that the improved agricultural technologies disseminated by AgriTecH are environmentally friendly. The results indicate that these technologies are sustainable with little or no harm to the environment. Long-term agricultural success depends on sustainable farming since it lessens the adverse effects of conventional farming practices that mostly rely on chemical inputs. AgriTecH promotes conservation agricultural practices in crop production. Camacho-Villa *et al.* (2016) mentioned conservation agriculture and integrated fertility management as among the agricultural technologies disseminated by MasAgro Hubs in Mexico. An alternative viewpoint to this was expressed by a male oil palm grower during the Focus Group Discussion, saying:

*‘‘….Since the establishment of an oil palm field requires a large area to maximize productivity, land clearance done during the land preparation stage for field establishment involves cutting down trees, which contributes to environmental destruction..…’' (Male Oil palm farmer during FGD at Ntalikwa Village on July 30, 2024)*

# **Cost-effective technologies**

The results presented in Table 3 show that the majority (91.6%) of participants agreed that AgriTecH offers technologies at affordable prices. This means that it is possible for smallholder farmers to pay for the improved technologies disseminated by the AgriTecH, including seeds/seedlings of different crops. Furthermore, most advisory services are provided free of charge to ensure that they can be accessed easily by the target group. The findings from this study conform with the findings in a study by Singh and Karla (2019) who reported that the majority of the farmers (83.56%) and (87.96%) were satisfied with the prices of planting materials and seeds, respectively. However, this finding is in contrast with the findings from a study by Makundi (2017), who reported limited affordability of the Chinese mechanization equipment and the use of recommended fertilizer rates in rice production among farmers who were served by ATDC in Dakawa, Tanzania. Farmers being satisfied with the prices of the seeds and planting materials indicates that seeds and planting materials are sold at affordable prices. However, this observation was contrasted with the remarks by a female oil palm farmer when commented,

*‘‘… The improved oil palm planting materials are sold at a high cost due to increased demand. To ensure sufficient availability of improved oil palm planting materials, the government should increase support to TARI Tumbi and TARI Kihinga as the major sources of improved oil palm planting material (tenera) in Western zone as well as support and capacitate other public and private organizations which will be ready to engage in oil palm seedlings development. Also, to encourage more farmers to adopt improved planting materials, they should be subsidized or sold at a relatively lower price so that farmers can afford …’’ (Female Oil palm farmer during FGD at Isengule Village on July 11, 2024).*

# **Conclusion**

The study attempted to describe the characteristics of the improved oil palm production technologies disseminated by the AgriTecH. It can be concluded that the majority of the farmers have a positive perception towards the characteristics of the disseminated oil palm production technologies. Their positive perception is attributed to the level of awareness of technologies, which is a prerequisite for adoption. TARI should increase investment in both research and technology transfer to ensure that improved oil palm production technologies are available and accessible to farmers so that they can incorporate them in their farming activities to raise agricultural productivity, income and ensure food security.

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**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

# **References**

Adams, A., & Jumpah, E.T (2021). Agricultural technologies adoption and smallholder farmers’ welfare: Evidence from Northern Ghana, *Cogent Economics* & *Finance,* 9(1): 200-6905.

Adam, M. R., Kidudu, J. S., & Mwaseba, D. L. (2025). Perceived Effectiveness of AgriTecH in Disseminating Oil Palm Production Technologies in Western Tanzania. *Asian Journal of Advanced Research and Reports*, *19*(1), 37–55.

Adiyoga, W (2021). Innovation attributes and their linkages to behavioral drivers of farmers’ intention to adopt True Shallot Seed. *E3S Web of Conferences,* 316: 02003 (2021).

Akudugu, M.A, Guo, E., & Dadzie, S.K. (2012). Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence Their Decisions? *Journal of Biology, Agriculture and Healthcare* 2012: 2-3.

Alex, B. (2021). Agricultural Innovation Characteristics and Their Utilization: A Case of National Agricultural Research Organization. A Dissertation Submitted to the Directorate of Postgraduate Training in Partial Fulfilment of the Requirements for the Award of a Master of Business Administration of Kabale University.

Andrea, A., & Mishili, F. (2023). Profitability of Oil Palm Farming in Kigoma Rural District,

Asfaw, S., Shiferaw, B., Simtowe, F., & Lipper, L. (2012). Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. *Food Policy,* 37(2012): 283–295.

Awotide, B.A, Diagne, A., & Omonona, B.T. (2012). Impact of Improved Agricultural Technology Adoption on Sustainable Rice Productivity and Rural Farmers’ Welfare in Nigeria: A Local Average Treatment Effect (LATE) Technique.

Ayenew, W., Laken, T., & Kristos, E. H. (2020). Agricultural technology adoption and its impact on smallholder farmers’ welfare in Ethiopia. *African Journal of Agricultural Research,* *15*(3): 431–445.

Bold, T., Kaizzi, K. C., Svensson, J., & Yanagizawa-Drott, D. (2017). Lemon technologies and adoption: measurement, theory, and evidence from agricultural markets in Uganda. *Quarterly Journal of Economics,* 132(3):1055-1100.

Buadi, D. K., Anaman, K. A., & Kwarteng, J. A. (2013). Farmers’ perceptions of the quality of extension services provided by non-governmental organisations in two municipalities in the Central Region of Ghana*. Agricultural Systems, 120: 20-26.*

Businge, J., Kityo, R., & Ninsheka, L. (2024). Perception and Adoption of Government Agricultural Technologies among Smallholder Farmers in Western Uganda. *East African Journal of Agriculture and Biotechnology,* 7(1): 236-245.

Camacho-Villa, T. C., Almekinders, C., Hellin, J., Martinez-Cruz, T. E., Rendon-Medel, R., Guevara-Hernández, F., Beuchelt, T. D., & Govaerts, B. (2016). The evolution of the MasAgro hubs: responsiveness and serendipity as drivers of agricultural innovation in a dynamic and heterogeneous context. *Journal of Agricultural Education and Extension,* *22*(5): 455-470.

Challa, M., & Tilahun, U. (2014). Determinants and Impacts of Modern Agricultural Technology Adoption in West Wollega: The Case of Gulliso District. *Journal of Biology, Agriculture and Healthcare, 2014: 4-20.*

Daniso, B. (2022). Determinants of farmers’ utilization of improved agricultural technologies in Ethiopia. *Journal of Science and Inclusive Development,* 4:1.

Dhehibi, B, Dhraief, M.Z., Ruediger, U., Frija, A., Werner, J., Straussberger, L., & Rischkowsky, B. (2022). Impact of improved agricultural extension approaches on technology adoption: Evidence from a randomised controlled trial in rural Tunisia. *Experimental Agriculture,* 58(13):1–16

Farquharson R., J., Martin, R.J, Mccorkell, B., Scott, J. F., Sotheary, E., Phaloeun, C., Sophors, H., Sinath, S., Monida, C., Sinarong, S., & Sokun, B. (2013). Characteristics of an Agricultural Innovation and Incentives for Adoption: Rhizobium in Cambodia. *International Journal of Environmental and Rural Development, 2013: 4-2.*

Feyisa, B.W. (2020). Determinants of agricultural technology adoption in Ethiopia: A meta-analysis, *Cogent Food & Agric*ulture, 6:1-10.

Gagoitsiwe, M., & Keba, H. (2019). Challenges in the Adoption of Improved Arable Technologiesand Possible Solutions: A Perspective of Farmers in the Southern District of Botswana. *International Journal of Agricultural Extension,* 07(03): 257-266.

Gollin, D., Hansen, C.W., & Wingender, A. (2018). Two blades of grass: the impact of the green revolution. NBER Working Paper, w24744.

Habtewold, T.M., & Heshmati, A. (2023). Impacts of improved agricultural technologies on food security and child nutrition in rural Ethiopia. *Cogent Food & Agriculture*, 9(2): 227-6565.

Hailu, M., Tolossa, D., Girma, A., & Kassa, B. (2021). The impact of improved agricultural technologies on household food security of smallholders in Central Ethiopia: An endogenous switching estimation. *World Food Policy* 2021: 1–17.

Hawas, L. D., & Degaga, D. T. (2023). Impact of Improved Agricultural Technologies Adoption on Farm Household Income in East Shewa Zone, Ethiopia. Journal of Sustainable *Development in Africa*, 25(4).

Isibor, A.C., & Ugwumba, C.O.A. (2014). Adoption of oil palm production technologies in ihiala local government area of Anambra State, Nigeria. *Journal of Agriculture and Veterinary Sciences,* 6: 2.

Issahaku, G., & Abdulai, A. (2019). Can farm households improve food and nutrition security through adoption of climate-smart practices? Empirical evidence from northern Ghana. *Applied Economic Perspectives and Policy,* 1–22.

Jain, R., Arora, A., & Raju. S. (2009). A novel adoption index of selected agricultural technologies: Linkages with infrastructure and productivity: *Agricultural Economics Research Review,* 22: 109-120.

Kabunga, N., & Bizimungu, E. (2018).A Latent Class Analysis of Agricultural Technology Use.

Kumar, A., Takeshima, H., Adhikari, N., Thapa, G., Joshi, P. K., & Karkee, M. (2018). Adoption and Diffusion of Improved Technologies and Production Practices in Agriculture Insights from a Donor-led Intervention in Nepal.

Lantican, M. A., Braun, H. J., Payne, T. S., Singh, R., Sonder, K., Baum, M., van Ginkel, M., & Erenstein, O. (2016). Impacts of international wheat improvement research, 1994- 2014. International Maize and Wheat Improvement Center (CIMMYT). Mexico, DF: CIMMYT.

Lasway, J.A., Selejio, O., &Temba, G.R (2020). Modeling Multiple Adoption Decisions on Agricultural Technologies in Tanzania: A Multinomial Probit Analysis. *Tanzanian Economic Review*, 10(2): 69–83.

Li, J. (2010). Sino-Africa agricultural cooperation experience sharing. Foreign Economic Cooperation Centre, Ministry of Agriculture of the People’s Republic of China. In Proceedings of the Agriculture, Food Safety, and Rural Development for Growth and Poverty Reduction.

Loevinsohn, M., Sumberg, J., Diagne, A., & Whitfield, S. (2013). Under what circumstances and conditions does adoption of technology result in increased agricultural productivity? A Systematic Review.

Makundi, H. (2017). Diffusing Chinese rice technology in rural Tanzania: Lessons from the Dakawa agro-technology demonstration center, Working Paper, No. 2017/12, China Africa Research Initiative (CARI), School of Advanced International Studies (SAIS), Johns Hopkins University, Washington, DC. <https://hdl.handle.net/10419/248140>.

Mannan, S., Nordin, S., & Galea, S.R. (2015). Influence of Innovation Attributes and Communication Channels on New Fertilizer Technology Adoption by Paddy Farmers. *Australian Journal of Basic and Applied Sciences* 9(19):109-111

Masanja, I., Shausi, G. L., & Kalungwizi, V. J. (2023). Attitude of Farmers and Factor Associated with Farmers Attitude towards Agricultural Extension Services Provided by Private Organizations in Kibondo District, Tanzania. *Asian Journal of Agricultural Extension, Economics &**Sociology, 41(10): 556-566.*

Mgumia, A. H., Mattee, A.Z., & Kundi, B. A.T (2015). Characteristics of agriculture technology and application of an agricultural innovation system in Tanzania. *African Journal of Science, Technology, Innovation and Development,* 7(2): 73-83.

Mgendi, G., & Cheng, X. (2019). A review of agricultural technology transfer in Africa: lessons from Japan and China case projects in Tanzania and Kenya. *Sustainability*, 1-11.

Mottaleb, K. A. (2018). Perception and adoption of a new agricultural technology: Evidence from a developing country. *Technology in Society* 55(2018): 126–135.

Munguia, O.M.O., Pannell, D. J., & Llewellyn, R. (2021). Understanding the adoption of innovations in agriculture: A review of selected conceptual models. *Agronomy,* 11, 139.

Mwangi, M., & Kariuki, S. (2015). Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. *Journal of Economics and Sustainable Development,* 6(5): 208-216.

Norton, G. W., & Alwang, J. (2020). Changes in agricultural extension and implications for farmer adoption of new practices. *Applied Economic Perspectives and Policy,* 42(1): 8-20.

Ogundari, K. & Bolarinwa, O.D. (2018). Impact of agricultural innovation adoption: a meta-analysis. *Australian Journal of Agricultural and Resource Economics* 59: 1–20.

Okonji, C. J., & Awolu, O. T. (2021). Factors Influencing Adoption of Improved Technology among Maize Farmers in Ekiti State Nigeria. *Agrosearch* 20(2): 102-112.

Oyewole, A. L., Ayanrinde, F. A., Oyewole, S. O., & Ayanrinde, O. A. (2023). Effect of Improved Farm Technologies Adoption on Productivity among Staple Crop Farmers of Nigeria Agricultural Transformation Agenda. *J. Appl. Sci. Environ. Manage,* 27(10): 2251-2256.

Ruzzante, S., Labarta, R., & Bilton, A. (2021). Adoption of agricultural technology in the developing world: A meta-analysis of the empirical literature. *World Development,* 146(2021):105-599.

Singh, D., & Kalra, R. K. (2019). Level of Satisfaction of Farmers from the Services Provided by Agricultural Technology and Information Centre (ATIC) Run by Punjab Agricultural University. *International Journal of Bio-resource and Stress Management, 10*(5): 575-579.

Stewart, R., Langer, L., Da Silva, N.R., Muchiri, E., Zaranyika, H., & Erasmus, Y. (2015) The effects of training, innovation and new technology on African smallholder Farmers' economic outcomes and food security: a systematic review. *Campbell Systematic Reviews* 11: 1–224.

TARI (2020). Proposal for Establishment of Agriculture Technology Transfer Hubs (AgriTecH).

TARI (2021). Report on the Official Launch of the Fatma Mwasa Agricultural Technology Transfer Hub in Western zone.

Udimal, T.B., Jincai, Z., Mensah, O.S., & Caesar, A. E. (2017). Factors Influencing the Agricultural Technology Adoption: The Case of Improved Rice Varieties *(*Nerica) in the Northern Region, Ghana. *Journal of Economics and Sustainable Development,* 8 (8): 2017.

Wainaina, P., Tongruksawattana, S., & Qaim, M. (2016). Tradeoffs and complementarities in the adoption of improved seeds, fertilizer, and natural resource management technologies in Kenya. *Agricultural Economics,* 47(3): 351-362.

Walker, T. S., & Alwang, J. (2015). The importance of generating and documenting varietal change in sub-Saharan Africa. In: T. S. Walker and J. Alwang (Eds), Crop *Improvement, Adoption, and Impact of Improved Varieties in Food Crops in sub-Saharan Africa*. Consortium of International Agricultural Research Centers and CAB International, London. pp. 1–6.

Wordofa, M.G., Hassen, J.Y., Endris, G.S., Aweke, C.S., Moges, D.K., & Rorisa, D.T. (2021). Adoption of improved agricultural technology and its impact on household income: a propensity score matching estimation in eastern Ethiopia. *Agriculture & Food Security,* (2021: 10:5.

Wossen, T., Abdoulaye, T., Alene, A., Heile, M. G., Feleke, S., Olanrewaju, A., & Manyong, V. (2017). Impacts of extension access and cooperative membership on technology adoption and household welfare. *Journal of Rural Studies,* *54*(2017): 223–233.

Xu, W., & Zammit, K. (2020). Applying thematic analysis to education: A hybrid approach to interpreting data in practitioner research*. International Journal of Qualitative Methods,* 19: 1–9.

Yakamo, S. (2020). Adoption of improved agricultural technologies in Developing Countries. Literature Review. *International Journal of the Science of Food and Agriculture,* 4(2): 183-190.

Yitayew, A, Abdulai, A., & Yizegu, Y. A. (2022). Improved agricultural input delivery systems for enhancing technology adoption: evidence from a field experiment in Ethiopia. *European Review of Agricultural Economics,* 49(3: 527–556.

Yitayew, A., Abdulai, A., Yigezu, Y, A., Deneke, T.T., & Kassie, G.T. (2021). Impact of agricultural extension services on the adoption of improved wheat variety in Ethiopia: A cluster randomized controlled trial. *World Development 146: 1-16,*

Zamzami, L., Sugiyatno, A., & Harwanto, E. (2021). Innovation Characteristics and Adoption Opportunity of Bujangseta Technology for Tangerine Farming. *Caraka Tani: Journal of Sustainable Agriculture*, *36*(1), 144-154.