

**Sokoine University of Agriculture**



**MSc Dissertation**

**Farmer Research Networks Project  
and Adoption of Improved  
Groundnut Cultivars Amongst  
Smallholder Farmers in Singida  
District of Central Tanzania**

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May 2024**

**FARMER RESEARCH NETWORKS PROJECT AND ADOPTION  
OF IMPROVED GROUNDNUT CULTIVARS AMONGST  
SMALLHOLDER FARMERS IN SINGIDA DISTRICT OF CENTRAL  
TANZANIA**

*Dissertation Submitted to Sokoine University of Agriculture in  
Partial Fulfilment of the Requirements for the Degree of Master  
of Science in Agricultural Extension of the*

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## EXTENDED ABSTRACT

Despite being one of the most vital food and income crops in the world, studies show that groundnut is not widely adopted by farmers. Age, gender, education, group participation, and seed accessibility were amongst the characteristics that were reported to influence the adoption. However, the impact of these factors on the adoption of improved groundnut cultivars amongst Singida Farmer Research Networks project beneficiaries' is not sufficiently documented. Farmer Research Networks (FRNs) is a collaborative strategy designed to aid the agro ecological intensification of smallholder farming. Although FRN was intended for use in Latin America and Africa, there is little information available on how its implementation, especially the three FRN principles, affects the uptake of agricultural technologies. This study sought to assess the factors that influence the adoption of improved groundnuts by smallholder farmers in the research networks project in Singida District. Specifically, the study (1) assessed how FRN guiding principles, that is, i) farmer participation, ii) usefulness of on-farm research, and iii) collaboration amongst players in networks, were applied in enabling farmers' adoption of improved groundnuts. The study, (2) determined the relationship between access to improved seeds and the adoption of improved groundnuts, and (3) analysed factors that influenced the adoption of improved groundnut cultivars amongst the beneficiaries of FRN project. The study was guided by innovation systems, networks, and Roger's theories of innovation diffusion. A cross-sectional research design and mixed research methods were employed. Content analysis and descriptive statistics were used to assess how FRN principles were applied to influence the adoption of improved groundnuts. The binary logistic regression model (inferential statistics) was used to determine the relationship between access to improved seeds and the adoption of improved groundnuts, together with other factors that influenced the adoption of improved groundnuts. Chi-square test cross-tabulations were used to compare the socioeconomic traits of farmers. Farmers'

perceptions regarding the adoption of improved groundnuts in relation to service accessibility, technological features, and the institutional environment were measured using a Likert scale. Findings show that farmers took part in establishing FRN groups, producing seeds with quality declarations, and offering farmer-to-farmer extension services. In order for farmers to observe, understand, and use the innovation, on-farm research was essential for observational and experimental study. Farmers work together through project meetings, farmers' field days, and mutual research, learning, and resource sharing. It is concluded that farmers engaged in on-farm research and worked together with various network participants, demonstrating that FRN principles were used to sway consumers to adopt improved groundnuts. Additionally, the study showed that socioeconomic factors such as age, sex, marital status, education, and wealth had no discernible impact on the adoption of improved groundnuts. Three criteria, including FRN group membership, seed accessibility, and technological traits including agro ecological zone adaptability, high yields, early maturation, drought tolerance, pest and disease resistance, had a substantial impact on the adoption of improved groundnuts. The majority of farmers had positive opinions of the institutional context, technological characteristics, and accessibility to services for the adoption of improved groundnuts. The report recommends for encouraging farmer participation in the initial meetings and fostering connections between farmers and more actors. Sensitization of more farmers to join groups, increased timely seed availability, and accessibility of improved groundnut cultivars with the characteristics preferable to farmers are essential in this regard.

## IKISIRI KUU

Licha ya kuwa moja ya mazao muhimu ya chakula na mapato duniani, tafiti zinaonyesha kuwa karanga haziasiliwi sana na wakulima. Umri, jinsia, elimu, ushiriki wa kikundi, na upatikanaji wa mbegu ni miongoni mwa sifa zinazohusiana na kuasiliwa. Athari za sababu hizi kwa walengwa wa kutumia aina ya karanga zilizoboreshwa wa Mradi wa Mtandao wa Utafiti wa Wakulima (FRN) wilaya ya Singida, hata hivyo, hazijaandikwa vya kutosha. Mitandao ya Utafiti wa Wakulima (FRN) ni mkakati shirikishi ulioundwa kusaidia kuboresha kilimo cha wakulima wadogo. Ingawa FRN ilikusudiwa kutumika Amerika Kusini na Afrika, kuna taarifa kidogo kuhusu jinsi utekelezaji wake, hasa kanuni tatu za FRN, zinavyoathiri matumizi ya teknolojia ya kilimo. Utafiti huu ulilenga kubainisha sababu za kuasiliwa kwa karanga zilizoboreshwa miongoni mwa walengwa wa mradi wa mtandao wa utafiti wa wakulima wadogo katika wilaya ya Singida. Kimaalum, utafiti (1) ulitathmini jinsi kanuni elekezi za FRN, yaani, i) ushiriki wa mkulima, ii) manufaa ya utafiti wa shambani, na iii) ushirikiano kati ya wahusika katika mitandao, zilivyotumika katika kuwezesha wakulima kuasili aina ya karanga zilizoboreshwa. (2) kuainisha uhusiano kati ya upatikanaji wa mbegu bora na kuasiliwa kwa karanga zilizoboreshwa, na (3) ilichanganua mambo ambayo yalichangia kuasiliwa kwa aina za karanga zilizoboreshwa miongoni mwa wanufaika wa mradi wa FRN. Nadharia za mifumo ya uvumbuzi, mitandao, na nadharia za Roger za uenezaji wa uvumbuzi ziliongoza utafiti huu. Mbinu mchanganyiko za utafiti zilitumika. Uchanganuzi wa maudhui na takwimu za maelezo zilitumika kutathmini jinsi kanuni za FRN zilivyotumika kushawishi uasiliwaji wa aina za karanga zilizoboreshwa. Mtindo wa takwimu ulitumiwa kubainisha uhusiano kati ya upatikanaji wa mbegu bora na uasiliwaji wa aina za karanga zilizoboreshwa, pamoja na mambo mengine yaliyoathiri uasiliwaji wa karanga zilizoboreshwa. Majedwali ya Chi-square yalitumika kulinganisha sifa za kijamii na kiuchumi za wakulima. Maoni ya wakulima kuhusu kuasiliwa kwa karanga

zilizoboreshwa kuhusiana na upatikanaji wa huduma, sifa za kiteknolojia, na mazingira ya kitaasisi yalipimwa kwa kutumia mizani ya Likert. Matokeo yanaonesha kuwa wakulima walishiriki katika kuanzisha vikundi vya FRN, kuzalisha mbegu zenye ubora, na kutoa huduma za ugani za mkulima kwa mkulima. Ili wakulima wachunguze, waelewe, na watumie uvumbuzi, utafiti wa shambani ulikuwa muhimu kwa uchunguzi na majaribio. Wadau hufanya kazi pamoja kupitia mikutano ya mradi, siku za wakulima, utafiti, kujifunza na kushirikishana rasilimali. Inahitimishwa kuwa wakulima walijihusisha na utafiti wa mashambani na kufanya kazi pamoja na washiriki mbalimbali wa mtandao, kuonyesha kwamba kanuni za FRN zilitumika kuwashawishi wakulima kuasili karanga zilizoboreshwa. Zaidi ya hayo, utafiti ulionyesha kuwa masuala ya kijamii na kiuchumi kama vile umri, jinsia, hali ya ndoa, elimu, na kipato havikuwa na athari dhahiri katika kuasili karanga zilizoboreshwa. Vigezo vitatu, vikiwemo uanachama wa kikundi cha FRN, upatikanaji wa mbegu, na sifa za kiteknolojia ikiwa ni pamoja na kuendana na ukanda wa ikolojia ya kilimo, mavuno mengi, kukomaa mapema, kustahimili ukame, kustahimili wadudu na magonjwa, vilikuwa na athari kubwa katika kuasiliwa kwa karanga zilizoboreshwa. Wakulima walio wengi walikuwa na maoni chanya kuhusu muktadha wa kitaasisi, sifa za kiteknolojia, na upatikanaji wa huduma kwa ajili ya uasiliwaji wa karanga zilizoboreshwa. Ripoti inapendekeza kuhimiza ushiriki wa wakulima katika mikutano ya awali na kukuza uhusiano kati ya wakulima na wadau zaidi. Uhamasishaji wa wakulima zaidi kujiunga na vikundi, kuongezeka kwa upatikanaji wa mbegu kwa wakati, na upatikanaji wa karanga zilizoboreshwa zenye sifa zinazofaa zaidi kwa wakulima ni muhimu katika suala hili.

**DECLARATION**

I, **Humphrey S. Chilewa**, do hereby declare to the Senate of the Sokoine University of Agriculture that this dissertation is my original work, done within the period of registration and that it has neither been submitted nor been concurrently submitted for a higher degree award in any other Institution.



15 May 2024

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15 May 2024

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**Date**

## **DEDICATION**

This piecework is dedicated to God the Almighty for his grace, mercy, the gift of life, and the provision of good health and energy to conduct this academic assignment. The dedication also goes to my beloved wife, Mrs. Evelyne George Rwela, and our dear children, Joshua, Caleb, and Dorcas, for their family engagement through the provision of financial, spiritual, emotional support via family monetary contribution, prayers and encouragement. My dear parents, Mr. Shadrack J. Chilewa and Mrs. Margereth Daniel, your parental love, nurturing, instructions, and guidance have made me attain this educational milestone.

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## LIST OF ABBREVIATIONS AND ACRONYMS

CCRP	Crop Collaborative Research Programme
CoP	Community of Practice
COVID	Corona Virus Disease
DALFO	District Agricultural Livestock and Fisheries Officer
FFDs	Farmer Field Days
FGD	Focus Group Discussion
FRG	Farmers Research Group
FRN	Farmer Research Networks
GAPs	Good Agricultural Practices
GDP	Gross Domestic Product
GNP	Gross National Product
JAERD	Journal of Agricultural Extension and Rural Development
KII	Key Informant Interview
LGA	Local Government Authority
NGOs	Non-Governmental Organizations
NMAIST	Nelson Mandela African Institution of Science and Technology
QDS	Quality Declared Seeds
RECODA	Research Community and Organizational Development Associates
RIPAT	Rural Initiatives for Participatory Agricultural Transformation
SPSS	Statistical Package for Social Science
SUA	Sokoine University of Agriculture
TAJAS	Tanzania Journal of Agricultural Sciences
TARI	Tanzania Agricultural Research Institute
TICD	Tengeru Institute of Community Development
URT	United Republic of Tanzania
VSLA	Village Savings and Loans Associations
WADC	Ward Development Committee

## CHAPTER ONE

### 1.0 INTRODUCTION

#### 1.1 Background Information

Groundnut (*Arachis hypogaea* L.) is a legume crop that is synonymously named "earthnut," "peanut, monkey nut," or "goobers." The crop has been widely acknowledged as one of the significant food and cash crops grown on a large scale in nearly all tropical and subtropical countries worldwide (Abady *et al.*, 2019; Ahmed *et al.*, 2020; Shasani *et al.*, 2020; Mwatawala and Kyaruzi, 2019). For instance, according to Mwakimata (2018), Asia accounts for 56 per cent of the global groundnut cultivation area and 68 per cent of the global production of groundnuts, whereas, Africa accounts for 40 per cent of the global groundnut cultivation area and 25 per cent of the global production of groundnuts. If focused efforts were made, these output numbers demonstrate how groundnut may potentially contribute to stronger economies all across the world.

In Africa, the major groundnut-producing countries are Nigeria, Sudan, Tanzania, Chad, Senegal, and Cameroon. Nigeria was the leading groundnut producer during the 2010–2014, with an average volume of groundnut production of about 3,192,599.40 metric tonnes (Mwakimata, 2018). Increased adoption of improved groundnuts may result in increased groundnut production and increasing farmer income in the respective countries.

Tanzania was rated the third groundnut-producing country in Africa as it increased groundnut production volume at an average rate of 19.23 per cent for the past 20 years, from 1995 to 2014 (Mwakimata, 2018). The primary groundnut production agro-ecologies of Tanzania are located in the Shinyanga, Tabora, Dodoma, Mbeya, and Mtwara regions (Daudi *et al.*, 2018). Singida is a semi-arid area and considered as amongst the top ten rated regions potential for groundnut production in terms of quantity (tonnes) and harvested area (ha) in Tanzania (URT, 2016). Despite this, Sawe *et al.* (2018)

found that groundnut is one of the crops with low tolerance capacities in semi-arid regions, which results in a 1.97 per cent drop in production yield trends.

According to The FRN Project Report (2018), changes in rainfall distribution and pattern have affected groundnut production. Though not a recent crop in Singida, the yield of groundnuts is declining because of changes in the distribution of rainfall. Previous work by Research Community and Organizational Development Associates (RECODA), amongst the FRN project's key players in Tanzania, indicated that improved groundnut cultivars could perform well in Singida District.

The implementation of a project titled "Farmer Research Networks' (FRN) Participation in Agro-Ecological Intensification for Improved Soil Health, Productivity, Nutrition, and the Development of Legume Seed Systems in Singida" by Research Community and Organizational Development Associates (RECODA) was done to address the issue of declining trends in groundnut production yields (FRN, 2018). According to Nelson *et al.* (2019), farmers who collaborate with researchers and development organizations to conduct research are said to be part of farmer research networks (FRN). A set of principles for farmer research networks (FRNs) was created by the Crop Collaborative Research Programme (CCRP) to serve as a guide for project execution. The main ideas are: (i) a farmer-centred strategy where a variety of farmers takes part in each stage of the research process; (ii) thorough, democratic, and useful research; and (iii) collaborative networks to encourage knowledge exchange and learning (Richardson *et al.*, 2021; Haussman *et al.*, 2020).

The FRN project was implemented as part of the Crop Collaborative Research Programme (CCRP), financed by the McKnight Foundation, to address the effects of climate change on groundnut and other crops. The project specifically encouraged the adoption and use of technology that harness rainwater harvesting and moisture conservation, as well as drought-tolerant crop cultivars

(groundnuts, bambara nuts, lablab, and pigeon peas). The FRN initiative aimed to promote agricultural productivity and sustainable food production through better soil health practices, which would result in greater income and household resilience through increased food security. To determine how a seed system improves productivity, one of the FRN project's main goals was to create seed systems for legumes, specifically groundnuts, bambara nuts, lablab, and pigeon peas (FRN, 2018).

The FRN project also sought to address the lack of improved groundnut seeds because, as a new crop, their availability was not guaranteed in the project area, despite the fact that Singida was listed as one of Tanzania's top ten groundnut producers (URT, 2016). In order to test the improved groundnut seeds in the project region, RECODA purchased the seeds from TARI-Naliendele (Lukurugu *et al.*, 2021). After purchasing the improved groundnut seeds, RECODA made them available to the beneficiaries through the FRN project, and 420 direct beneficiary farmers (FRN group members) in eight project villages received 112.5 kg of the improved groundnut seeds. The improved groundnut seeds were given to 420 direct beneficiary farmers to multiply them and redistribute them to at least 1260 target beneficiaries (420 direct beneficiaries or FRN group members and 840 indirect beneficiaries or FRN non-group members) in the project area, who would then spread the innovation to their fellow indirect beneficiaries in their own and the nearby villages as well (FRN, 2018). In 2017, the FRN project embarked on evaluating the suitability of four introduced improved groundnut cultivars: Mangaka, Naliendele, Mnanje, and an indigenous farmer cultivar in Singida District. The results of the evaluations and trials indicated that in terms of yields, Naliendele took the lead (92 kg/acre), followed by Mangaka (90 kg/acre), then an indigenous farmer cultivar (66 kg/acre), and lastly Mnanje (61 kg/acre) grown under pure crop (FRN, 2018). Despite FRN project interventions and the results of the trials in terms of yield, further research was required to determine factors that affect the adoption of improved groundnut cultivars in the project area.

## 1.2 Problem Statement

Groundnut is amongst the important oil seed crops with significant contributions to the economy, food, and nutritional security (Abady *et al.*, 2019; Shasan *et al.*, 2020). This is an indication that when further adopted by more farmers, the crop could increase the national economy in terms of Gross National Product (GNP), increase household income, reduce hunger, improve nutritional status, and hence reduce poverty. Furthermore, as a leguminous crop, groundnut contributes significantly to soil fertility by converting atmospheric nitrogen into a useful form that can be absorbed in the soil by plants (Akpo *et al.*, 2020; Vabi *et al.*, 2019). This means that the crop has a natural contributory role in addressing the challenge of nutrient deficiency in the soil in addition to the mechanical application of organic and inorganic fertilizers. Due to its beneficial importance, different studies have indicated how diverse stakeholders have made some efforts to promote improved groundnut cultivars. For example, Hanif *et al.* (2021) reported the promotion of improved groundnut cultivars after the local groundnut cultivars experienced lower productivity. In addition, Katunga *et al.* (2021) proposed the promotion of an integrated seed system for the adoption and conservation of improved and conventional groundnut cultivars in order to attain farmer food and income security. Furthermore, Konja (2020) noted the recent growth in interest amongst a variety of specialists in performing adoption studies on new agricultural technology in the production of groundnuts.

Despite its promotion and indication of its importance, various studies indicate that improved groundnut cultivars are not widely adopted. This is to say, the adoption of improved groundnut cultivars in Tanzania has been notably low. To give examples, Takahash *et al.* (2019) reported on the poor acceptance rate of new agricultural technologies such as improved groundnut cultivars, while Lukurugu *et al.* (2021) revealed low adoption of improved groundnut cultivars in the Tanzanian southern zone. Again, Tanzania's groundnut production falls behind other African countries like Nigeria, with

yields lagging at 2.5 to 3 times lower, as per Das *et al.* (2023). This discrepancy suggests a notable gap in adoption or implementation of best practices in groundnut cultivation within Tanzania. The huge acceptance gap between farmer practices and enhanced innovations, such as improved groundnut cultivars created by agricultural university experts, was also highlighted by Gorfad *et al.* (2018). An innovation, such as improved groundnuts, should address problems that have been recognized. Researchers should also be mindful that innovations are not always embraced just for their technical merits (Orr, 2018).

Before the Farmer Research Networks (FRNs) project was implemented, the government of Tanzania tried to tackle this issue of low adoption by forming policies to emphasize the adoption of agricultural innovations for increased production. The policy statements include the government of Tanzania, in collaboration with academic and research institutions, creating linkages with farmers in the adoption of new technologies (MAFC, 2013); and seed policies and regulatory frameworks to guide Tanzania's seed industry and ensure the production of improved seed varieties of high quality. The two Seed Acts (the Seeds Acts No. 29 of 1973 and No. 18 of 2003) specify each seed actor's obligations in ensuring that high-quality seed is produced and distributed to farmers throughout the nation (Akpo *et al.*, 2021). The introduction of FRNs complimented a collaborative approach, enabling farmers, researchers, non-government organizations, and extension agents to work together in developing tailored technologies (Richardson *et al.*, 2021; Hausman *et al.*, 2020).

A survey to ascertain the adoption of improved pigeon pea was conducted and the results, according to the FRN progress report (2018), revealed the adoption rate of 80 per cent. Regarding the adoption of improved groundnut cultivars, no evidence was made available for this assessment. On the adoption and appropriateness of the improved groundnut cultivars in Singida, further study was recommended in the FRN project assessment report.

Still, Lee (2020) referenced Simtowe *et al.* (2019) who claimed that the size of the family, increased income, the receiving of more knowledge on cultivars, and increased the use of hired labour and manure were the factors that had the most impact on the adoption of improved groundnut cultivars amongst the Ugandan farmers. The following variables also influenced Tanzania's adoption of improved groundnut cultivars: age, gender, education, land ownership, group participation, farm size, experience, grain price, seed availability, and seed cost (Mwalongo *et al.*, 2020). These observations notwithstanding, the impact of these factors on farmers' adoption of improved groundnut cultivars in Singida District amongst FRN project beneficiaries was not sufficiently documented. This study has filled this research gap by establishing the determinants of the adoption of improved groundnut cultivars amongst the beneficiaries of FRN Project in Singida District.

### **1.3 Study Justification**

The findings from this research can inform policy decisions and program implementations by providing evidence-based recommendations on issues related to the application of farmer research network principles, farmers' groups, and factors influencing the adoption of improved groundnut cultivars. The dissemination of this knowledge would be used as a reference to benefit various stakeholders, including the government, NGOs like RECODA, academic and research institutions, and farmers themselves. That is to say, these insights can inform future research, planning, and implementation of improved groundnut projects and programmes, thereby contributing to improved agricultural practices and outcomes. This would potentially enhance wider adoption and, subsequently, increased yield, income, and attainment of food and nutritional security, leading to poverty reduction in Tanzania.

Linking this with existing policies, the study aligns with the UN's Millennium Development Goal No. 1, which targets poverty and hunger eradication for all individuals (URT, 2005). Additionally, it supports Tanzanian policy statements emphasizing the adoption of agricultural innovations for increased production, as outlined by the

Ministry of Agriculture, Food, and Cooperatives (MAFC, 2013). The policy states, "*The government, in collaboration with academic and research institutions, shall create linkages with farmers in the adoption of new technologies*" (MAFC, 2013).

## **1.4 Research Objectives**

### **1.4.1 Overall objective**

The study intended to establish the determinants of the adoption of improved groundnut cultivars amongst FRN Project beneficiaries in Singida District.

### **1.4.2 Specific objectives**

Specifically, the study intended;

- i. To assess how FRN guiding principles are applied in enabling farmers' adoption of improved groundnut cultivars
- ii. To determine the relationship between access to improved seeds and adoption of improved groundnut cultivars
- iii. To analyse factors influencing adoption of improved groundnut cultivars amongst FRN Project beneficiaries

## **1.5 Research questions**

- i. How FRN guiding principles work in facilitating the adoption process in the study area?
- ii. What is the influence of improved groundnut seeds accessibility on the adoption process amongst FRN project beneficiaries?
- iii. What factors affected the adoption of improved groundnut cultivars?

## **1.6 Theoretical Framework**

This study was guided by three theories: networking theories of diffusion of innovations, innovation systems theory, and Roger's theory of innovations. The rationale to use three theories was based on their strengths and limitations of each theory in fitting to the three principles of FRNs as described hereunder in each theory.

### **1.6.1 Networking theories of diffusion of innovations**

The network theory of innovation suggests that for innovative firms to achieve and improve innovation performance, they should use a broadened spectrum of external skills, network relations, and sources of information (Chesbrough, 2003; Fert *et al.*, 2016). Again, social network theory perceives relationships in terms of nodes (individual players) and ties (the relationship between players), with individual player characteristics weighing less heavily than their relationship with other players (Whelan, 2007).

In accordance with the social network diffusion hypothesis, farmers are more likely to accept an innovation if they receive information about it from a variety of sources. Further predictions include: (1) targeting is only important in a complex learning environment, whereas under simple learning, significant adoption gains are produced after three years. Others include (2) clustering seeds in the same area of the network is helpful if diffusion has complex contagion properties; and (3) under complex learning, the number of connections to seeds should be a good indicator of adoption (Beaman *et al.*, 2021).

Furthermore, attitudes of potential innovation adopters are also influenced by social inspiration since people are embedded in an interactive network. A person's willingness to persuade others as well as the choice of modifications are all necessary for an innovation to be adopted (Deroian, 2002). Figure 1.1 summarizes the independent variables in this study, whereby multiple information sources, a wider range of external skills, and multiple connections to seeds that influence the adoption of improved groundnut cultivars, were identified using networking theories of innovation diffusion. Social network diffusion theory was used in this study because it is congruent with FRN principles, despite the fact that it makes assumptions about networking, collaboration, and participatory processes. However, the limitation of this theory with respect to aligning with FRN principles is that networking theories of diffusion

typically emphasize the role of social ties, connectivity, and information transmission in facilitating the spread of innovations within a network. While these theories provide valuable insights into how information spreads through social connections, they may overlook the importance of participatory decision-making and the co-creation of knowledge that characterize FRNs.

### **1.6.2 Innovation Systems Theory**

The innovation system approach describes a network of private and public sector organizations whose interactions generate, disseminate, and apply economically useful knowledge (Lundvall *et al.*, 2002; Clark *et al.*, 2003; World Bank, 2007; Rajalahti *et al.*, 2008; Spielman *et al.*, 2009). The innovation systems approach contends that learning happens in networks, spreads to people and farmers, and results in innovation. Before adopting an innovation, farmers often learn on the farm about its effectiveness and adaptability to farming systems, as well as the sustainability of the inputs and the market for the produce (Ayele *et al.*, 2012).

The whole cast of actors and characteristics necessary to foster innovation and growth are highlighted by the innovation system framework (World Bank, 2007). The major players—knowledge and technology producers and users—as well as their roles, interactions with one another, and behaviours that affect collaborative learning and innovation are highlighted by Ayele *et al.* (2012). Players' closeness, including their physical proximity, the institutional context, which develops relationships based on trust, and their propensity to absorb new information, all influence interaction, and learning.

The suitability of the innovation entry process requires the coordination and participation of all players in agricultural innovation systems. Different studies have recommended demand-driven methodologies in planning project interventions and future investments, whereby the network of players should constantly search for new methods, markets, and contributions and conquer new opportunities in their working surroundings so as to be adaptive (Turyahikayo *et al.*, 2019; Toillier *et al.*, 2021). The adoption of

improved groundnut cultivars was conceptualized to be influenced by many independent variables, including demand-driven innovation, suitability of innovation, sustainability of inputs, market for the product, on-farm learning, providers of knowledge and technology, users of knowledge and technology, physical distance, and institutional environment. These independent variables were identified using the innovation system approach, as shown in Figure 1.1.

The innovation systems theory, which places greater emphasis on network cooperation and systems thinking, is related to the FRN approach. One limitation of the innovation systems approach in relation to Farmer Research Networks (FRNs) principles is the potential for top-down implementation and the lack of farmer involvement in decision-making processes. The innovation systems approach typically involves various stakeholders, including policymakers, researchers, and extension agents, collaborating to identify and implement innovations. However, there may be limited emphasis on engaging farmers directly in these processes. Integrating principles from farmer research networks can help address these limitations by ensuring that farmers play a central role in shaping agricultural research and innovation agendas.

### **1.6.3 Roger's theory of innovations**

According to Rogers (2003), adopting an innovation is choosing to do so fully as the best course of action that is now available; while, rejecting an innovation is choosing not to do so. Rogers (2003) asserts that innovations that have benefits are seen as compatible with the existing habits and beliefs, are simple, may be testable and observable will spread more quickly.

The innovation decision process consists of five steps: (i) The knowledge (cognitive) stage, where a beneficiary farmer seeks to know the what, how, and the why of the innovation, that is, improved groundnut. Others include (ii) persuasion (affective) stage, whereby a farmer's feeling is stimulated after knowing the improved groundnut to develop either a positive or negative attitude, and (iii) the decision stage, whereby a farmer chooses to use (adopt) the

improved groundnut or reject it. Others include (iv) the implementation stage, whereby a farmer practices the innovation; and (v) the confirmation stage, whereby a farmer assesses the decision already made about the improved groundnut and looks for support for his or her decision (Rogers, 2003).

Furthermore, as Rogers (2003) pointed out, the attributes of innovations, which include five characteristics of innovations: (i) relative advantage (perceived better than the idea it replaces); and (ii) compatibility (consistent with the existing values, beliefs, experiences, needs, and practices). Others include (iii) complexity or simplicity (relatively difficult or simple to understand and use); (iv) trialability (can be experimented with); and (v) observability (visible to others). Using the assumptions that innovators are risk- and change-takers, the late majority are sceptics, and laggards are traditionalists, *Vecchio et al.* (2020) described a normal distribution curve of the diffusion process by classifying the types of adopters as innovators (2.5%), early adopters (13.5%), the early majority (34%), the late majority (34%), and laggards (16%).

Roger's theories of innovation were applicable to FRN principles in on-farm research, where farmers could observe, evaluate how easily and compatible an innovation fit with their existing habits and beliefs, and learn about the advantages of innovation through on-farm experiments. One limitation of Rogers' theories of innovation in relation to Farmer Research Networks (FRN) principles is its focus on the diffusion of innovations from external sources to farmers rather than emphasizing participatory approaches that actively involve farmers in the innovation process. While Rogers' theories of innovation offer valuable insights into the diffusion of innovations, they may not fully align with the principles of farmer research networks, particularly regarding participatory approaches, context-specific adaptation, and the integration of local knowledge.

### **1.7 The concepts of Adoption and Diffusion**

According to *Vecchio et al.* (2020), when discussing the concept of diffusion, the adoption is referred to alternately as a component or sub process of diffusion, and hence,

*"Diffusion is the adoption process whereby an innovation is accepted across a population over time; whereas, adoption is the condition whereby an individual decides to accept an innovation and integrate it into his or her life."*

In this study, the term "adoption" refers to the cooperative testing, learning, understanding, and application of the innovation by the FRN project beneficiaries through the cultivation of either all or one of the three improved groundnut cultivars—*Mnanje*, *Naliendele*, and *Mangaka*—as part of their agro-ecological practices.

### **1.7.1 FRN approach and einstein ladder of participation**

Farmers that participate in research in collaboration with scientists and development organizations make up the many groupings that make up farmer research networks (FRN) (Nelson *et al.*, 2019). The Farmer Research Networks (FRN) principles were created by the Crop Collaborative Research Programme (CCRP) to serve as a guide for project implementation. The fundamental concepts are (i) a farmer-centred strategy in which several farmers take part in the research process; (ii) rigorous, democratic, and practical/useful research; and (iii) collaborative networks to promote learning and information exchange (Richardson *et al.*, 2021; Hausman *et al.*, 2020).

The FRN strategy, according to Descheemaeker *et al.* (2021), is intended to involve farmers so they may prioritize experiment, acquire data, and comprehend the outcomes. Since they were discovered through relevant, reliable, and valid research, the FRN principles are helpful in developing solutions and methods that are worth scaling to settings of a comparable sort. For the programme's ownership, learning, acceptance, diffusion, and sustainability, farmers' participation in the entire research process is crucial.

The incorporation of participatory research into a farmer research network (FRN) has the potential of boosting its efficacy (Wenndt *et al.* (2021) by increasing the sharing of information between regional

and international innovation systems. As Nelson and Haussmann (2019) observed, major institutional innovation along with the adjustments to the relationships and roles amongst researchers, extension experts, and farmers, would be needed to empower FRNs. On the FRN tenets, various authors have reported focusing on how to interpret, put into practice, and use the principles to direct learning and information exchange between domestic and global innovation systems (Richardson *et al.*, 2021; Wenndt *et al.*, 2021). According to Hassen *et al.* (2019), research on the social value of FRN, after the majority of farmers had engaged, the knowledge transfer led to the adoption of push-pull technology. The majority (97%) of farmers claimed that FRN enhanced social connection, which influenced the adoption of push-pull technology (PPT) (Hassen *et al.*, 2019). In this study, FRN principles and FRN group membership were identified as amongst the independent variables influencing the adoption of improved groundnut cultivars as shown in Figure 1.1.

According to Arnstein (1969, 2020), the levels of citizen participation are described by using the symbol of a ladder with eight ascending rungs (manipulation, therapy, informing, consultation, placation, partnership, delegated power, and citizen control), each representing increasing levels of citizen agency, control, and power. Arnstein (1969) further describes a continuum of participatory power moving from non-participation/no power (manipulation and therapy); degree of tokenism/counterfeit power (informing, consultation, and placation) to citizen participation/actual power (partnership, delegated power, and citizen control). The Arnstein ladder of participation was employed to determine the level of FRN farmer participation in answering specific objective 1.

### **1.7.2 Seed accessibility and diffusion of improved groundnut**

Researchers from several fields have documented how farmers lack access to seeds from improved groundnut cultivars (Akpo *et al.*, 2020; Akpo *et al.*, 2021; Miningou *et al.*, 2021). For example, more than 85 per cent of farmers reported difficulty of accessing seeds

from improved groundnut cultivars (Abady *et al.*, 2019). However, when availability of seeds is secured, various studies have found an increase in the adoption rates (Simtowe *et al.*, 2019; Mohammed *et al.*, 2021; Daudi *et al.*, 2018; Mwalongo *et al.*, 2020). With regard to improved seed accessibility, this research sought to answer the question, what was the influence of improved groundnut seed accessibility on the adoption process amongst FRN project beneficiaries, aiming at establishing the relationship between these factors.

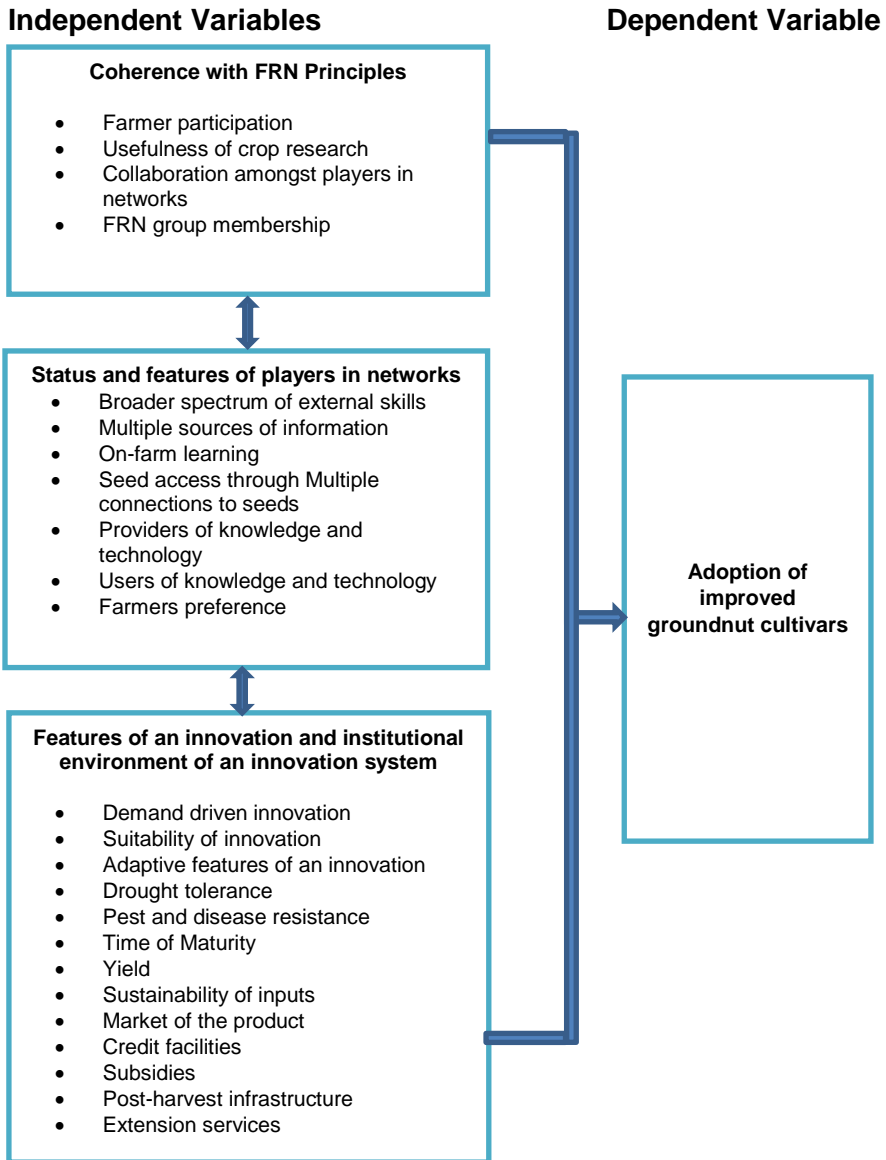
### **1.7.3 Factors influencing the adoption of innovations**

Amongst the factors that lead to the low adoption of innovations such as improved groundnut cultivars are a lack of agricultural information, poor linkages between knowledge providers and farmers, the climate, a lack of optimal results from experimentation, and a lack of immediate results (Mkenda *et al.*, 2020; Alvarez *et al.*, 2021). Mwangi and Kariuki (2015) have quoted various literatures stating the determinants of agricultural technology adoption, which include personal characteristics, input availability, infrastructural, informational, managerial structure, ecological, economic, social, institutional, technological, human capital, production, policy issues, and natural resource characteristics.

Additionally, amongst the factors that affect the adoption of groundnut in Tanzania are diseases, pests, drought, unavailability of improved seeds, price, seed cost, and extension services. Others include, credit facilities, market, age, gender, education, income, yield, attitude, mass media exposure, farmer preference, and perception (Ahmed *et al.*, 2020; Daudi *et al.*, 2018; Gorfad *et al.*, 2018; Mwalongo *et al.*, 2020; Mohammed *et al.*, 2021; Simtowe *et al.*, 2019). Nevertheless, the way these factors influence the adoption of innovations in Singida District amongst FRN project beneficiaries has not been sufficiently documented; hence, this study incorporated the factors as amongst the independent variables and has filled in this gap by determining how these factors affected the adoption of improved groundnut cultivars.

## **1.8 Conceptual Framework**

For guiding this research, the major factors that affect the adoption of improved groundnut cultivars were extracted and modified from theoretical frameworks and a review of the literature. These factors were categorized into three major factors: coherence with FRN principles, the status and features of players in the networks, the features of an innovation, and the institutional environment of an innovation system. Figure 1.1 presents further illustrations of the factors that affect the adoption of improved groundnuts.



**Figure 1.1: The Conceptual Framework (adopted and modified from the theoretical frameworks and review of literature).**

**Source:** Researcher's construction from review of literature 2022

## **1.9 Research Methodology**

### **1.9.1 Study area description**

The Singida District is located between 34<sup>0</sup> and 35<sup>0</sup> longitudes east of Greenwich and between 3<sup>0</sup> and 7<sup>0</sup> latitudes south of the equator. Singida Rural District has a semiarid climate. There are two seasons: the longest, which is the dry season (April to November) and the rainy season (December to March). The minimum temperature ranges from 15 to 30 °C, and the average annual precipitation is between 600 and 700 mm (Singida District Profile, 2015). Singida District, which is located in the east of the Great Rift Valley, is a large scarp with 180-meters height. These geographic and climatic characteristics favour the cultivation of groundnuts. One prominent feature of the land escarpment is the massive outcrops, or six rocky peaks (tors), of granite and metamorphic rocks that can be found in Singida District. These inselberg-like outcrops are the remnants of old land surfaces that have been washed away nearby to form a large, gently undulating pen plain (Singida District Profile, 2015). According to the Singida District Profile (2015), the Nyaturu, Sukuma, Taturu, Barbaig, Hadzabe, and Kimbu are the district's main indigenous ethnic groups. Barbaig, Hadzabe, and Kimbu make up a sizable portion of the population. The Nyaturu people are the largest ethnic group in the district compared to other tribes.

According to the FRN Project Report (2018), fluctuations in rainfall distribution and patterns affect groundnut yields. Despite groundnuts being a longstanding crop in Singida, inconsistent rainfall is leading to reduced production. Previous research by RECODA, a key partner in the FRN project in Tanzania, indicated that improved groundnut cultivars could thrive in Singida District (FRN, 2018). The selection of study villages based on topographic features, climatic conditions, and rainfall patterns that favour groundnut production underscores the strategic approach of the FRN project. By focusing on areas with conducive environmental conditions for groundnut cultivation, the FRN project aims to maximize the impact of interventions and innovations introduced through the project. Additionally, the presence of the FRNs project in these villages

facilitates the adoption and diffusion of improved groundnuts by leveraging existing networks and community structures for knowledge dissemination and outreach. FRNs are collaborative platforms that bring together farmers, researchers, extension agents, and other stakeholders to co-create knowledge, develop innovations, and address challenges in agriculture (Richardson *et al.*, 2021; Hausman *et al.*, 2020). Within the context of groundnut production, FRNs in the study villages engage in a range of activities aimed at enhancing productivity, sustainability, and resilience in groundnut farming. These activities include on-farm trials and research through demonstration plots, training and capacity building, and seed multiplication and distribution.

### **1.9.2 Study design**

This study used a cross-sectional research design as opposed to a longitudinal research design. A cross-sectional research design, as noted by Omair (2015), has a broad reach because it considers several variables at once and enables data gathering at a single point in time. Omair (2015) notes further that when looking for connections between variables and for descriptive reasons, it is more time and cost-effective than the longitudinal research design. Utilizing a combination of research methods, concurrent quantitative and qualitative data collection was carried out. To enhance the applicability of research findings, Glover *et al.* (2019) emphasized the importance of employing mixed research methods, highlighting their innovative and insightful nature across various contexts. In addition, a mixed-method study, according to Creswell (1999), uses both qualitative and quantitative data and analysis techniques in a single investigation. However, the qualitative research outweighed the quantitative research for Objective 1 because this study had a more inductive orientation and was intended to assess how farmers' participation, the value of crop research, and collaboration amongst network participants affected farmers' decisions to adopt improved groundnut cultivars. The factors that statistically influenced the adoption of improved groundnut cultivars, specifically *Mnanje*, *Mangaka*, and *Naliendele*, were determined for objectives 2 and 3

using quantitative research approaches. As a result, mixed research methods were complementary to each other, with qualitative research providing information that increased comprehension of situations that quantitative research could not sufficiently illustrate.

### **1.9.3 Population of the study**

The study population comprises 1260 target beneficiary farmers, including 420 direct beneficiaries (FRN group members) and 840 indirect beneficiaries (FRN non-group members), from eight project villages in Mtinko and Ilongero Divisions, Singida District, who were studied or surveyed in this research project. The target population refers specifically to the broader population encompassing all farmers in the project villages to which the study findings are intended to be applicable or generalized.

### **1.9.4 Sample size and sampling procedure**

Eight villages in Ilongero and Mtinko Divisions of Singida District, namely Sekoutoure, Mwakiti, Msimihi, Mdilu, Mvae, Mughanga, Minyenye, and Mtinko, were selected as study areas. The selection criteria for these villages included their topography, climate, and rainfall patterns, all of which are conducive to groundnut cultivation. Furthermore, the involvement of these villages in Farmer Research Networks (FRNs) facilitated the introduction and promotion of improved groundnut cultivars, enhancing the potential for adoption and diffusion of innovative agricultural practices within these communities.

With regard to quantitative data, proportionate random sampling techniques were first used to get representative of the population. This study used the formula proposed by Krejcie and Morgan (1970), to determine the sample size of smallholder farmers' direct and indirect beneficiaries from the 8 villages in Ilongero and Mtinko Divisions in Singida Rural District.

$$n = \frac{X^2 NP(1 - P)}{d^2(N - 1) + X^2 P(1 - P)}$$

Where: n=required sample size, X =z value (assumed to be 1.645 for 95% confidence level), N = Population size, P = Population proportion (assumed to be 0.5 since this would provide the maximum sample size), d = degree of accuracy (5%), expressed as a proportion (0.05).

$$n = \frac{1.64^2 \times 1260 \times 0.5 \times 0.5}{0.05^2 \times (1260 - 1) + (1.64^2 \times 0.5 \times 0.5)} = 212$$

To conduct random sampling for the selection of respondents from each village, a proportionate formula was applied to ensure representation of both direct and indirect beneficiaries (FRN group members and non-group members) in the study. Here is how the random sampling procedure was conducted:

#### **1.9.4.1 Calculation of Total Sample Size (n):**

For direct beneficiaries (FRN group members), the total sample size (n) was determined by multiplying the overall sample proportion (212) by the ratio of direct beneficiaries to the total population (420/1260). This yielded a total sample size of approximately 71. That is to say,

$$n = (420/1260) \times 212 = 70.67 \text{ approximately } 71$$

For indirect beneficiaries (FRN non-group members), the same procedure was applied using the ratio of indirect beneficiaries to the total population (840/1260), resulting in a total sample size of 141 i.e.,

$$n = (840/1260) \times 212 = 141$$

#### **1.9.4.2 Determination of Sample Size for Each Village (n1 to n8):**

For both direct and indirect beneficiaries, the sample size for each village was calculated by multiplying the proportion of beneficiaries in each village by the total sample size (n).

For direct beneficiaries, the proportion of beneficiaries in each village (e.g., 50 direct beneficiaries out of 420 total beneficiaries in village 1) was multiplied by the total sample size to determine the sample size for that village (e.g.,  $n_1 = (50/420) * 71 = 8$ ). That is to say,

$$n_1 = (50/420) * 71 = 8, n_2 = 8, n_3 = 17, n_4 = 5, n_5 = 14, n_6 = 5, n_7 = 6, n_8 = 8$$

Similarly, the sample size for each village of indirect beneficiaries was calculated using the proportion of indirect beneficiaries in each village (e.g.,  $n_1 = (100/840) * 141 = 17$ ). That is,

$$n_1 = (100/840) * 141 = 17, n_2 = 15, n_3 = 34, n_4 = 10, n_5 = 28, n_6 = 10, n_7 = 12, n_8 = 15$$

#### **1.9.4.2 Random Selection Procedure:**

Once the sample sizes for each village were determined, respondents were randomly selected from the list of direct and indirect beneficiaries in each village using a random number generator. This ensured that the selected respondents represented both direct and indirect beneficiaries from each village, allowing for a comprehensive analysis of the study data. By employing this proportionate random sampling procedure, the study ensured that both direct and indirect beneficiaries from each village were adequately represented in the sample, enhancing the reliability and generalizability of the study findings.

Table 1,1 provides breakdown of the sample size of direct and indirect beneficiaries per village.

**Table 1.1: Sample size**

Division	Ward	List of villages	Population (N)		Sample Size (n)	
			Direct	Indirect	Direct	Indirect
1. Ilongero	1. Ilongero	1. Sekoutoure	50	100	8	17
	2. Mrama	2. Mwakiti	45	90	8	15
	3. Ikhanoda	3. Msimihi	99	198	17	34
	4. Mwasawia	4. Mdilu	31	62	5	10
	5. Meria	5. Mvae	84	168	14	28
2. Mtinko	6. Mtinko	6. Mughanga	29	58	5	10
		7. Minyenye	37	74	6	12
		8. Mtinko	45	90	8	15
<b>Total</b>			<b>420</b>	<b>840</b>	<b>71</b>	<b>141</b>
<b>Grand Total</b>			<b>1 260</b>		<b>212</b>	

**Source:** Survey data 2022

For the case of qualitative data, key informants (i.e., Agricultural Officers, agro-vet dealers, and project staff) were purposefully selected for interviews and groups of beneficiary farmers were selected for focus group discussions. Two groups were purposefully selected from the eight villages for focus group discussions (FGDs), whereby each division had one group selected, that is, the Muungano group at Mvae village (Ilongero Division, with 12 participating farmers) and the Mshikamano group at Mughanga village (Mtinko Division, with 8 participating farmers). Following the guidelines provided by Nyumba *et al.* (2018), focus group discussions (FGDs) were held with eight to twelve farmers in each. It was proposed that groups beyond twelve would become challenging to manage and that these groups may divide into two or even three smaller ones, with each holding its own debate. The FGDs were conducted at the premises of village offices and lasted for about 60 to 90 minutes.

Two Agricultural Officers (one at the district level and one each at the ward and village levels) and two agro-vet dealers (one each at the district, ward, and village levels) served as key informants for the interviews. Programme leader, Project Manager, and Project Officer were amongst the project team members who underwent interviews.

The interviews lasted for about 60 to 90 minutes and took place at their respective offices. Key informants were chosen because they were perceived to have enough information and knowledgeable about the project being carried out in their specific spheres of influence.

The main issues in FGDs and KII concerned stakeholders' comprehension of FRN principles, the ways in which FRN principles were applied to facilitate the adoption of improved groundnut cultivars, and the identification of key players, their roles, and interaction with and collaboration in farmers' research networks. Others include understanding of how farmer characteristics, technological traits, and factors such as informational and socioeconomic factors influenced the adoption of improved groundnut cultivars in the region.

## **1.9.5 Data collection**

### **1.9.5.1 Primary data**

Primary data collection commenced after enumerators underwent training on 23 April 2022, to familiarize themselves with data collection techniques encompassing both quantitative and qualitative methods. During this session, research tools including survey questionnaires, key informant interview checklists, and focus group discussion guides were thoroughly reviewed and discussed. The study tools were pretested at Mwakiti community on 24<sup>th</sup> April 2022. Based on the results of the pretesting exercise, the data gathering instruments were modified. Between 25<sup>th</sup> April and 4<sup>th</sup> May 2022, field data were collected, and involved both quantitative and qualitative primary data/information. The collected data were taken in writing through note taking, snapshot photos, and short video records.

Through the use of semi-structured questionnaires with both closed- and open-ended questions, primary quantitative data on farmers' level of participation in FRN groups, the extent of usefulness of crop research, age, sex, marital status, education level, major source of income, technological characteristics, seed accessibility, FRN group membership, and institutional characteristics were collected. The

study's quantitative data, such as frequencies, percentages, means, and standard deviations, are crucial for illustrating the study's numerical and statistical numbers.

Farmers' feelings and opinions about why to adopt or reject improved groundnut, how they apply the FRN principles to encourage adoption, how the key players collaborate or interact in farmer research networks were all primary qualitative data that were gathered using qualitative research methods. Others included how the characteristics of the farmers, as well as technological, institutional, and informational factors, influenced the adoption of improved groundnut cultivars. Checklists with open-ended questions were used. To gain a thorough grasp of situations, which statistical data could not adequately describe, qualitative data were gathered.

#### **1.9.5.2 Secondary Data**

Secondary data was compiled through a documentary review process. The socioeconomic profile of the Singida District, the FRN project design, and the monthly, quarterly, and yearly monitoring and evaluation reports were amongst the documents examined. The online knowledge sources were primarily Google Scholar with papers published between 2017 and 2023. These documents were crucial since they were part of the literature review and offered information on what had already been done and reported; their major objective was to support (or contest) the findings from other data sources.

#### **1.9.6 Data analysis and interpretation**

Data analysis and interpretation were performed on both quantitative and qualitative data. Quantitative data were coded and compiled before the analysis. The survey's numerical data (from the questionnaires) were entered and evaluated using the Statistical Package for Social Science (SPSS) version 20, which produced descriptive statistics (mostly frequencies and percentages). To make the presentation of the frequencies and percentages simpler, they were further modified and turned into cross-tab and pivot tables.

The operational definition employed in this study served as the basis for measuring adoption. The improved groundnut cultivars (*Mnanje*, *Mangaka*, and *Naliendele*) were considered to have been adopted by respondents who indicated they had grown all of them or at least one of them (1 = yes) on a questionnaire, as opposed to those who indicated they had not grown them (0 = no). The questionnaire responses were used to record independent variables like FRN group membership and seed accessibility. Group members (direct beneficiaries) were coded as 1, and non-group members (indirect beneficiaries) as 0. Similarly, respondents who had access to improved groundnut seeds were coded as 1, and those who did not were coded as 0. The respondents' perceptions of technological and institutional qualities were recorded, converted, and classified into two groups by computing the mean: 1 for positive perception and 0 for negative perception.

Cross-tabulations employing the Chi-square test were used to examine the socioeconomic characteristics of farmers who adopted the improved groundnut cultivars and those who did not. The farmers' perceptions of the adoption of improved groundnut cultivars in connection to service accessibility, technological features, and institutional environment were measured using a Likert scale. To identify characteristics influencing smallholder farmers' adoption of improved groundnut cultivars, the binary logistic regression model was utilized. According to Astari (2019), the binary logistic regression model is represented by the accepted equation below.

$$\text{logit}(\pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p$$

Whereby,

$\beta_0, \beta_1, \dots$ , = Regression parameters;  $X_1, X_2, \dots, X_p$  = Independent variables

$\pi$  = Probability of adoption

$X_1$  = Respondent's age (the age of respondent in years)

$X_2$  = Respondent's sex (1 = male, 0 = female)

$X_3$  = Education (1 = primary education, 0 = other level of education)

X4 = Marital status (1=married, 0= otherwise)

X5 = Major source of income (1 = agriculture, 0 = others)

X6 = Technological characteristics (1 = positive perception, 0 = negative perception)

X7 = Seed accessibility (1 = accessible, 0 = not accessible)

X8 = FRN group membership (1= group member, 0 = non-group member)

X9 = Institutional characteristics (1 = positive institutional perception, 0 = negative perception)

Crosschecking, verifying, and complementing qualitative data from focus group discussions and interviews, particularly with the district, project officials, and other key informants, allowed the written notes to be in line with the brief video clips and photos that were taken in the field. The data were then manually coded, translated from Kiswahili to English, and crosschecked before the analysis. Specific themes were created by combining the codes, and these topics were then subjected to thematic analysis. Themes based on patterns and trends in the data were used to interpret the data. Table 1.2 provides the summary of the methodology used.

**Table 1.2: Summary of the Methodology**

<b>S N</b>	<b>Objectives</b>	<b>Types of data collected</b>	<b>Source of data</b>	<b>Method of data collection</b>	<b>Analysis</b>
<b>1</b>	To assess how FRN guiding principles are applied in enabling farmers' adoption of improved groundnut cultivars.	Qualitative  Quantitative	Project Documents Key informants FRN groups FRN Indirect beneficiaries	Documentary Review Interview Focus Group Discussion Observation Survey/Questionnaire	Content/Thematic analysis  SPSS version 20 • Descriptive • Crosstabs
<b>2</b>	To determine relationship between access to improved seeds and adoption of improved groundnut cultivars	Quantitative  Qualitative	FRN direct beneficiaries  FRN indirect beneficiaries  Key Informants FRN groups	Survey/Questionnaire  Documentary Review Interview Focus Group Discussion Observation	SPSS version 20 • Descriptive • Crosstabs • Multiple response • Likert scale • Chi-square Content Analysis
<b>3</b>	To analyse factors influencing adoption of improved groundnut cultivars amongst FRN Project beneficiaries	Quantitative  Qualitative	Project Documents Key informants FRN groups FRN direct beneficiaries FRN indirect beneficiaries	Survey/Questionnaire  Documentary Review Interview Focus Group Discussion Observation	SPSS version 20 • Descriptive • Crosstabs • Multiple response • Likert scale • Chi-square • Binary logistic regression Content/Thematic analysis

**Source:** Survey data 2022

### 1.10 Organization of the Dissertation

Following SUA's guidelines for publishable manuscripts, the dissertation is structured into five chapters. Chapter One contains the introductory part, while Chapters Two and Three comprise the publishable manuscripts from the study. Chapter Four presents the

dissertation's primary findings, and Chapter Five summarizes the overall conclusions and recommendations of the thesis.

In Chapter One, the introductory part offers a comprehensive background, encompassing the status of groundnut production worldwide, in Africa, Tanzania, and specifically in Singida. This section delves into a problem statement and rationale, emphasizing the significance of adopting improved groundnut cultivars and establishing farmer research networks. Furthermore, Chapter One outlines the study objectives, research questions, and the conceptual frameworks underpinning the research, notably innovation systems, networks, and Rogers' theories of innovation diffusion. Additionally, this chapter provides clear definitions of key concepts and outlines the research methodology employed in the study.

Chapter Two introduces the first manuscript, titled "The Role of Farmer Research Networks (FRN) Principles in Influencing Farmers' Adoption of Improved Groundnut Cultivars in Singida Rural District of Semi-Arid Central Tanzania." This manuscript illuminates how farmers engaged in on-farm research and collaborated with diverse network participants to promote the adoption of improved groundnuts.

The second manuscript, titled Factors Influencing Smallholder Farmers' Adoption of Improved Groundnut Cultivars in Singida, Tanzania, is presented in Chapter 3. The manuscript reveals that, the adoption of improved groundnuts was significantly influenced by three factors: FRN group membership, seed accessibility, and technological characteristics, which include adaptation to agro ecological zones, high yields, early maturity, drought tolerance, pests, and disease resistance.

Chapter Four presents the dissertation's primary findings derived from the manuscripts. The general discussion covers the major results, highlighting the role of FRN principles, the impact of seed accessibility, and other factors influencing the adoption of improved

groundnut cultivars among FRN project beneficiaries. These findings support the theories underpinning the study, including social network diffusion theory, innovation systems, and Rogers' theory of innovation diffusion.

Chapter Five presents the conclusions and recommendations. The conclusions drawn from this research show that farmers' collaboration with various players in the FRN network and participation in on-farm research demonstrated the influence of FRN principles—farmer participation, the usefulness of on-farm research, and network collaboration—on the adoption of improved groundnut cultivars in Singida District. Key factors impacting adoption included FRN group membership, seed accessibility, and technological qualities such as adaptation to agroecological zones, high yields, early maturity, drought tolerance, and pest and disease resistance. The chapter advises RECODA, local government authorities (District, Ward, and village governments), and other development stakeholders to encourage more farmers to form and join groups. It also emphasizes the need to ensure that improved groundnut seeds with farmer-preferred characteristics are readily available, easily accessible, and provided on time. These stakeholders should leverage farmers' positive perceptions of service access, technological characteristics, and institutional environments to promote the adoption of improved groundnut cultivars.

**CHAPTER TWO**

**MANUSCRIPT ONE**

**2.0 THE ROLE OF FARMER RESEARCH NETWORKS' (FRN)  
PRINCIPLES IN INFLUENCING FARMERS' ADOPTION OF  
IMPROVED GROUNDNUT CULTIVARS IN SINGIDA RURAL  
DISTRICT OF SEMI-ARID CENTRAL TANZANIA<sup>1</sup>**

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*Full Length Research Paper*

## The role of farmer research networks' (frn) principles in influencing farmers' adoption of improved groundnut cultivars in Singida Rural District of Semi-Arid Central Tanzania

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**Farmer Research Networks (FRN)** is a participatory approach aimed at supporting the agroecological intensification of smallholder farming. FRN was envisaged in Latin America and Africa, however, little has been documented on how the application of FRN principles influences adoption of agricultural technologies. Guided by networking, innovation systems and Roger's theories of diffusion of innovations, this research assessed how the application of three principles, that is, 1) farmer participation, 2) usefulness of on-farm research, and 3) collaboration amongst players in networks influenced the adoption of improved groundnuts. Cross sectional mixed research methods were used. Findings show that farmers participated in forming FRN groups, the production of Quality Declared Seeds and the provision of farmer-to-farmer extension services. On-farm research was instrumental for observational and experimental research whereby farmers were able to see, learn, and adopt the innovation. Players collaborate through joint research, learning, and sharing of knowledge and resources; farmers' field days; and project meetings. It is concluded that farmers participated in conducting on-farm research and collaborated with different players in the network, indicating that FRN principles were applied to influence the adoption of improved groundnuts. The study recommends farmer participation in preliminary meetings and strengthening the linkage between farmers and more actors.

**Key words:** FRN principles, participation, on-farm research, collaboration, adoption of improved groundnut cultivars, Singida Tanzania.

### INTRODUCTION

Farmer Research Networks (FRNs) are made up of several groups of farmers who participate in research in

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liaison with researchers and development institutions (Nelson et al., 2019). In guiding project implementation, the Crop Collaborative Research Programme (CCRP) developed a set of FRN principles comprising (i) farmer's centred approach whereby diverse farmers participate in the research process, (ii) rigorous, democratic and useful/practical research, and (iii) collaborative networks to facilitate learning and knowledge sharing (Richardson et al., 2022; Haussmann et al., 2020). For success and sustainability purposes, it is expected that key players/actors understand the principles and apply them in the FRN project implementation process.

Different scholars including Descheemaeker et al. (2021), Nelson et al. (2019) and Hassen et al. (2019) have reported on the FRN approach by pointing out the elements of participation, practical research and collaboration which are the key three principles of FRN. The first principle is about farmer centred approach which requires diverse farmers to participate in the research process so that they can learn, solve their problems and adopt agricultural innovations. Descheemaeker et al. (2021) pointed out that, the FRN approach is designed to engage farmers so that they prioritize, experiment, gather data, and understand the results. The participation of farmers in the research process carries due weight for the ownership, learning, technology adoption, diffusion, and sustainability of the programme.

The second principle is on rigorous, democratic and useful/practical research which requires the research to have beneficial importance for farmers to conduct and adopt the appropriate agricultural technologies. In this aspect, Descheemaeker et al. (2021) stated that the FRN principles are supportive in generating answers and procedures worth scaling to similar contexts since they were found through pertinent, dependable and valid research. Additionally, according to Tao et al. (2019), Nelson et al. (2019) and Hassen et al. (2019), on-farm research can be used as a problem-solving and demonstration tool, allowing farmers to use it to address issues with farm management, learn empirical lessons through observational and experimental research, and replicate it in fields with similar challenges.

The third principle is about collaborative networks that require the facilitation of learning and knowledge sharing amongst actors to adopt the appropriate agricultural technologies. According to Wenndt et al. (2021), by facilitating the exchange of information between regional and international innovation systems, the integration of participatory research inside a farmer research network (FRN) has the potential increasing its efficacy. According to Nelson and Haussmann (2019), to empower FRNs, significant institutional innovation will be required, along with changes to the relationships and roles amongst researchers, extension agents and farmers. FRN encourages collaborative networks which favour systems thinking as opposed to linear thinking. This is supported by Takahashi et al. (2019) who reported on the growing

number of research regarding social networks and farmer-to-farmer technology transfer being amongst the more effectual extension model compared to the traditional linear model widely used by the public sector. Besides, Oluwatoyin (2021) proposed the connection between researchers, innovators and farmers who are the adoption clients of agricultural innovations. Moreover, Haussman et al. (2020) reported that, in the overall FRN model, there is an organization that, whenever possible, supports the cooperative network of farmer organization (s), Non-Governmental Organizations (NGOs) and development projects, researchers/research institutions and the private sector. Local expertise, social capital and infrastructure are combined with advances in science from around the world in this network, which benefits all participants.

To further enlighten the adoption of agricultural technologies such as push-pull technology, different scholars have reported on FRN principles. The reports were centred on the interpretation, implementation and usage of the principles to guide learning and the flow of knowledge between home-grown and worldwide innovation systems (Richardson et al., 2022; Wenndt et al., 2021). Hassen et al. (2019) reported on the social value of FRN whereby the knowledge transfer resulted in the adoption of push-pull technology after the majority of farmers had participated. The study by Hassen et al. (2019) suggest that FRN promotes social interaction, which contributes to the adoption of Push-Pull Technology (PPT). It is advised that the system be spread to other farmers who are engaged in the production of sorghum as the majority of farmers who participated in the FRN have adopted the innovation. However, little has been documented regarding how FRN principles were applied to facilitate farmers' adoption of agricultural technologies. Thus, this study aimed at assessing how FRN guiding principles were applied in enabling farmers' adoption of improved groundnut cultivars in Singida region, Tanzania. Specific objectives were (1) to assess how participation influenced farmers' adoption of improved groundnut cultivars, (2) to determine the usefulness of on-farm research in influencing farmers' adoption of improved groundnut cultivars, (3) and to evaluate how collaboration amongst players in the network influenced farmers' adoption of improved groundnut cultivars. Specific questions that the study sought to answer were how the three principles of FRN, namely (1) farmer participation, (2) the usefulness of on-farm research, and (3) collaboration amongst players in the network influenced farmers' adoption of the improved groundnut cultivars.

This study was guided by networking theories of diffusion of innovations, innovation systems theory and Rodger's theory of innovations. Social network diffusion theory posits that diffusion follows a complex contagion pattern whereby farmers tend to adopt a new technology provided that the basis of information about that

technology comes from multiple sources. Furthermore, individuals were rooted in an interactive network and the belief of prospective innovation adopters is subjected to social inspiration (Beaman et al., 2021). The adoption of innovation goes beyond simple information transmission and involves amendments of decisions, discussions in a wider practice related to the socioeconomic system and an individual sincerity to influence (Derjarian, 2002). Social network diffusion theory was incorporated in this study since it is in line with the FRN principles as it hypothesizes on participatory processes, collaboration, and networking. Additionally, Roger's theory was connected to FRN principles in the aspect of on-farm research, where farmers could observe, learn the advantages of innovation through on-farm trials, and weigh how simple and compatible the innovation was with their existing practices and beliefs.

According to Rogers (2003), "innovations that offer advantages, perceived compatibility with existing practices and beliefs, low complexity, potential trialability, and observability, will have a more widespread and rapid rate of diffusion". To clarify the concepts of adoption and diffusion as used in the theories guiding this study, Vecchio et al. (2020) stated that adoption is used interchangeably as a part or sub-process of diffusion; hence, "Diffusion is the adoption process whereby innovation is accepted across a population over time, whereas adoption is the condition whereby an individual decides to accept an innovation and integrate it into his or her life." This study has used the term "adoption" to refer to the FRN project beneficiaries' collaboratively participating in testing, learning, understanding, and practising the innovation by growing all or one of the improved groundnut cultivars, that is, *Mnarja*, *Nalendele* and *Mangaka* as amongst their agro-ecological practices.

The innovation systems approach postulates that learning in networks outspreads individual players and farmers and produces innovation. Before accepting an innovation, farmers normally learn on-farm about the performance and suitability of the innovation to farming systems and the sustainability of the inputs and market of the product (Ayele et al., 2012). The innovation system framework emphasizes the entirety of players and features essential to bring about innovation and growth (World Bank, 2007). Ayele et al. (2012) point out the key players comprising knowledge and technology providers, users of the knowledge and technology, their roles, and the interaction between players and their habits and practices that influence joint learning and innovation. Interaction and learning are dependent on players' closeness such as physical distance, and institutional environment which shapes trust-based relationships and players' characteristics to absorb new ideas. The innovation systems theory was linked to the FRN approach since it reflects more on collaboration in networks and systems thinking.

Furthermore, having the component of collaboration and/or networking, FRN group membership coupled with

FRN principles were also identified as amongst the independent variables that were conceptualized to influence the adoption of improved groundnut cultivars.

## METHODOLOGY

### Description of the study area

Singida Rural district has a semi-arid climatic condition. There are two seasons; the dry season, which is the longest (April to November) and the rainy season from December to March. The average rainfall is between 600 and 700 mm per annum while the average minimum temperature is 15 to 30°C (Singida District Profile, 2014). This study was conducted in Singida Rural District, Ilongero and Mlanko divisions in eight villages which are Sekoutoure, Mwakili, Msimbi, Mdilu, Mvao, Mughanga, Mnyerere and Mlanko (Figure 1). Selection of these villages was based on topographic features, climatic conditions and rainfall patterns that favour groundnut production. These villages were also selected because the improved groundnuts were introduced and promoted for adoption and diffusion through the FRN project.

### Research design

A cross-sectional research design was adopted in this study whereby data were collected at a single point in time. According to Omar (2015), a cross-sectional study design enables data collection at a single moment in time and has a broad scope by incorporating many variables at once. Omar (2015) further suggests that it is more time- and money-efficient than the longitudinal design for determining relationships between variables as well as for descriptive reasons. Mixed research methods were applied to collect both quantitative and qualitative data at the same time. The mixed research methods are reported by other scholars as being advanced, perceptive and useful for the improvement of the generalizability of research (Glover et al., 2019; Folt and Beck, 2010). Additionally, Creswell (1999) stated that, in a mixed-method study, the researcher uses both qualitative and quantitative data gathering and analysis techniques in a single investigation. Objectives 1 and 3 exhibit characteristics of the qualitative research philosophy, whereas objectives 1 and 2 have some numerical descriptions falling under the quantitative research philosophical orientation. However, qualitative research was dominant over quantitative since this study aimed at assessing how FRN principles, that is, farmer participation, the usefulness of on-farm research and collaboration amongst players in networks influenced farmers' choice to adopt improved groundnut cultivars namely *Mnarja*, *Mangaka* and *Nalendele*.

### Sampling procedure and sample size

Concerning quantitative data, proportionate random techniques were used to get a representative sample from the population of 1200. This study used the formula proposed by Krejcie and Morgan (1970), to determine the sample size of 212 smallholder farmers from the 8 project villages in Ilongero and Mlanko divisions, Singida Rural district.

$$n = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

where required sample size: X = z value (assumed to be 1.645 for 90% confidence level), N = population size, P = population



**Figure 1.** Map of the study area  
Source: Survey data 2022

**Table 1.** Sample size

Division	Ward	List of villages	Population (N)		Sample Size (n)	
			Direct	Indirect	Direct	Indirect
Ilongero	Ilongero	Sakoutoure	50	100	8	17
		Mwanki	45	90	8	15
		Mwanoda	99	198	17	34
		Mwasawis	31	62	5	10
		Meria	84	168	14	28
Minko	Minko	Mughanga	29	58	5	10
		Mnyenye	37	74	6	12
		Minko	45	90	8	15
Total			420	840	71	141
Grand total				1,260		212

Source: Survey data 2022

proportion (assumed to be 0.5 since this would provide the maximum sample size),  $d$  = degree of accuracy (5%), expressed as a proportion (0.05).

$$n = \frac{1.64^2 \times 1260 \times 0.5 \times 0.5}{0.05^2 \times (1260 - 1) + (1.64^2 \times 0.5 \times 0.5)} = 212$$

Simple random sampling was applied to select respondents from each village (direct and indirect beneficiaries). Table 1 provides the breakdown of the sample size of direct and indirect beneficiaries per village.

For the case of qualitative data, key informants (agricultural officers, agro-vet dealers, and project staff) were purposively selected for interview. The interviews were conducted with the key informants.

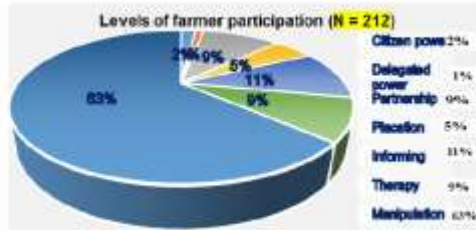


Figure 2. Levels of farmers' participation in the project launch. Source: Survey data 2022

comprising 2 Agricultural Officers (1 at the district and 1 at the ward and village levels); 2 agro-vet dealers (1 at the district and 1 at the ward and village levels). The project staff who were interviewed included Programme Leader, Project Manager and Project Officer. Key informants were selected because of their familiarization and sufficient information they need to have concerning the project implemented in their respective areas of influence. Two groups were purposively selected for focus group discussions (FGDs) whereby each division had one group selected namely, Muanjano group at Mvua village (longero Division) and Mshakamano group at Mughanga village (Mtenko Division). The FGDs consisted of 8 to 12 farmers each. Key issues in FGDs and key informant interviews (KI) centred on stakeholders' understanding of FRN principles, the ways FRN principles were applied to facilitate the adoption of improved groundnut cultivars, identification of key players, their roles and interaction/collaboration in farmers' research networks.

#### Data collection

##### Primary data

Before the collection of primary data, training on data collection by using both quantitative and qualitative tools was conducted for enumerators in April 2022. Pre-testing of the research tools was conducted at Mwaikili village in April 2022. From the pre-testing exercise, amendment to the data collection tools was made based on the field reality. The field data collection exercise was held from April 2022 through May 2022 where both quantitative and qualitative primary data/information were collected.

Primary quantitative data such as farmers' level of participation and the extent of usefulness of crop research were collected by using semi-structured questionnaires with both closed and open-ended questions. These quantitative data were important to show the numeric/statistical figures of the study such as frequencies, percentages, mean and standard deviation.

Primary qualitative data such as farmers' feelings and opinions on why to accept or reject improved groundnut, how the farmers apply the FRN principles to facilitate the adoption of improved groundnut and how the key players collaborate/interact in farmer research networks were collected by using qualitative data collection tools such as key informant interviews, focus group discussion and observation. Checklists with open-ended questions were employed. The qualitative data were collected to provide an in-depth understanding of issues that could not be explained by statistical information.

##### Secondary data

A documentary review was employed to collect secondary data. The reviewed documents include information from the internet (mainly google scholar with the interval of 2017 to 2022 publications), Sangda rural district socio-economic profile, FRN project design, monthly, quarterly, annual and monitoring and evaluation reports. These documents were important since they were part of the literature review which provided information on the existing situation of what has already been done and reported, the major purpose being to complement (reinforce/dispute) findings from other sources of data.

##### Data analysis and interpretation

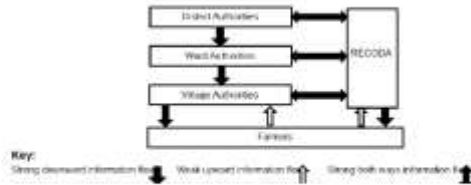
Quantitative data were coded and summarized before analysis. The numeric data from the survey (questionnaires) were keyed in and analysed using Statistical Package for Social Science (SPSS) version 20 to obtain descriptive statistics (mainly frequencies and percentages). For ease of presentation, frequencies and percentages were further refined and converted into charts and/or cross-tabular tables by using excel.

Qualitative information obtained from the focus group discussions and interviews particularly with the district, project officials and other key informants was translated from Kiswahili to English and was manually coded before analysis. The codes were combined to give specific themes which were analysed by using thematic analysis. Interpretations were done using themes based on patterns and trends of information gathered.

## RESULTS AND DISCUSSION

### Farmers' participation in the project launch and its influence on the adoption of improved groundnut cultivars

Figure 2 summarizes the findings on the level of farmer participation in the project launch. The majority (83%; N=212) responded that participants were made to believe that the project of improved groundnut cultivars was good for farmers to engage in execution (manipulation). By 11% (N=212) participants were informed through local



**Figure 3.** Project introduction process and farmers' participation.  
 Source: Survey data 2022

government authorities and Research Community and Organizational Development Associates (RECODA) with no negotiation meeting being held to argue about the improved groundnut projects (informing). Besides, 9% (N=212) responded that participants negotiated better ideas/shared funding that contributed to the smooth running of the improved groundnut project (partnership).

These quantitative figures provide a picture of the level of participation based on the frequency of respondents on the subject matter. However, Bigonnesse (2016) pointed out that while it was very simple to evaluate participation frequency with an attendance sheet, the quality of participation was still debatable since the frequencies alone could not provide the details. Therefore, to complement the findings, the qualitative information through Key Informant Interview and Focus Group Discussion coupled with secondary data provided the details of how farmers participated during the introduction of the project.

The entire procedure for introducing the improved groundnut cultivars in the project area is depicted in Figure 3. The procedures show that, farmers had no direct role; instead, they were represented by district and village administrations. At the district level, the project was presented to the district officials before being forwarded to the District Agricultural, Livestock, and Fisheries Officer's (DALFO) office. The project concept was presented by RECODA and debated during the meeting with DALFO's staff. The committee decided to propose villages depending on requirements. The proposed villages were accepted, and official letters were issued to the relevant ward and village officials informing them of the project. A Ward Development Committee (WADC) meeting was then organized at the ward level with participation from important leaders from the designated wards and villages. Ward executive officials, ward councillors, Village Executive Officers, village chairpersons, community development officers, and headteachers were amongst the important figures. RECODA and employees from DALFO's office presented the project idea to the participants, who all agreed to accept it and pledged to give it the necessary support.

The agenda for the village-level awareness-raising meetings was developed from this meeting. These findings are consistent with the findings from a key informant who stated:

*"The meetings held at district and ward levels had not involved farmers since the process for introducing a new project required following those procedures instead of directly getting into contact with farmers. Farmers started to participate during village awareness creation meetings that were held at each of the respective proposed villages" (FRN Project Manager, RECODA Office at Jongero Village, Singida District, 4 May 2022).*

Lack of farmer participation in district and ward decision-making is detrimental to project ownership and efficient implementation. Aribi et al. (2018) made similar observations, noting a participation gap between local government entities and farmers that impeded the efficient implementation of land use policies.

The Mshikamano and Muungano FGDs stated that the village officials arranged for village meetings, to which all villagers were invited. The new idea of improved groundnut cultivars was introduced by RECODA at village sensitization workshops, along with other topics. The Tanzania Agricultural Research Institute (TARI) Naliendele produced the cultivars (namely Mnanje, Mangaka and Naliendele) and brought them to the project area in Singida for testing and adoption purposes, which sounded like a good idea for the farmers to embark on. Farmers took part in those meetings by showing up, listening to and following the promotional and instructional messages and dialogues, and asking questions about the RECODA-promoted improved groundnut cultivars. After each meeting, farmers were asked to form groups of their choice. Farmers who expressed interest in the project idea were registered, and with RECODA's guidance, actively participated in the group formation process. These findings imply that the processes of project introduction in the project area used both "top-down" and "bottom-up" approaches, whereby, at the district and ward levels, there was no participation of farmers, but

**Table 2.** Arnstein ladder of community level of participation.

Level of participation	Clarification	Implication
Citizen Power	Participants govern a programme/project to take full charge	
Delegated Power	Participants have some degree of control/management	Citizen control
Partnership	Participants negotiate better ideas/share funding	
Placation	Participants have a limited degree to influence decisions	
Consultation	Participants' ideas/concerns not taken into account	Tokenism
Informing	Participants are informed with no negotiation meeting	
Therapy	Participants are convinced that there is a problem to address	
Manipulation	Participants are educated/made to believe the project is good	No participation

Source: Conceptualized, operationalized and modified from Arnstein (1969) and Rosyida and Nasdian (2011).

at the village level, participation of farmers in the village sensitization meetings was noted. Apart from the FRN approach, RECODA implements projects by using the Rural Initiatives for Participatory Agricultural Transformation (RIPAT) model which was reported by Vesterager et al. (2017) as a combination of 'top down' and 'bottom up' approaches for technology transfer. Contrary to 'top-down' and 'bottom-up' approach, Singgalen et al. (2019) reported the existence of societal control and citizen power in all phases of development, including the project introduction phase. Elsewhere, Hausman et al. (2020) and Masambuka-Kanchewa et al. (2020) proposed a paradigm shift in which small-scale farmers were viewed as co-researchers rather than reflexive adopters or recipients of the best innovations established by scientists.

According to Arnstein (1969), full community participation was equated with citizen power. Participation was graded into levels equivalent to a ladder that could be used in the decision-making (inception phase), implementation and evaluation phases. Arnstein's ladder of community participation has been summarized in Table 2 through conceptualization, operationalization and modification as cited by Rosyida and Nasdian (2011).

Reflecting on the study findings via the Arnstein ladder of participation, it can be observed that during the project inception phase, there was a limited level of farmer participation in the aspect of development of technology or innovation. Similar observation is made by Namirembe et al. (2022) concerning the participation of farmers and other stakeholders in grounding a global tool on the principles and practice of agroecological assessments. Despite the project's initial lack of engagement, farmers were more interested in learning about innovation that resulted in its adoption after awareness-raising activities regarding improved groundnut cultivars which happened during village meetings. Through this process, farmers who were intrigued by the concept established the FRN groups, which catalysed the persuasion of other farmers to observe, learn, try out, and adopt improved groundnut cultivars.

#### Farmers' participation in project implementation and its influence on the adoption of improved groundnut cultivars

The findings show that there was farmers' participation during project implementation contributing to the adoption of improved groundnut cultivars. During the Mshikamano and Muungano FGDs it was observed that after the groups were formed, RECODA facilitated the training on group dynamics, leadership and group constitution. Farmers participated in attending the training, the election of group leaders, and the preparation of the group constitution. Additionally, RECODA facilitated a dialogue with the group participants to discuss the challenges farmers face concerning groundnut production and proposed ways forward to improve the situation. In the dialogue, farmers participated by identifying the challenges associated with groundnut production, including low yield from the local farmer cultivars, diseases, pests, drought and floods. This shows an element of farmers' participation which provided useful information of identifying the problems. As Cuthbertson (2019) stated, the protocol might change as a result of a group review, but at the very least it would provide useful information that would aid in designing future participation activities.

The FGDs further pointed out that, the promotion of improved groundnut cultivars inspired farmers to test them since they were reported to have higher yields and be marketable compared to the local farmer cultivars. While RECODA proposed bringing the improved groundnut cultivars for trial and adoption following confirmation, farmers proposed capacity-building programmes so that they can produce the quality-declared seeds of improved groundnut cultivars rather than relying on TARI Naliendele as the source of improved groundnut seeds because Naliendele was located far away from Singida. The fruitful idea from farmers' participation was positively taken up for action by RECODA. RECODA developed a capacity-building programme for farmers to get them to produce quality-declared seeds (QDS) of

**Table 3.** Usefulness of research in enhancing the adoption of improved groundnut cultivars (N = 212)

FRN project group member	The usefulness of research in enhancing the adoption of improved groundnut cultivars	
	Research useful (%)	Research not useful (%)
Direct beneficiaries	69 (97.2)	2 (2.8)
Indirect beneficiaries	117 (83.0)	24 (17.0)

Source: Survey data 2022

improved groundnuts. Farmers participated in the capacity-building programmes by attending both theoretical and practical training on the production of improved groundnut QDS. These findings imply that the participatory communication led to the proposal of a capacity-building programme by farmers who later participated in its implementation. A similar observation is made by Hansen et al. (2019) who reported that farmers may relate complex climatic information to their experience and incorporate it into management decisions by using organized participatory communication procedures.

Additionally, the findings show that farmers participated in carrying out participatory research through on-farm trials and demo plots. The FGDs stated that, farmers participated in field preparation, the layout of trial plots, digging, hole-making, seed sowing at recommended spacing and conducting all crop management practices, including weeding, pest management, and disease management, by observing agroecological practices. They also participated in harvesting and weighing the yields for comparison purposes. Furthermore, farmers participated in making decisions based on the crop performance out of on-farm trials and in the production of improved groundnut quality declared seeds through demo plots and individual farmer plots. The improved groundnut quality declared seeds produced by the FRN group farmers were spread to non-group members either for sale or given out freely. Again, farmers actively participated in knowledge dissemination concerning improved groundnut cultivars. This was achieved through farmer-to-farmer extension service provision, whereby the FRN group farmers visited the non-group members and taught them about Good Agricultural Practices (GAPs) related to improved groundnut production based on their experience acquired through both theoretical and practical training offered by the FRN project. Also, non-group members were able to learn by observing both the demo and individual farmer plots. Equally, the key informant declared that farmers were actively participating in the project implementation as indicated in the following extract:

*"Farmers participate in training sessions, conducting on-farm trials, transferring the knowledge gained to their fellow farmers, and producing improved groundnut, which is the new cultivar in the project area. Before the FRN*

*project was introduced, farmers used to produce the local groundnut cultivars, which had relatively lower yields compared to the improved ones" (District extension officer, Singida District, 3 May 2022).*

The review of the project report indicated that, in the second phase of the soil amendment trial, about 86% of farmers participated in the soil health research based on their willingness to participate (FRN Quarter 1 Report, 2022). These findings indicate that there was more engagement of farmers during the implementation of the project activities compared to participation during the introduction of the improved groundnut project. This is because farmers were more familiar with the project than they were at the beginning. Participation of farmers in the research and implementation of project activities strengthens group cohesion and is healthy for the adoption, ownership, co-researching, learning, success, and sustainability of the project. As Hassen et al. (2019) reported, about 98.7% of farmers had asserted enhanced social interaction and increased technological diffusion through their engagement in research networks. Likewise, Goswami et al. (2017) insisted on livelihood and ecological sustainability through partnership with farmers in the decision-making process related to farming practices. This is consistent with social network theory, which asserts that people are embedded in interactive networks and that potential innovation adopters' beliefs are influenced by social inspiration. The adoption of innovation entails more than just disseminating information; instead, it involves changing the existing decisions, engaging in wider discussions about the socioeconomic system and showing personal sincerity in trying to make a difference (Deroian, 2002).

#### The usefulness of the on-farm research in enhancing the adoption of improved groundnut cultivars

From the survey, the on-farm research appeared to be useful or practical to 97.2 and 83% (N=212) of the direct and indirect project beneficiaries, respectively as summarized in Table 3. Both the direct and indirect beneficiaries had the majority score, which showed that research was useful in enhancing the adoption of improved groundnut cultivars in the project area.

Similarly, the key informant agreed that on-farm

research was useful in enhancing the adoption of improved groundnut cultivars in the project area. The extension officer was quoted saying:

*"On-farm research has been so useful to farmers since they experiment together, observe, discuss, and come up with informed decisions on the appropriate innovations to adopt out of the research. Through this process, the majority of farmers in the project area have proven the Mnarja cultivar to have performed well and farmers have benefited from the sale of the improved seeds to other farmers and hence getting the cultivar spread to other villages" (District extension officer, Singida District, 3 May 2022).*

In addition, it was highlighted from the Muungano focus group discussion that doing research through on-farm trials had helped spread improved groundnut cultivars. Farmers learnt about appropriate agricultural methods and how to use biological pesticides during on-farm trials. When other farmers saw the crops grown in demonstration plots, they were inspired to learn more and inquired about the source of improved groundnut seeds. Furthermore, as reported by Mshikamano FGD, the main reason why research was useful in enhancing the adoption of improved groundnut cultivars was that on-farm research provided a conducive environment to learn by seeing and practising good agricultural practices. Other reasons include learning and comparing to see the difference in yield between the local and improved cultivars, proving an appropriate technology to adopt, and creating a good environment to learn together.

These findings imply that conducting research with farmers is an important factor in developing innovations and getting those innovations widely adopted by farmers. Through on-farm research, FRN group farmers have been able to learn, produce and play a role in spreading the quality declared seeds of improved groundnut cultivars to their fellow farmers, who did not have access to them, either by sale or just giving them out for free, while teaching them how to grow the crop. By doing so, the improved groundnut cultivars were widely adopted by more farmers in the study area. Studies (Tao et al., 2019; Nelson et al., 2019; Hassen et al., 2019) indicated that on-farm research could function as a tool for problem-solving and demonstration, which could be used by farmers to solve problems related to farm management and empirically learn through observational and experimental research and replicate it in similar fields. The results support the innovation systems perspective, which holds that learning occurs in networks and spreads to individuals and farmers, resulting in innovation. Farmers typically learn on the farm about the performance and applicability of the innovation to farming systems, as well as the sustainability of the inputs and market for the product, before accepting it (Ayele et al., 2012). The findings on on-farm trials also support Roger's theory of innovations, which claims that "innovations that

offer advantages, perceived compatibility with existing practices and beliefs, low complexity, potential trialability, and observability, will have a more widespread and rapid rate of diffusion" (Rogers 2003).

#### **Collaboration of key players in the network of FRN and their influence on the adoption**

##### **Key players and their frequency of interaction in the FRN project**

The study findings show that there was a collaboration amongst key players in the FRN network that contributed to the adoption of improved groundnut cultivars. From the Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and review of project documents, the identified key players who either regularly or seldom interacted with farmers were RECODA, extension officers, farmer groups, village leaders, middlemen, agro-input suppliers, village agro-vet dealers, and academic institutions. As summarized in Table 4, this study revealed the difference in the magnitude of interaction/collaboration amongst players in the FRN network whereby some players regularly interacted while others moderately and rarely interacted with farmers.

Mshikamano and Muungano FGDs revealed that RECODA frequently interacted with farmers once every week either for training or following-up/monitoring of the project activities (Table 4). Similar to RECODA, the FGDs reported of frequent interaction amongst the FRN farmer groups once every week to discuss matters related to project implementation. The findings suggest that the frequent interaction between farmers and RECODA contributed significantly to the spread and adoption of improved groundnut cultivars in the study area. According to Joffe et al. (2019), the adoption of practices was influenced by the increased rate of collaboration amongst participants, including those in the public and private sectors.

As pointed out by Mshikamano and Muungano FGDs, the interaction between Extension Officers and farmers was rated moderate since the Extension Officers happened to meet farmers on a monthly to quarterly basis. Equally, village leaders had had moderate interaction with farmers, whereby they happened to have interacted on project-related matters in each quarter, twice to thrice a year. The FGDs also determined that the relationship between farmers and academic institutions was graded as a medium since, at a minimum, one representative from an academic institution would visit farmers for either learning or research purposes once every three months. Moderate interaction with farmers is an indicator of moderate provision of services required from the service providers. Moderate interaction implies the limited provision of extension services required by farmers. To fill in the gap Ayodele and Akindele (2018) recommended more involvement of private agencies in

**Table 4.** Relative frequency of interaction between farmers and key players

Key players	Relative frequency of interaction		
	Regular	Moderate	Rare
RECODA	1 meeting per week	-	-
Action Aid	-	-	1 to 2 meetings per year
Extension officer	-	1 to 4 meetings per year	-
Farmer groups	1 meeting per week	-	-
Village leaders/LGAs	-	1 to 4 meetings per year	-
Middlemen/Traders	-	-	1 to 2 meetings per year
Agro-input suppliers/companies	-	-	1 to 2 meetings per year 1 to 2 meetings per year
Village agro-vet dealers	-	-	1 to 2 meetings per year
Academic institutions	-	1 to 4 meetings per year	-

Source: Survey data 2022

the provision of extension services.

Infrequent interaction was reported by the Mshikamano and Muungano FGDs to have been occurring between farmers and Action Aid whereby farmers appeared to mutually co-operate with Action Aid once to twice a year. Correspondingly, there was infrequent interaction between farmers and agro-input suppliers, agro-companies, and village agro-vet dealers since they mostly happened to be in touch seasonally, specifically during planting season when there was high demand for farm inputs and tools such as seeds and hand hoes. This suggests that as interactions between farmers and players such as Action Aid, Agro-vet dealers, middlemen, and other actors increase in regularity, there will be stronger networks and more possibilities for discussion of the problems each player in the network encounters. If such problems are resolved, more people would adopt improved groundnut cultivars. According to Golovina et al. (2019), farmers with stronger networks outperform their less-connected peers in terms of agricultural prosperity and financial stability.

#### The roles of key players in the FRN network and their influence on the adoption of improved groundnut cultivars

Table 5 provides a summary of the roles played by the key players in FRN network and their influence on the adoption of improved groundnut cultivars in the study area.

The findings summarized in Table 5 show that collaboration amongst players in the FRN network facilitated the processes that contributed to the adoption of improved groundnut cultivars. As reported by Mshikamano and Muungano FGDs, RECODA facilitated

the group formation process where farmers formed the FRN groups that enabled them to access seeds, learn, and work together in groups as opposed to individuals. RECODA transferred knowledge and resources (seeds of improved groundnuts) to farmers, and farmers practised what they learned. RECODA guided and facilitated the collaborative research process. FRN group farmers carried out participatory research through on-farm trials conducted in demo plots. The demo plots have been instrumental in attracting more farmers to adopt the improved groundnuts since farmers were able to learn by seeing and practising. In addition, through interaction between RECODA and farmers, farmers have been linked with academic institutions such as Sokoine University of Agriculture (SUA), Nelson Mandela African Institution of Science and Technology (NMAIST) and Tengeru Institute of Community Development (TICD). This linkage facilitated field-practical training programmes and research activities undertaken by students and instructors on issues related to agroecological practices, with the adoption of improved groundnut cultivars being included. This implies that the more farmers interact with the implementing organizations, the closer and more trust they build with each other, the more chances they have to participate in co-researching, the more lessons they learn together, the more actors they get connected with, and the higher the chances of adopting the innovations.

The interaction between FRN farmers and RECODA as an NGO has catalysed the adoption of improved groundnut cultivars in the study area. These findings are similar to those reported in a study by Hartmann et al. (2019), who revealed that the NGO significantly affected the community's farmers' social cohesiveness and capacity for innovation. The NGO enabled the creation of a local effective organization and assisted in bringing together farmers from various villages while also giving

**Table 5.** The roles of key players in the FRN and their influence on the adoption

Key players	Major roles
	Facilitating the process of group formation
RECODA	Transferring knowledge and resources (seeds) to farmers, co-researching & learning Guiding/facilitating the collaborative research process Monitoring/following up on the implementation of project activities through farm visits Reporting progress of the project during stakeholders' meetings Linking farmers with academic institutions such as SUA, MMAIST and TICD
Action Aid	Transferring knowledge to farmers on agroecology and climate change Sharing the knowledge gained from FRN groups to other farmers in their areas of operations
Extension officer	Transferring knowledge/information/advisory services, co-researching & learning Provision of government directives concerning improved groundnut production Monitor the implementation of the project through farm visits Report the progress of the project to the district authorities
Farmer groups	Form groups, prepare group constitutions and elect leaders Attend training/meeting sessions organized by the group Establish demonstration and individual farmers' plots for participatory research and learning Production/multiplication of improved groundnut seeds Transfer the knowledge gained and seeds multiplied to indirect beneficiaries Conduct farm visits to indirect project beneficiaries
Village leaders/LGAs	Provision of project legal permit to operate in the area Calling for village meetings for awareness creation and Farmer Field Days Enacting by-laws for the formed groups to operate accordingly Overseeing the project operations in their respective areas of influence
Middlemen/Traders	Visiting farmers at their homesteads/villages to advertise for demand and price of groundnuts Collecting/buying groundnuts at farmgate price Transporting the collected groundnuts to other markets
Agro-input suppliers/companies	Seasonal promotion of agro-inputs and farm tools Seasonal supply of agro-inputs specifically fertilizers, pesticides and maize seeds on a mobile basis using company vehicles Seasonal supply of agricultural tools mainly hand hoes on a mobile basis using company vehicles Wholesaling of agro-inputs and farm tools to the Village Agro-vet shops
Village Agro-vet dealers	Retailing of agro-inputs and farm tools to the farmers Collecting improved groundnut from producers and retailing to other farmers (act as middlemen as well)
Academic institutions (SUA, MMAIST& TICD)	Sharing knowledge and experience through field practical training Conducting participatory research and co-learning Preparing research reports for publications

Source: Survey data 2022

them access to outside information. The findings also corroborate with innovation systems theory which states that interaction and learning are dependent on players' closeness such as physical distance, the institutional

environment which shapes trust-based relationships and players' characteristics to absorb new ideas (Ayeye et al., 2012).

Additionally, the Mshikamano and Muungano FGDs

highlighted that participant interacted during the group formation process, writing of the group constitution and the election of group leaders. Participants ensured that they elected good and strong leaders who lead the groups according to the group constitution to achieve the desired goals. Through this interaction, farmers were able to establish demo and individual farmers' plots for participatory research and learning, production and multiplication of improved groundnut quality declared seeds, transfer the knowledge gained and seeds to indirect beneficiaries and conduct farm visits to the indirect project beneficiaries. The findings imply that the adoption of improved groundnut cultivars in the study area was facilitated by the frequent interaction and collaboration of FRN groups amongst themselves and indirect beneficiaries. FRN group members, being the primary recipients of the knowledge, information, and assets (improved groundnut seeds), played a key role in transferring the acquired knowledge, information, and improved groundnut quality declared seeds to the indirect beneficiaries. Similar findings are reported in a study by Hassen et al. (2019) who revealed that FRN heightened the transmission of knowledge, which led to the adoption of push-pull technology (PPT), by 97%, and enhanced social collaboration by 96%. Likewise, FRN and Farmers Research Group (FRG) were beneficial and had a substantial influence on social and other related matters as agreed by 98% of the respondents.

From the Kil, the FRN project staff reported that collaboration between farmers and village leaders through village meetings and farmer field days (FFDs) contributed to the adoption of improved groundnut cultivars as quoted:

*"Although not conducted regularly, through village meetings and FFDs, agroecology practices and improved groundnut cultivars were promoted to a significant number of participants from different corners who happened to attend. There was the inclusion of youth and football in learning agroecology during farmer field days. Through this way of collaboration, there are increasing numbers of non-FRN members who are adopting agroecology practices and improved groundnut cultivars after seeing them in the demonstration plots and on their neighbours' farms" (FRN Project Manager, RECODA Office at Ilongero Village, Singida District, 4 May 2022).*

This implies that village meetings and FFDs were instrumental in raising awareness of improved groundnut cultivars amongst farmers and by increasing the frequency of interaction through village meetings and FFDs, more clients who are in need would be reached at a reasonable cost, hence increasing the chances of the adoption of improved groundnut cultivars. The findings corroborate with the findings in a study by Emerick and Dar (2021) who revealed that field days benefited impoverished farmers more and were more cost-

effective.

Farmers interact with district agro-vet dealers for procurement of other agro-inputs. The quotation from the key informant pointed says,

*"We have a big number of farmers from different corners who usually come to buy agro-inputs, mainly pesticides, fertilizers, maize seeds, and vegetable seeds, but not improved groundnut seeds because we do not sell them because they are not available. Once farmers come to buy the agro-inputs, they normally ask us questions on how to properly use the inputs, and we advise them accordingly" (District Agro-Vet Dealer, Singida District, 3 May 2022).*

Furthermore, the interview with the village agro-vet dealers revealed that there was interaction with improved groundnut producers during harvesting season, whereby farmers tended to sell the seeds. The collected seeds were then sold to other farmers who needed to grow the improved nuts the next season. The quotation from the Kil had this to say:

*"In this area, the agro companies' vehicles do not supply groundnut seeds; instead, they supply fertilizers, pesticides, and maize seeds, which we buy wholesale and sell at retail prices. However, during the harvesting seasons, farmers who produce improved groundnut seeds on their farms tend to sell the seeds at our small agro-vet shops and the nearby open markets for cash. We tend to sell the improved groundnuts to farmers and other customers who need them at a price similar to that offered by the middlemen. Nevertheless, the supply of improved groundnut seeds is not reliable" (Ward/Village Agro-Vet Dealer, Mvae Village, Singida District, May 2, 2022).*

Similarly, the Mshikamano and Muungano FGDs noted that throughout harvest, middlemen engaged in active connection with farmers, frequently visit farmers' houses to purchase the improved groundnuts. These findings imply that collaboration between farmers, agro-vet dealers and middlemen was not formal but played a role in spreading the quality declared seeds of improved groundnut cultivars in the study area. Kivimaa et al. (2020) claim that to hasten transitions, transition intermediates had become potentially strong actors and entities.

In addition, the key informant reported that collaboration occurred through formal meetings, which were customarily held in the project area. These meetings included stakeholders' meetings, quarterly coordination meetings, and community of practice meetings as revealed by the FRN project staff,

*"Stakeholders' meetings are the annual meetings and would have wider participation from NGOs, district*

extension staff, and farmer representatives. Stakeholder meetings are more about sharing the results (not much planning) while quarterly coordination meetings are reporting, solution-seeking, and planning meetings for the implementers (a lot of planning is done here). The participants in the quarterly coordination meetings are village leaders, group leaders, extension staff, and RECODA staff" (FRN Programme Leader, RECODA Headquarters Office, Arusha, 15 August 2022).

This implies that the stakeholder and quarterly coordination meetings were the indicators of collaboration amongst actors in FRN networks, which played a role in influencing the adoption of improved groundnut cultivars in the study area through planning, sharing progress reports and seeking solutions to the problems. Through this process, other participants might improve the performance and uptake of improved groundnut cultivars by imitating the successful results made by achievers. The FRN project report (2022) indicates that, through these meetings, the local government has appreciated agroecology as a solution to the soil fertility challenges in Singida. Furthermore, the local government was aware of the spread of the improved groundnut cultivars in the project area, although they stated that availability of the improved groundnut seeds seemed to be a challenge since the demand was high after farmers had observed good performance of the crop in the study area.

FRN project staff pointed out another way of collaborating known as "community of practice" (CoP) meetings by stating that,

*"Community of Practice Meeting is a kind of interaction that goes beyond country boundaries and was conducted physically and online during the corona virus disease (COVID 19) era" (FRN Programme Leader, RECODA Headquarters Office, Arusha, August 15, 2022).*

This implies that, apart from interacting with local partners, FRN has a system of collaboration that opens the doors for the actors to interact globally through CoP meetings. With this form of interaction, the participants can learn globally and apply the good lessons they learn locally. According to the FRN progress report (2019), the meeting had been organized and executed with participation from transversely located CoP members interacting on agroecology conversions and research emerging from local, regional, and global trends. For instance, at the East and Southern Africa Community of Practice Annual Meeting held on September 30 through October 3, 2019, farmers' participation in the research was reported to have contributed to improved productivity through a combination of actions and activities; and to some extent, farmer capacity to undertake research had increased, and the farmers see the network as an instrument for learning. As reported by Nicklin et al. (2021), through social learning, the communities of

practice of the McKnight programme have given a range of actors in Africa and the Andes a place to build their adaptability concerning food system research and action.

## Conclusion

The synthesis of the research findings leads to the conclusion that farmers participated in conducting participatory on-farm research and collaborated with different players in the FRN network, indicating that FRN guiding principles were applied to influence the adoption of improved groundnut cultivars in Singida Rural District. Reflecting on each principle, the participation of farmers has been evident, although there was more engagement of farmers during the implementation of the project activities compared to the level of participation during the initial stages of the introduction of improved groundnut cultivars in the project area. Farmers participated in forming FRN groups, production of QDS of improved groundnut cultivars and provision of farmer-to-farmer extension services through farmers' visits, and transfer of knowledge and assets (seeds), which contributed to the adoption of improved groundnut cultivars in the study area.

The study also revealed that participatory on-farm research was useful in enhancing the adoption of improved groundnut cultivars in the study area. The on-farm trials being undertaken have empirically been instrumental for observational and experimental research whereby farmers have been able to see, learn, and adopt the innovation by growing and spreading the improved groundnut cultivars, unlike the case before the inception of the project.

This study has furthermore observed evidence of collaboration and interaction amongst players in FRN networks, though differing in the magnitude of interaction. Some players regularly interact with farmers, while others only moderately and rarely interact with them. The major ways of interaction were noted to include joint research, learning, and sharing of knowledge and resources; village meetings; farmers' field days; stakeholder meetings; quarterly coordination meetings; and community of practice meetings. In one way or another, this collaboration, coupled with the participation of farmers in carrying out participatory on-farm research, has played a role in enhancing the adoption of improved groundnut cultivars in the study area.

## RECOMMENDATIONS

Based on the research findings, hereunder are some recommendations worth noting:

(1) RECODA and local government authorities (district, ward, and village) may make sure that deliberate efforts

are made to ensure that during the project inception phase, farmers participate by negotiating project ideas during the preliminary meetings that are held at the district and ward levels. Instead of being represented by the DALFO's office and local government authorities alone, there may be representatives of farmers in those preliminary meetings.

(2) RECODA may include other actors in FRN networks who can also contribute to the value addition of improved groundnut cultivars. Such actors include consumers, processors, traders, transporters, quality controllers, political authorities, media, financial institutions, researchers, breeders/pre-basic seed producers, basic/foundation seed producers, and certified seed producers, QDS producers, export aggregators etc.

(3) RECODA may make sure collaboration is strengthened more by having regular farmers' interactions with more players in a network of the improved groundnut value chains while observing agroecological practices sensitive to sustainable energy and environmental protection.

#### CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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**CHAPTER THREE**

**MANUSCRIPT TWO**

**3.0 FACTORS INFLUENCING THE ADOPTION OF IMPROVED  
GROUNDNUT CULTIVARS AMONGST SMALLHOLDER  
FARMERS IN SINGIDA RURAL DISTRICT OF THE CENTRAL  
TANZANIA<sup>2</sup>**

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## Factors Influencing the Adoption of Improved Groundnut Cultivars amongst Smallholder Farmers in Singida Tanzania

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### Abstract

*Groundnut is amongst the global important food and cash crops; irrespective of its importance, studies report its low adoption. Amongst the reported adoption factors were age, gender, education, group membership and seed availability. Nevertheless, there is insufficient documentation on the influence of these factors on the adoption of groundnut amongst beneficiaries of Singida Rural Farmer Research Networks (FRNs). Innovation systems, networks and Roger's theories of diffusion of innovations guided this study to establish the determinants of the adoption of improved groundnut cultivars amongst these target groups. Specifically, the study (1) assessed the adoption of improved groundnuts in relation to farmers' socio-economic characteristics; (2) determined the factors that influenced the adoption of improved groundnuts and (3) examined farmers' adoption perception towards access to services, technological characteristics and the institutional environment. Cross-sectional design and mixed research methods were used. The socioeconomic characteristics of farmers were compared using Chi-square test cross-tabulations. The binary logistic regression model was used to determine factors influencing the adoption of improved groundnut cultivars. A Likert scale was used to assess the farmers' perceptions towards the adoption of improved groundnut cultivars in relation to access to services, technological characteristics and the institutional environment. Findings show that socioeconomic characteristics such as age, sex, marital status, education level and income had no significant influence on the adoption of improved groundnuts. The adoption of improved groundnuts was significantly influenced by three factors: FRN group membership, seed accessibility and technological characteristics which include adaptive to agroecological zones, high yields, early maturity, drought tolerance, pests and disease resistance. The majority of farmers had a positive perception towards access to services, technological characteristics and the institutional environment for the adoption of improved groundnut cultivars. In this regard, sensitization for more farmers to join groups and enhancement of timely seed availability and accessibility of improved groundnut cultivars are recommended.*

**Keywords:** Adoption, Improved groundnut cultivars, Farmer Research Networks, RECODA, CCRP, Singida Tanzania

### Introduction

Groundnut (*Arachis hypogaea* L.) is a leguminous crop known by different names such as earthnut, peanut, monkey nut or goobers. Scholars (i.e., Abady *et al.*, 2019; Shasani *et al.*, 2020; Mwatawala & Kyaruzi 2019) consider groundnut as amongst the important food and cash crops grown in almost all of the world's tropical and subtropical countries. In Africa, the major groundnut-producing countries are Nigeria, Sudan, Tanzania, Chad,

Senegal and Cameroon (Mwakimata, 2018).

The major groundnut production regions in Tanzania include Shinyanga, Tabora, Dodoma, Mbeya and Mtwara regions (Daudi *et al.*, 2018).

According to the United Republic of Tanzania (URT) (2016), Singida is a semi-arid region and amongst the top ten rated regions with the potential for groundnut production in terms of quantity (tonnes) and harvested area (ha) in Tanzania. Thus, groundnut can have a significant contribution to increased income, food and

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nutritional security for farmers in Tanzania, if it is widely adopted to improve their productivity. Despite its potential, the study by Sawe *et al.* (2018) revealed that groundnut is amongst the crops characterised by low tolerant capacity in semi-arid areas; hence it records a decline in terms of yields trends by 1.97 per cent. According to FRN Project Report (2018), the change in rainfall patterns and distribution has affected the production of groundnuts. Groundnut is not a new crop in Singida, however, due to changes in the rainfall pattern, its production has been declining. To address the challenge of declining trends in groundnut production yields, Research Community and Organizational Development Associates (RECODA) implemented a project titled "Farmer Research Networks' Participation in Agro-Ecological Intensification for Improved Soil Health, Productivity, Nutrition and the Development of Legume Seed Systems in Singida" (FRN, 2018). Farmer research networks (FRN) are associations of farmers who collaborate with researchers and development organizations to do research (Nelson *et al.*, 2019). The Crop Collaborative Research Programme (CCRP) created a set of farmer research network (FRN) principles to serve as a roadmap for project execution. The fundamental ideas include (i) a farmer-centred strategy in which a variety of farmers take part in the entire research process; (ii) rigorous, democratic and practical/useful research and (iii) collaborative networks to promote learning and information sharing (Richardson *et al.*, 2021; Hausman *et al.*, 2020).

Under the Crop Collaborative Research Programme (CCRP), which is funded by the McKnight Foundation, the FRN project was implemented to address the effects of climate change on groundnut and other crops. Specifically, the project promoted the adoption and use of drought-tolerant crop cultivars (groundnuts, bambara nuts, lablabs and pigeon peas) and technologies that harness rainwater harvesting and moisture conservation (FRN, 2018). The FRN project's goal was to boost sustainable food production and farm productivity emanating from improved soil health practices, leading to food security and increased income, which would increase

household resilience. One of the FRN project's specific objectives was to develop seed systems for legumes, specifically groundnuts, bambara nuts, lablabs, and pigeon peas, to establish how a seed system enhances productivity and diet diversification (FRN, 2018).

The FRN project also aimed to address the unavailability of seeds of improved groundnut cultivars because, being a new crop, the availability of seeds of improved groundnut cultivars was not assured in the project area, despite that Singida was reported as amongst the top ten groundnut producers in Tanzania (URT, 2016). RECODA procured the seeds of improved groundnut cultivars from the Tanzania Agricultural Research Institute (TARI)-Naliendeke, which were introduced for trying out in the project area (Lukurugu *et al.*, 2021). After procurement, RECODA, through the FRN project facilitated the availability of seeds of improved groundnut cultivars, whereby 112.5 kg of seeds of improved groundnut cultivars were distributed to 420 beneficiary farmers in eight project villages. These 420 beneficiary farmers who received seeds of the improved groundnut cultivars were expected to multiply them for spreading out to at least 1260 target beneficiary farmers in the project area, who would further diffuse the innovation to their fellow indirect beneficiary farmers in their respective and neighbouring villages (FRN, 2018).

Konja (2020) pointed out the recently developed interest by a diversity of professionals in conducting adoption studies on new agricultural technologies in groundnut production. In respect of its importance, different studies report low adoption rates of improved groundnut cultivars. For instance, Lukurugu *et al.* (2021) identified low adoption of improved groundnut cultivars in the Tanzanian southern zone, while Takahashi *et al.* (2019) reported a low adoption rate of improved agricultural technologies such as improved groundnut cultivars. Similarly, Gorfad *et al.* (2018) reported the existence of a wide adoption gap between farmer practices versus improved innovations including improved groundnut cultivars that were developed by scientists from agricultural Universities. It is worth noting that an innovation, including improved groundnut

cultivars, should solve identified problems, and researchers should be aware that an innovation is not adopted because of its technical advantages alone (Orr, 2018).

According to the FRN progress report (2018), an assessment was done to determine the adoption of improved pigeon peas, which established an adoption rate of 80 per cent. In this assessment, no documentation was done about the adoption of improved groundnut cultivars. The project assessment report proposed further research on the adoption and suitability of the improved groundnuts in Singida. On the other hand, Simtowe *et al.* (2019), as cited by Lee (2020), identified the factors that affected the adoption of improved groundnut cultivars in Uganda which included the size of the household, higher income, receipt of extra information on cultivars and more usage of hired labour and manure. The factors that influenced the adoption of improved groundnut cultivars in Tanzania were age, gender, education, land ownership, group membership, farm size, experience, grain price, seed availability and seed cost (Mwalongo *et al.*, 2020). Nevertheless, there is insufficient documentation on the influence of these factors on the adoption of improved groundnut cultivars by amongst FRN beneficiary farmers in Singida Rural District.

This study aimed at establishing the factors which influenced the adoption of improved groundnut cultivars amongst FRN beneficiaries. The specific study objectives were (i) to assess the adoption status of improved groundnut cultivars in connection to farmers' socio-economic characteristics (ii) to determine the factors influencing the adoption of improved groundnut cultivars in the study area and (iii) to examine the perception of farmers towards the adoption of improved groundnut cultivars regarding access to services, technological characteristics and institutional environment.

### Theoretical framework

Networking theories of innovation diffusion, innovation systems theory and Rodger's theory of innovations served as the foundation for this study. According to the social network diffusion theory, the adoption of new technologies by farmers typically follows

a complex contagion pattern and is based on a variety of sources of information (Beaman *et al.*, 2021). Additionally, people are embedded in an interactive network, and potential innovators' attitudes are influenced by social inspiration. The adoption of innovation entails more than just the dissemination of information; it also involves changes to decisions, conversations in a wider context pertaining to the socioeconomic system and the sincerity of an individual to exert influence (Deroian, 2002). Since social network diffusion theory makes assumptions about networking, collaboration and participatory processes, it was incorporated into this research because it is consistent with FRN principles. Social network diffusion theory was used to identify the independent variables used in this study, including multiple sources of information, a broader spectrum of external skills, an on-farm learning environment and multiple connections to seeds that were conceptualized as determinants of the adoption of improved groundnut cultivars.

In addition, Roger's theory was related to FRN principles in the area of on-farm research, where farmers could watch, learn about the benefits of innovation through on-farm experiments and assess how easy and compatible the innovation was with their current practices and beliefs. As Rogers (2003) observes, innovations with benefits, perceived compatibility with current practices and beliefs, low complexity, possible trialability and observability will spread more quickly. In order to make the terms "adoption" and "diffusion" clearer as they are used in the theories that underpin this study, Vecchio *et al.* (2020) noted that "adoption is the condition whereby an individual decides to accept an innovation and integrate it into his or her life, whereas diffusion is the process by which innovation is adopted across a population over time." The term "adoption" used in this study refers to the collaborative testing, learning, understanding and application of the innovation by the FRN project beneficiaries through the cultivation of all or a single improved groundnut cultivar, namely Mnanje, Naliendele and Mangaka, as part of their agro-ecological practices.

According to the innovation systems

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perspective, learning occurs in networks and spreads to individuals and farmers, leading to innovation. Farmers typically learn on the farm about the performance and applicability of the innovation to farming systems, as well as the sustainability of the inputs and market for the produce, before accepting it (Ayele *et al.*, 2012). The diversity of players and characteristics necessary to promote innovation and growth are highlighted by the innovation system framework (World Bank, 2007). Ayele *et al.* (2012) identify the essential players, which include knowledge and technology suppliers and users, as well as their roles, interactions with one another, and routines and behaviours that affect collaborative learning and innovation. Players' proximity, such as physical separation, the institutional setting, which moulds relationships based on trust and the ability to assimilate new information are factors that affect interaction and learning. The FRN approach and the innovation systems theory were related because the latter focuses more on network cooperation and systems thinking. The innovation system approach was used to identify the independent variables such as demand-driven innovation, suitability of innovation, sustainability of inputs, market of the product, on-farm learning, providers of knowledge and technology, users of knowledge and technology and institutional environment, which were conceptualized to influence the adoption of improved groundnut cultivars.

### Methodology

#### Study Area

Singida Rural District lies between 30 and 70 latitudes south of the Equator and 340 and 350 Longitudes East of Greenwich. A semi-arid climate prevails in Singida Rural District. There are two seasons: the dry season which is the longest (April to November), and the rainy season (December to March). The annual average precipitation is between 600 and 700 mm, while the minimum temperature ranges from 15 to 30°C (Singida District Profile, 2015). Topographically, Singida District, which is in the east of the Great Rift Valley, is a significant scarp that can reach heights of 180 metres. These climatic and topographical features favour groundnut cultivation. The

enormous outcrops, or six rocky peaks (tors), of granite and metamorphic rocks that can be found in Singida District are a notable aspect of the land escarpment. These outcrops, often referred to as inselbergs, are the remains of ancient land surfaces that have in the nearby areas been eroded to create a vast, gently undulating pen plain (Singida District Profile, 2015). Furthermore, according to the Singida District Profile (2015), the Nyaturu, Sukuma, Taturu, Barbaig, Hadzabe and Kimbu are the primary indigenous ethnic groups in the district. The Barbaig, Hadzabe, and Kimbu constitute a sizeable minority. Compared to other tribes, the Nyaturu people make up the largest ethnic group in the district. Singida Rural District was chosen because its topographical characteristics, climatic factors and rainfall patterns favour the production of groundnut.

The FRN Project Report (2018) states that variations in the distribution and pattern of rainfall have an impact on groundnut yield. Although groundnuts are not a new crop in Singida, variations in rainfall distribution are causing a decline in output. Prior work

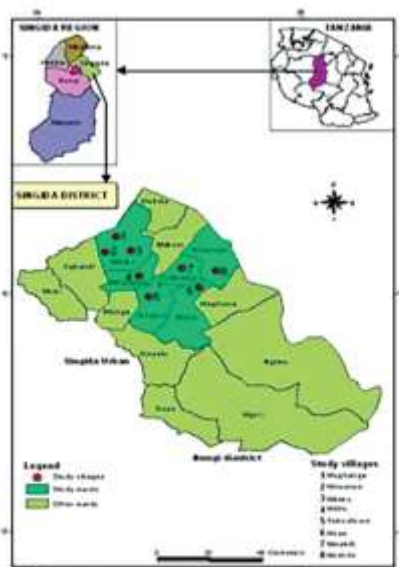


Figure 1: Map of the study area

Source: Survey data 2022

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conducted by one of the main partners in the FRN project in Tanzania, Research Community and Organizational Development Associates (RECODA), suggested that improved groundnut cultivars could be successful in Singida Rural District.

#### Research Design

This study used a cross-sectional research design, in which information was gathered all at once. As Omar (2015) observes, a cross-sectional research design has a broad scope because it incorporates numerous variables at once and allows for data collection at a single point in time. The author further observes that the design is more cost and time-effective than the longitudinal approach when looking for relationships between variables and for descriptive purposes. Both quantitative and qualitative data were gathered concurrently using mixed research techniques. Mixed research methods have been cited by Glover *et al.* (2019) and Polit and Beck (2010) as being cutting-edge, perceptive and helpful for enhancing the generalizability of research. Additionally, according to Creswell (1999), a mixed-method study employs both qualitative and quantitative data collection and analysis methods in a single inquiry. In the context of this study, while the qualitative research focused on how FRN group membership was governed by FRN principles with an emphasis on participation, the practicality of on-farm research, networking and collaboration, quantitative research techniques were used to identify the factors that statistically influenced the adoption of improved groundnut cultivars, specifically Mnanje, Mangaka and Naliendele. Therefore, mixed methods complimented each other, whereby quantitative research provided numeric data while qualitative research provided information that deepened understanding of the situations that numerical data could not adequately illustrate.

#### Sampling procedure and sample size

The study population consisted of 1260 target beneficiary farmers from eight project villages in Ilongero and Mtinko Divisions of Singida Rural District (420 direct beneficiaries

and 840 indirect beneficiaries). Eight villages—Sekoutoure, Mwakiti, Msimihi, Mdlu, Mvae, Mughanga, Minyenyeny and Mtinko—in the Ilongero and Mtinko Divisions of Singida Rural District participated in this study (Fig. 1). These villages were chosen based on topographical characteristics, climatic factors and rainfall patterns that favour the production of groundnut. Additionally, the FRN initiative introduced and promoted improved groundnuts for adoption and diffusion in these villages. In order to obtain a representative sample of the population for quantitative data, random sampling procedures were applied. The sample size for smallholder farmers' direct and indirect beneficiaries from the 8 villages in the Ilongero and Mtinko Divisions of Singida Rural District was calculated using the formula used by Krejcie and Morgan (1970).

$$n = \frac{X^2 NP(1 - P)}{d^2(N - 1) + X^2 P(1 - P)}$$

Where: n = required sample size, X = z value (assumed to be 1.645 for 95% confidence level), N = Population size, P = Population proportion (assumed to be 0.5 since this would provide the maximum sample size), d = degree of accuracy (5%), expressed as a proportion (0.05).

$$n = \frac{1.64^2 \times 1260 \times 0.5 \times 0.5}{0.05^2 \times (1260 - 1) + (1.64^2 \times 0.5 \times 0.5)} = 212$$

Simple random sampling was applied to select respondents from each village (direct and indirect beneficiaries).

#### Proportionate Formula Random Sampling Procedure

**Direct Beneficiaries (FRN group members):**  
 $n = (420/1260) \times 212 = 70.67$  approximately 71  
 $n1 = (50/420) \times 71 = 8, n2 = 8, n3 = 17, n4 = 5, n5 = 14, n6 = 5, n7 = 6, n8 = 8$

**Indirect Beneficiaries (Non-group members):**  
 $n = (840/1260) \times 212 = 141$   
 $n1 = (100/840) \times 141 = 17, n2 = 15, n3 = 34, n4 = 10, n5 = 28, n6 = 10, n7 = 12, n8 = 15$

Table 1 provides a breakdown of the sample size of direct and indirect beneficiaries per village.

Key informants who provided qualitative data were specifically chosen for interviewing.

Table 1: Sample size

Division	Ward	List of villages	Population (N)		Sample Size (n)	
			Direct	Indirect	Direct	Indirect
1. Ilongero	1. Ilongero	Sekoutoure	50	100	8	17
	2. Mrama	Mwakiti	45	90	8	15
	3. Ikhanoda	Msimihi	99	198	17	34
	4. Mwasawia	Mditu	31	62	5	10
	5. Meria	Mvae	84	168	14	28
2. Mtinko	6. Mtinko	Mughanga	29	58	5	10
		Minyenye	37	74	6	12
		Mtinko	45	90	8	15
<b>TOTAL</b>			<b>420</b>	<b>840</b>	<b>71</b>	<b>141</b>
<b>GRAND TOTAL</b>			<b>1,260</b>		<b>212</b>	

Source: Survey data 2022

The major informants were District Agricultural Extension Officers and project employees. Key informants were picked based on their positions about the initiative and the information they had access to in their respective spheres of influence. Two groups the Mshikamano group in Mughanga village (Mtinko Division) and the Mungano group in Mvae village (Ilongero Division) were purposefully chosen based on their divisions to participate in focus group discussions (FGDs). FGDs were made up of 8 and 12 farmers from Mshikamano and Mungano groups respectively. The composition of 8 and 12 farmers in the FGD was according to the suggestion by Nyumba *et al.*, (2018) who suggested that, the group gets difficult to lead when it has more than 12 participants, and it may split up into two or even three smaller groups, each conducting its own separate debate. The main topics discussed in FGDs and KII were on understanding how farmer traits, technological traits, and factors including informational and socioeconomic factors influenced the adoption of improved groundnut cultivars in the research area.

#### Data collection

Enumerators were trained in data collection using both quantitative and qualitative instruments in April 2022, before the collection of primary data. In April 2022, the data collection tools underwent preliminary testing in the community of Mwakiti. The data-

gathering methods were modified in light of the outcomes of the pretesting exercise. Between April and May 2022, the field data collection operation was conducted to gather both primary quantitative and qualitative data.

Semi-structured copies of a questionnaire with both closed- and open-ended questions were used to collect primary quantitative data on factors such as age, sex, marital status, level of education, primary source(s) of income, technological characteristics, seed accessibility, FRN group membership status and institutional characteristics. These numerical statistics were crucial for illustrating the study's numerical and statistical numbers, such as frequencies, percentages, means and standard deviations.

Primary qualitative data were gathered using qualitative data collection methods such as key informant interviews, focus group discussions and observation. The collected data focused on farmers' feelings and opinions on why to accept or reject improved groundnut cultivars as well as how farmer characteristics, technological characteristics, institutional characteristics and information factors affected the adoption of improved groundnut cultivars. Checklists with open-ended questions were used. Qualitative data were collected to fully understand situations that statistical data could not sufficiently depict.

The secondary data were gathered through a documentary review. The online sources of knowledge (mainly Google Scholar with the

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interval of 2017 to 2022 publications), the socioeconomic profile of the Singida Rural District, the FRN project design, and monthly, quarterly, yearly, monitoring and evaluation reports were amongst the materials which were studied. Since these were part of the literature review and included details on what had already been done and reported, these documents were significant since their main goal was to complement (or refute) the conclusions drawn from other data sources.

#### Data analysis and interpretation

Prior to the analysis, quantitative data were coded and summarized. The Statistical Package for Social Science (SPSS) version 20 was used to input and evaluate the survey's numerical data (questionnaires) in order to provide descriptive statistics (mainly frequencies and percentages). Frequencies and percentages were further adjusted and transformed into cross-tab and pivot tables for simplicity of presentation.

The adoption was measured based on the operational definition used in this study. Respondents who reported to have either grown all or one of the improved groundnut cultivars (i.e., Mnanje, Mangaka and Naliendele) (1 = Yes) in a questionnaire were considered to have adopted them, while those who reported not to have grown the cultivars (0 = No) were treated as not having adopted them. Independent variables such as FRN group membership and seed accessibility were captured from the questionnaire responses, where 1 was coded for group members and 0 for non-group members; similarly, 1 was coded for respondents who had access to improved groundnut seeds and 0 was for respondents who had no access to improved groundnut seeds. Technological characteristics and institutional characteristics were captured from respondents' perceptions and were transformed and categorized into two by calculating the mean, whereby 1 was coded for positive perception and 0 for negative perception.

The socioeconomic traits of farmers who adopted and did not adopt the improved groundnut cultivars were compared using Chi-square test cross-tabulations. A Likert scale was used to assess the farmers' perceptions of

the adoption of improved groundnut cultivars in relation to access to services, technological characteristics and the institutional environment. The binary logistic regression model was used to determine factors influencing smallholder farmers' adoption of improved groundnut cultivars. The following adopted equation is the binary logistic regression model according to Astari (2019).

$$\text{logit}(\pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p$$

Whereby,

$\beta_0, \beta_1, \dots$  = Regression parameters:  $\lambda_1, \lambda_2, \dots$

$X_p$  = Independent variables

$\pi$  = Probability of adoption

$X_1$  = Respondent's age (the age of respondent in years)

$X_2$  = Respondent's sex (1= male, 0= female)

$X_3$  = Education (1 = primary education, 0 = other level of education)

$X_4$  = Marital status (1=married, 0= otherwise)

$X_5$  = Major source of income (1 = agriculture, 0 = others)

$X_6$  = Technological characteristics (1= positive perception, 0 = negative technological perception)

$X_7$  = Seed accessibility (1 = accessible, 0 = not accessible)

$X_8$  = FRN group membership (1= group member, 0 = non-group member)

$X_9$  = Institutional characteristics (1 = positive institutional perception, 0 = negative perception)

Before the analysis, the qualitative data from the focus group discussions and interviews, particularly with the district, project officials, and other key informants, were translated from Kiswahili to English and then coded. Specific themes were created by combining the codes, and these topics were then subjected to thematic analysis. Themes based on similar patterns and trends in the data were used to interpret the data.

#### Results and discussion

##### Socioeconomic characteristics and adoption of improved groundnut cultivars

Table 2 presents the comparative adoption status amongst farmers based on their socioeconomic characteristics. The Chi-square tests show the P values as follows: age (P= 0.128),

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sex ( $P=0.427$ ), marital status ( $P=0.226$ ), an education level ( $P=0.414$ ) and major sources of income ( $P=0.708$ ) indicating that there is no statistical significance concerning farmers' socio-economic characteristics and the adoption of improved groundnut cultivars. This implies that there is no significant difference between those who adopted and those who did not adopt improved groundnut cultivars. Thus, social economic characteristics (i.e., age, sex, marital status; education and income) did not influence the adoption of improved groundnut cultivars in the project area.

However, from the descriptive statistics, the following are the study findings: In terms of age groups, 60.8 per cent adopted the innovation while 39.2 per cent did not adopt it. The majority of adopters were middle-aged people between the ages of 36 and 65 years (65.7%), followed by 51.6 per cent young people of between 18 and 35 years of age. The elderly group above 65 years that adopted improved groundnuts constitutes 50 per cent. Similar findings are reported in a study by Lindsjö *et al.*, (2020) who revealed that the majority (72.4%) of respondents were aged between 36 to 64 years. This is consistent with what is reported by Mwalongo *et al.*, (2020) who revealed that farmers aged between 35 to 50 years have adopted the improved cultivars of groundnuts. These findings imply that the age category of 36 to 65 years constitutes middle-aged adult farmers who are socially responsible and mature enough to decide to participate, conduct on-farm trials, interact in networks and adopt appropriate innovations that are economically useful.

Gender-wise, the group of adopters constituted 60.8 per cent while the non-adopters were 39.2 per cent for both males and females. However, the majority of adopters were females, accounting for 63.8 per cent with males accounting for 58.5 per cent. The analysed information from Mshikamano group disclosed that, in Singida, groundnuts are considered women's crops to assure the availability of household cooking oil as one of the main ingredients in meal preparation, while men are the decision-makers on land use and concentrate more on the production of cash crops mainly sunflower. These findings are in contrast to the

findings in a study by Banla *et al.*, (2018), who found that 62.2 per cent of males as opposed to 37.8 per cent of females were participating in groundnut farming in three regions of Togo. Likewise, Mwalongo *et al.*, (2020) reported more males adopting the improved groundnut cultivars than is the case with females, due to higher position of the former in decision-making about the allocation of household resources. This implies that there is still gender inequality in matters related to decision-making over resource allocation for groundnut production and hence influences its adoption by gender.

In terms of marital status, there were 60.8 per cent adopters and 39.2 per cent non-adopters amongst the married and single respondents. Amongst the group of adopters, the majority (62.4%) of the respondents were married, followed by 50.0 per cent who were single. Other scholars also found that new technologies in production were more widely adopted by married farmers than was the case with unmarried farmers (Konja, 2022; Kalinda *et al.*, 2014). The findings imply that married farmers are relatively settled with established permanent settlements and are responsible for taking care of their family members; hence, they are more likely to adopt any technology that sounds useful to them.

In terms of education, primary school leavers, secondary school alumni, and those who never attended formal school education have 60.8 and 39.2 per cent of adopters and non-adopters respectively. From amongst the group of adopters, the majority (62.5%) had attained primary education, followed by 52.6 per cent who were secondary school alumni and 44.4 per cent who had never attended formal schooling. Complementary to these findings, the analysed qualitative information from the Mungano FGD revealed that the majority of those who participated in groundnut production were primary school leavers. The analysed information showed that those who attained secondary and tertiary education were fast adopters, but they were few in the village since the majority of them normally did not engage in farming activities as they were more focused on looking for employment opportunities created by other sectors of the economy. These

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results support those reported by Lee (2020), who stated that, amongst other factors, the adopters of innovations were more educated and informed than the non-adopters. Similarly, Daudi *et al.* (2018) reported that the low levels of education and literacy limited the adoption of agricultural technologies by farmers. These results suggest that formal education matters in influencing adoption and that the more educated a person becomes, the more he or she is likely to become aware of and adopt new technology.

As far as major sources of income are concerned, there were 60.8 per cent adopters amongst farmers, employees, petty business persons and livestock keepers and 39.2 per cent non-adopters. The majority (62.0%) of adopters depended on agriculture/farming, as their main source of income. Other scholars (Suleiman,

2018; Mwaisakila & Matemani, 2021) have stated that agriculture is the backbone of the Tanzanian economy, contributing approximately 30 per cent of the total GDP, employing 65-70 per cent of the population and accounting for approximately 75 per cent of rural income. Similarly, Ahmed *et al.* (2020) observed that agriculture was a livelihood practised by about 85 per cent of household heads. This reality informs us that agriculture is the main source of income amongst farmers, and there is a need to optimize income through the adoption of improved technologies. The adoption of improved groundnut cultivars is part of agricultural development, which, when internalized, will ultimately contribute to the increase of the Tanzanian Gross Domestic Product (GDP).

**Table 2: Comparison of farmers' socio-economic characteristics and adoption of improved groundnut cultivars (N=212)**

Socio-economic characteristics		Adoption Status			Pearson Chi-Square
		Adopted	Not adopted	Total	
Age Groups	18 - 35 years	32 (51.6%)	30 (48.4%)	62 (100%)	0.128
	36 - 65 years	92 (65.7%)	48 (34.3%)	140 (100%)	
	Above 65 years	5 (50.0%)	5 (50.0%)	10 (100%)	
	<b>Total</b>	<b>129 (60.8%)</b>	<b>83 (39.2%)</b>	<b>212 (100%)</b>	
Respondent's sex	Male	69 (58.5%)	49 (41.5%)	118 (100%)	0.427
	Female	60 (63.8%)	34 (36.2%)	94 (100%)	
	<b>Total</b>	<b>129 (60.8%)</b>	<b>83 (39.2%)</b>	<b>212 (100%)</b>	
Marital status	Married	116 (62.4%)	70 (37.6%)	186 (100%)	0.226
	Single	13 (50.0%)	13 (50.0%)	26 (100%)	
	<b>Total</b>	<b>129 (60.8%)</b>	<b>83 (39.2%)</b>	<b>212 (100%)</b>	
Education Level	Primary	115 (62.5%)	69 (37.5%)	184 (100%)	0.414
	Secondary	10 (52.6%)	9 (47.4%)	19 (100%)	
	Never attended school	4 (44.4%)	5 (55.6%)	9 (100%)	
	<b>Total</b>	<b>129 (60.8%)</b>	<b>83 (39.2%)</b>	<b>212 (100%)</b>	
The major source of income	Agriculture/Farming	119 (62.0%)	73 (38.0%)	192 (100%)	0.708
	Employment	3 (50.0%)	3 (50.0%)	6 (100%)	
	Petty business	3 (42.9%)	4 (57.1%)	7 (100%)	
	Livestock keeping	4 (57.1%)	3 (42.9%)	7 (100%)	
	<b>Total</b>	<b>129 (60.8%)</b>	<b>83 (39.2%)</b>	<b>212 (100%)</b>	

Source: Survey data 2022

**Factors influencing the adoption of improved groundnut cultivars**

The binary logistic regression was used to determine factors influencing smallholder farmers' adoption of improved groundnut cultivars. Table 3 shows that the value of the log-likelihood is 79.555, while the Nagelkerke R square is 0.833, which indicates that the model explained about 83.3 per cent of the variation in the dependent variable. The higher Nagelkerke R square suggests that the model fitted the data has high explanatory power for the joint association of the factors influencing the adoption of improved groundnut cultivars in the study area.

Furthermore, the results show that the model fitted the data well at  $p = 0.00$ . This indicates that the variables were good at predicting the likelihood of smallholder farmers' adoption of improved groundnut cultivars.

**Table 3: Model Summary: Omnibus Tests of Model Coefficients**

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	79.555a	0.610	0.833
	Chi-square	df	Sig. (p-value)
Step 1	Step 199.370	9	0.000
	Block 199.370	9	0.000
	Model 199.370	9	0.000

Source: Survey data 2022

While the adoption of improved groundnut cultivars was the dependent variable, the independent variables used in the regression model were age, sex, education, marital status, major source of income, technological characteristics, seed accessibility, FRN project group membership and institutional characteristics. The study results in Table 4 indicate that out of nine independent variables, three variables, namely FRN group membership, seed accessibility and technological characteristics, had a significant influence on the dependent variable (adoption of improved groundnut cultivars).

The study findings (Table 4) show that FRN group membership was significant at  $p$  less than 0.05. The findings imply that FRN group membership status (direct beneficiaries) increases the likelihood of adopting the improved groundnut cultivars by 6.28 units. To

their credit, the information analysed from both the Mungano and Mshikamano FGDs showed that, compared to non-FRN group members, the FRN group members interacted more with the project facilitators and extension workers, who offered training, information and other extension services. Also, the seeds of improved groundnut cultivars were first provided through the channels of active group membership status. The non-FRN group members had indirect access to seeds of improved groundnut and extension-related services. Similar to these findings, Kimaru-Muchai *et al.* (2020) used binary logistic regression, which showed that membership in a social group was amongst the factors that influenced the adoption of Zaipit technologies in drier upper Eastern Kenya. Furthermore, Israr and Khan (2019) confirmed that membership in a farm service centre influenced the adoption of improved wheat seed

innovations in Khyber Pakhtunkhwa using a binary logistic regression model.

The findings show that seed accessibility was highly significant at  $p$  less than 0.05. The findings imply that an increase in seed accessibility increases the likelihood of adopting improved groundnut cultivars by 114.12 units (Table 4). The direct beneficiaries of the project who belong to FRN groups had more access to seeds of improved groundnut cultivars compared to indirect beneficiaries. The information sourced from KII indicate that, the FRN project facilitated the availability of improved groundnut seeds for the selected FRN group members to multiply and spread. In the process of seed distribution, FRN group members were given priority due to their group membership status. During the interview, one key informant said,

*"The priority in seed distribution of the*

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*improved groundnut cultivars was given to the active direct beneficiaries of the project/FRN group members" (FRN Project Officer, RECODA Office at Ilongero village, Singida District, 4 May 2022).*

Similar findings were reported by Selahkwe *et al.* (2021), who used a logistic regression model to arrive at the results, which showed that farmers who were supplied with improved seeds from non-governmental organizations had a higher probability of adopting the innovation than the non-recipients. Again, Lee (2020) stated that if seed accessibility was ensured coupled with awareness creation, the adoption rate was likely to have increased to 30 per cent.

Table 4 displays the research findings, which revealed that perception of technological characteristics (i.e., adaptive to agroecological zones, high yields, early maturity, drought tolerance, pests and diseases resistance) were highly significant at  $p$  less than 0.05. This implies that changing the status of the technological characteristics of improved groundnut cultivars from undesirable (such as low yield, late maturity and drought intolerance) to desirable (such as high yield, early maturity and drought tolerance) increases the likelihood that farmers will adopt improved groundnut cultivars by 14.93 units. The key informant complimented by pointing out the aspect of high yield being the driving factor that contributed to the adoption of improved groundnut cultivars as follows:

*"Prior to the FRN initiative, farmers produced local groundnut cultivars, which had substantially lower yields than the improved cultivars they are now widely adopting" (District agricultural extension officer, Singida District, 3 May 2022).*

Additionally, a farmer from Mvae village declared to have had harvested higher yields from improved groundnut cultivars than the local groundnut cultivars:

*"After I learned from the trial plot how to produce improved groundnut cultivars, I practiced the knowledge in my plot where I grew Mnanje by observing correct spacing and timely weeding as we were taught by our project facilitators. I managed to harvest 10 bags of improved groundnut cultivars on 1 acre. Before that, I was harvesting an average of 2 bags of*

*local groundnut cultivars in the same acre" (Joseph Mwiru Muna, a farmer from Mvae village, Singida District, May 2, 2022).*

It was further noted from the analysis of the Muungano and Mshikamano FGDs which showed that improved groundnut cultivars such as Mnanje had some relatively unique characteristics over local farmer cultivars. The key features of Mnanje that were pointed out by participants in FGDs as being preferable to farmers and buyers in the market include its high yield, vigour and large grain size, attractive reddish colour, a large amount of oil once pressed and good taste when eaten in all forms, that is raw, cooked, roasted or boiled. The literature states that Mnanje 2009 has unique characteristics that attract customers in the market, including its highest oil content (51%), highest iron composition (65.4 mg/kg), and sweetness when eaten in raw or in cooked form (Lukurugu *et al.*, 2021). The findings are also similar to Mehmood and Khan (2021), who found that the majority of farmers in the Potwar Plateau of Pakistan considered improved groundnut cultivars as better than the traditional or local cultivars in terms of yield, pod size and marketing.

**Farmers' perception on the adoption of improved groundnut cultivars**

**Farmers' perception towards access to services**

The study findings in Table 5 indicate that farmers had a positive perception towards access to services for the adoption of improved groundnut cultivars since mean score was used as a decision rule whereby the mean score of 2 and above was judged as positive perception and the mean score of less than 2 was judged as negative perception. For instance, farmers agreed that multiple connections to improved groundnut seeds affected the adoption of improved groundnut cultivars. "I am sure that multiple connections to improved groundnut seeds influence the adoption of improved groundnut cultivars" had a mean score of 2.81 and 84.9%. Oluwatoyin (2021) suggested a solution to the constraints of the adoption associated with availability, accessibility and affordability. Furthermore, access to credit

**Table 4: Factors influencing the adoption of improved groundnuts cultivars (N=212)**

Independent Variables	B	S.E.	Wald	df	Sig. (p-value)	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Constant	-2.752	2.197	1.570	1	0.210	0.064		
Respondent's age	-0.373	0.695	0.288	1	0.592	0.689	0.177	2.689
Respondent's sex	0.059	0.609	0.009	1	0.923	1.060	0.321	3.501
Education	-1.604	1.561	1.056	1	0.304	0.201	0.009	4.287
Marital Status	0.854	1.119	0.583	1	0.445	2.350	0.262	21.050
Major sources of income	0.970	1.086	0.797	1	0.372	2.637	0.314	22.179
Technological characteristics	2.703	0.653	17.148	1	0.000	14.930	4.153	53.671
Seed accessibility	4.737	0.881	28.941	1	0.000	114.123	20.315	641.108
FRN project group membership	1.837	0.816	5.076	1	0.024	6.280	1.270	31.057
Institutional characteristics	0.291	0.629	0.214	1	0.643	1.338	0.390	4.588

Source: Survey data 2022

services was agreed by 82.5% of farmers that it influences the adoption of improved groundnut cultivars. The perception statement "I am sure that access to credit services influences the adoption of improved groundnut cultivars" had a mean score of 2.76. Similarly, Chandio and Jiang (2018) stated that the availability of credits was a determinant for the adoption of improved wheat cultivars in Pakistan. The perception statement "I am sure that access to post-harvest infrastructure influences the adoption of improved groundnut cultivars" had a mean score of 2.60. By 67.0%, farmers agreed that access to post-harvest infrastructure influenced the adoption of improved groundnut cultivars. Kumara *et al.*, (2018) reported that the majority of farmers have been constrained by a lack of seed storage. Multiple connections to improved groundnut seeds, amongst other factors facilitated farmers' access to quality seeds, which was similarly stated by Vabi *et al.* (2018) to have influenced decisions to adopt improved groundnut innovations. Likewise, access to on-farm learning, access to information and a broader spectrum of external skills regarding improved groundnut cultivars from multiple sources were agreed upon by 87.7, 84.9 and 78.8 per cent of farmers (with mean scores of 2.82, 2.81 and 2.73) respectively, to influence the adoption of improved groundnut cultivars. The

literature shows that learning innovations are a complex process that requires farmers to have access to information from multiple sources for them to adopt technologies (Beaman *et al.*, 2018; Fisher *et al.*, 2018; Lee 2020; and Puzozaa *et al.*, 2021). These findings corroborate with social network diffusion theory, which posits that diffusion follows a complex contagion pattern whereby farmers tend to adopt a new technology provided that information about that technology comes from multiple sources (Beaman *et al.*, 2021). These findings suggest that access to services such as multiple connections to seeds, on-farm learning, a broader spectrum of external skills and information, credit and post-harvest infrastructure are potential influencing factors towards the adoption of improved groundnut cultivars.

#### Farmers' perception towards technological characteristics of an innovation

The mean scores of 2 and above indicate that farmers had a positive perception towards the technological characteristics of improved groundnut cultivars, regardless of a negative perception of introduction of improved groundnut cultivars as demand driven technology which had a mean score of less than 2 (Table 6). To support this, the analysis from the Mungano and Mshikamano FGDs showed that

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Table 5: Farmers' perception towards access to services (N=212)

Statements	Agree %	Neutral %	Disagree %	Mean
I am sure that multiple connections to improved groundnut seeds influence the adoption of improved groundnut cultivars	84.9	11.3	3.8	2.81
I am sure that access to on-farm learning regarding improved groundnut cultivars influences its adoption	87.7	6.6	5.7	2.82
I am sure that access to information regarding improved groundnut cultivars from multiple sources influences its adoption	84.9	10.8	4.2	2.81
I am sure that a broader spectrum of external skills concerned with improved groundnut cultivars influences its adoption	78.8	15.6	5.7	2.73
I am sure that access to credit services influences the adoption of improved groundnut cultivars	82.5	10.8	6.6	2.76
I am sure that access to post-harvest infrastructure influences the adoption of improved groundnut cultivars	67.0	25.9	7.1	2.60

Source: Survey data 2022

they had preferred improved groundnut cultivars to traditional farmer cultivars. The information sourced from both FGDs further shows that, after they participated in testing through on-farm trials, the demand for improved groundnut cultivars rose as a result of the good performance of the crop in terms of high yield, sweet taste, drought tolerance, pests and diseases resistance, early maturity, adaptive to the environment and marketability. These findings support Roger's theory of innovations related to FRN principles in the components of participation and usefulness of on-farm research, where farmers could watch, learn about the benefits of innovation through on-farm experiments, and assess how easy and compatible the innovation was with their current practices and beliefs. Rogers (2003) asserts that innovations with benefits, perceived compatibility with current practices and beliefs, low complexity, possible trialability and observability will spread more quickly. The findings are also in line with the innovation systems perspective, which states that learning occurs in networks and spreads to individuals and farmers, leading to innovation. Farmers typically learn on the farm about the performance and applicability of the innovation

to farming systems, as well as the sustainability of the inputs and market for the produce, before accepting it (Ayele *et al.*, 2012).

To complement the study findings by taking the example of yield, the key informant stated:

*"Before the introduction of improved groundnut cultivars, farmers used to harvest an average of 1 to 2 bags of unshelled local groundnut cultivars per acre, but after project interventions, they can harvest an average of 7 to 10 bags of unshelled improved groundnut cultivars per acre. This has motivated farmers to prefer improved groundnut cultivars to local farmer cultivars"* (FRN Project Officer, RECODA Office at Ilongero village, Singida District, 4 May 2022).

Other studies also revealed similar results. Akpo *et al.* (2021) reported that farmers preferred improved groundnut cultivars to the traditional ones. Daudi *et al.* (2018) and Mwalongo *et al.* (2020) reported on the superior qualities of improved groundnut cultivars over the local cultivars in the aspects of drought tolerance, pest and disease resistance, early maturity, high yield, big grain size, attractive grain colour, good taste, high oil content and a good market price. These findings suggest

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that technological characteristics such as the adaptation to agroecological zones, drought tolerance, pest and disease resistance, early maturity and higher yields are preferable to farmers and hence have a positive influence on the adoption of improved groundnut cultivars.

However, the statement "I am certain that improved groundnut cultivars were introduced as a demand-driven technology" had a mean score of 1.44 indicating that 75.5% farmers disagreed and hence had a negative perception that improved groundnut cultivars were introduced as demand-driven technology. The results show that there was low farmer involvement in the development of innovations from the beginning thus, farmers did not consider themselves as part of the process of developing demand-driven technologies. To support this, the information sourced from Muungano and Mshikamano FGDs stated that before the introduction of the FRN project, farmers used to grow the traditional groundnut cultivars, and due to a lack of information, it was initially not their demand to grow improved groundnut cultivars. The FGDs stated that it was RECODA that introduced the idea of improved groundnut cultivars developed by Tanzania Agricultural Research Institute (TARI) Naliendele and brought to the project area in Singida for testing and adoption purposes. The literature shows that while the FRN approach emphasizes

participation, the usefulness of on-farm research, and collaboration amongst stakeholders in the network (Richardson *et al.*, 2021; Haussman *et al.*, 2020), the improved groundnut seeds were initially produced by breeders and then passed to farmers for production of quality declared seeds (QDS) through farmer research groups, non-governmental organizations, and individual seed entrepreneurs (Akpo *et al.*, 2021; Lukurugu *et al.*, 2021). The findings imply that farmers had a negative perception towards developing demand-driven innovations since improved groundnut cultivars were initially not their idea, regardless of their later being preferred and adopted after participation in learning, testing, successful demonstrations, implementation and good performance from the on-farm trials.

#### Farmers' perception towards the institutional environment

The mean scores of 2 and above show that farmers had a positive perception of the institutional environment for the adoption of improved groundnut cultivars indicating that institutional environment such as markets, agro-input suppliers, credit facilities, subsidies and extension services were important for the adoption of improved groundnuts (Table 7). According to literature (Orr, 2018), amongst the key determinants of efficacious adoption are efficient institutions, demanding markets and

**Table 6: Farmers' perception towards technological characteristics (N=212)**

Statements	Agree%	Neutral%	Disagree%	Mean
I am certain that improved groundnut cultivars are adaptive to our agro-ecological zones	66.5	10.4	23.1	2.43
I am certain that improved groundnut cultivars are more drought tolerant than local cultivars	58.5	17.0	24.5	2.34
I am certain that improved groundnut cultivars are more pests and diseases resistant than local cultivars	44.3	25.9	29.7	2.15
I am certain that improved groundnut cultivars mature earlier than local cultivars	66.5	10.4	23.1	2.43
I am certain that improved groundnut cultivars have higher yields than local cultivars	67.9	8.5	23.6	2.44
I am certain that farmers prefer improved groundnut cultivars to local cultivars	71.2	7.1	21.7	2.50
I am certain that improved groundnut cultivars were introduced as a demand-driven technology	19.3	5.2	75.5	1.44

Source: Survey data 2022

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favourable policies.

The findings further revealed that 85.4 per cent of farmers agreed that the availability of markets influences the adoption of improved groundnut cultivars whereby the statement "I have no doubt that availability of markets affects the adoption of improved groundnut cultivars" had a score of 2.75. To complement this, the analysed information from both Muungano and Mshikamano FGDs showed that there was a reliable market for improved groundnut cultivars in the study area, but the seed availability of improved groundnut cultivars was limited. Those farmers who multiplied the seeds of improved groundnut cultivars usually provided the seeds to their fellow farmers free of charge, and those who sold the seeds normally sold them to their fellow farmers, middlemen and agro vet shops. With regard to market availability, the literature states that proximity to the market increases farmers' adoption (Orr, 2018), and a strong export market is amongst the adoption drivers (Ojiewo *et al.*, 2020). The findings imply that the availability of markets is essential for enhanced interaction between breeders, traders, transporters, farmers and agro-input suppliers, hence increasing the chances of the adoption of improved groundnut cultivars.

It was perceived positively by 81.6% farmers who agreed with the statement that "I have no doubt that availability of agro-input suppliers affects the adoption of improved groundnut cultivars" with a mean score of 2.72.

Additionally, the information analysed from Muungano and Mshikamano FGDs showed that the seeds of improved groundnut cultivars were mainly supplied by the FRN project and RECODA. Both FGDs stated that the agro-companies had supplied farm inputs and tools such as seeds and hand hoes, during planting seasons by using their trucks. Nevertheless, the maize seeds were the major types of seeds that were mostly supplied by the agro-companies in the project area, not the groundnut seeds. Rutsaert *et al.*, (2021) reported that nearly 30 per cent of farmers travelled more than 60 minutes to look for at least one nearby agro-dealer, irrespective of the high number of agro-dealers. This implies that the availability of agro-input suppliers is still limited while is essential for enhancing interaction amongst players in networks and, hence, influencing the adoption of improved groundnut cultivars.

Furthermore, respondents perceived positively by agreeing with the statements that they had no doubt that the availability of credit facilities (78.8%), subsidies (87.3%) and extension services (81.6%) affected the adoption of improved groundnut cultivars with the mean scores of 2.68, 2.79 and 2.72 respectively. The analysis of information from the Muungano and Mshikamano FGDs showed that farmers accessed credit through village savings and loans associations (VSLAs), which is one of the interventions being introduced by the project. The participants further stated that they accessed

**Table 7: Farmers' perception towards the institutional environment (N=212)**

Statement	Agree	Neutral	Disagree	Mean
I have no doubt that availability of markets affects the adoption of improved groundnut cultivars	85.4	4.7	9.9	2.75
I have no doubt that availability of agro-input suppliers affects the adoption of improved groundnut cultivars	81.6	8.5	9.9	2.72
I have no doubt that availability of credit facilities affects the adoption of improved groundnut cultivars	78.8	10.8	10.4	2.68
I have no doubt that availability of subsidies affects the adoption of improved groundnut cultivars	87.3	4.7	8.0	2.79
I have no doubt that availability of extension services affects the adoption of improved groundnut cultivars	81.6	9.0	9.4	2.72

Source: Survey data 2022

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fertilizer and sunflower seeds as subsidies from the government. The major extension service providers mentioned by the FGD participants were RECODA and government extension workers. According to literature, (i.e., Chandio and Jiang, 2018; Ohwatoyin, 2021), credit availability was a significant determinant of the adoption of improved agricultural technologies. Additionally, Shiferaw *et al.*, (2015, as cited by Takahashi *et al.*, 2018), reported that a lack of credits, seed supply, and technological information lowered the adoption of improved groundnut cultivars. According to Liu *et al.* (2020), fair subsidies boost agricultural enterprises and farmers' participation in the innovation diffusion process enthusiasm. In the instance of the adoption of improved varieties, Norton and Alwang (2020) pointed out that extension services could take the place of education. These findings suggest that the availability of credit facilities, subsidies and extension services is essential for interaction amongst players in FRN networks and hence influencing the adoption of improved groundnut cultivars.

### Conclusion and Recommendations

From the research findings, the following conclusions and recommendations can be drawn: Socioeconomic characteristics such as age, sex, marital status, education level and income did not influence the adoption of improved groundnut cultivars in the project area. The adoption of improved groundnut cultivars was significantly influenced by three factors: FRN group membership, seed accessibility and technological characteristics which include adaptation to agroecological zones, high yields, early maturity, drought tolerance, pests and disease resistance. In comparison to farmers who had a negative perception, the majority of farmers had a positive perception of access to services, technological characteristics and the institutional environment for the adoption of improved groundnut cultivars.

The findings support the theories that guided this study. FRN principles were observed by FRN group members through their participation in carrying out on-farm trials and collaboration with other players in the

networks. FRN members participated in project implementation that facilitated the adoption of improved groundnut cultivars. This is in line with the social network diffusion theory, which posits that people are embedded in an interactive network, and potential innovators' attitudes are influenced by social inspiration since diffusion follows a complex contagion pattern whereby farmers tend to adopt a new technology provided that the basis of information about that technology comes from multiple sources. Furthermore, FRN group members conducted on-farm research and learnt about and later on practised good agroecological practices about the cultivation of improved groundnut cultivars that support the innovation systems and Roger's theory of innovations. The innovation systems perspective postulates that learning occurs in networks and spreads to individuals and farmers, leading to innovation, whereby farmers typically learn on the farm about the performance and applicability of the innovation to farming systems, as well as the sustainability of the inputs and market for the produce, before accepting it. Similarly, Roger's innovation theory asserts that innovations with benefits, perceived compatibility with current practices and beliefs, low complexity, possible trialability, and observability will spread more quickly.

RECODA, the local government authorities in Singida rural district, and other development stakeholders should sensitize more farmers to form and join groups for them to get more access to education, information, agricultural inputs, credits, on-farm learning, a broader spectrum of external skills, networking and collaboration amongst different stakeholders and hence pave the way for wider adoption of agricultural innovations.

RECODA, the local government authorities in Singida rural district, and other development actors should ensure that improved groundnut seeds with the characteristics preferred by farmers are readily available and easily accessible on time to widen the adoption spectrum of improved groundnut cultivars.

RECODA, the local government authorities in Singida rural district, and other development stakeholders should take advantage of farmers' positive perceptions of access to services,

technological characteristics, and institutional environments to promote improved groundnut cultivars so that they are widely adopted by many more farmers.

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## CHAPTER FOUR

### 5.0 GENERAL DISCUSSION OF THE MAJOR FINDINGS

This chapter presents a summary of the discussion of the major findings emanating from the study conducted in Singida District, a semi-arid area of central Tanzania. The study intended to establish the determinants of the adoption of improved groundnut cultivars amongst FRN Project beneficiaries in Singida District.

#### 5.1 The role of FRN principles

The first specific objective was to assess how FRN guiding principles were applied in enabling farmers' adoption of improved groundnut cultivars. The study findings indicate that farmers' participation was higher during the the implementation of project activities than was the case when improved groundnut cultivars were first introduced into the project area. Farmers took part in the creation of FRN groups, the production of QDS for improved groundnut cultivars, the delivery of farmer-to-farmer extension services via farmers' visits, and the exchange of knowledge and resources (seeds), all of which aided in the adoption of improved groundnut cultivars in the study area. These findings are consistent with Hassen *et al.* (2019), who reported that approximately 96.7% of farmers experienced improved social interaction and increased technological diffusion through their participation in research networks. Similarly, Goswami *et al.* (2017) emphasized the importance of livelihood and ecological sustainability achieved by involving farmers in the decision-making process related to agricultural practices.

The study also showed that participatory on-farm research helped farmers in the study area adopt improved groundnut cultivars more quickly. In contrast to the situation before the start of the project, farmers were able to witness, understand, and adopt the innovation by cultivating and disseminating the improved groundnut cultivars. Other scholars have reported similar findings. Studies by Tao *et al.*

(2019), Nelson *et al.* (2019), and Hassen *et al.* (2019) indicated that on-farm research serves as a valuable tool for problem-solving and demonstration. This approach allows farmers to address farm management issues, learn empirically through observation and experimentation, and apply these practices to similar fields.

In addition, although the degree of interaction amongst players in FRN networks varied, this study revealed indications of cooperation and interaction between them. Some players had frequent interactions with farmers, whereas others had only sporadic or infrequent interactions. Joint research, learning, and resource sharing were recognized as the main forms of contact, along with village meetings, farmers' field days, stakeholder gatherings, quarterly coordination meetings, and community of practice gatherings. This partnership, along with farmers' involvement in participatory on-farm research, has helped to increase the adoption of improved groundnut cultivars in the study area. Similarly, Hassen *et al.* (2019) revealed that FRN significantly increased knowledge transmission, leading to a 97% adoption rate of push-pull technology (PPT) and a 96% improvement in social collaboration. Likewise, Nicklin *et al.* (2021) reported that the McKnight programme's communities of practice have facilitated social learning, providing diverse actors in Africa and the Andes with opportunities to enhance their adaptability in food system research and action.

## **5.2 The influence of seed accessibility on the adoption of improved groundnut cultivars**

The specific object two intended to determine the relationship between access to improved seeds and the adoption of improved groundnut cultivars. The results for this objective demonstrate that seed accessibility was extremely significant at  $p < 0.01$ . The results suggest that the likelihood of adopting improved groundnut cultivars increased by 114.12 units with an increase in seed accessibility. In comparison to indirect beneficiaries, the project's direct beneficiaries who are members of FRN groups had more access to seeds from improved groundnut cultivars. This is because of the FRN project

making it possible for the chosen FRN group members to reproduce and spread using improved groundnut seeds. Due to their status as group members, FRN group members received preference when it came to the time of distributing seeds. Selahkwe *et al.* (2021) similarly found that farmers who received improved seeds from non-governmental organizations were more likely to adopt the innovation compared to those who did not. Additionally, Lee (2020) noted that ensuring seed accessibility and raising awareness could increase the adoption rate by up to 30%.

### **5.3 Factors influencing the adoption of improved groundnuts cultivars**

Objective three intended to analyse the factors that influenced the adoption of improved groundnut cultivars among the beneficiaries of FRN Project. Age, sex, marital status, level of education, and income are socioeconomic factors that had no influence on farmers' adoption of improved groundnut cultivars in the study area. FRN group membership was significant at  $p < 0.05$ , indicating that being a direct beneficiary of the FRN group enhanced the likelihood of utilizing improved groundnut cultivars by 6.28 units. Similar to these findings, Kimaru *et al.* (2020) found that membership in social groups was a significant factor influencing the adoption of Zaipit technologies in the drier regions of upper Eastern Kenya. Additionally, Isra and Khan (2019) confirmed that being part of a farm service center positively affected the adoption of improved wheat seed innovations in Khyber Pakhtunkhwa.

In addition, according to the study results, technological traits (such as adaptability to agroecological zones, high yields, early maturity, drought tolerance, and resistance to pests and diseases) were highly significant at  $p < 0.01$ ; this indicated that shifting the technological traits of improved groundnut cultivars from undesirable to desirable increased farmers' propensity to adopt them by 14.93 units. According to the literature, Mnanje 2009 possesses unique qualities that appeal to customers, such as its high oil content (51%), high iron content (65.4 mg/kg), and sweetness when eaten raw or

cooked (Lukurugu *et al.*, 2021). These findings align with those of Mehmood and Khan (2021), who discovered that most farmers in Pakistan's Potwar Plateau preferred improved groundnut cultivars over traditional or local ones due to their superior yield, larger pod size, and better marketability.

The findings also showed that most farmers had positive perceptions of service accessibility, technological features, and the institutional framework for adopting improved groundnut cultivars. The study found that farmers had a positive perception of access to services for adopting improved groundnut cultivars, with mean scores of 2 and above indicating positive perceptions. Solutions to adoption constraints, such as availability, accessibility, and affordability, were suggested by Oluwatoyin (2021). Chandio and Jiang (2018) noted that credit availability was crucial for adopting improved wheat cultivars in Pakistan. Access to quality seeds, as Vabi *et al.* (2019) indicated, also facilitated adoption. This shows that farmers need access to information from multiple sources for technology adoption. Thus, services like seed access, on-farm learning, external skills, credit, and post-harvest infrastructure are key factors that were perceived to influence the adoption of improved groundnut cultivars.

Mean scores of 2 and above indicate that farmers view the technological characteristics of improved groundnut cultivars positively. Studies by Daudi *et al.* (2018) and Mwalongo *et al.* (2020) emphasized the superior qualities of these cultivars over local ones, including drought tolerance, pest and disease resistance, early maturity, high yield, large grain size, attractive color, good taste, high oil content, and good market price. These findings suggest that technological characteristics such as adaptation to agroecological zones, drought tolerance, pest and disease resistance, early maturity, and higher yields are preferred by farmers and are perceived to positively influence the adoption of improved groundnut cultivars.

The mean scores of 2 and above indicate that farmers had a positive perception of the institutional environment for adopting improved

groundnut cultivars. Key factors like markets, agro-input suppliers, credit facilities, subsidies, and extension services were important. Literature (Orr, 2018) highlights that efficient institutions, demanding markets, and favorable policies are crucial for adoption. Proximity to markets and strong export markets drive adoption (Ojiewo *et al.*, 2020). Additionally, fair subsidies and extension services boost adoption by enhancing interactions among breeders, traders, transporters, farmers, and suppliers (Liu *et al.*, 2020; Norton and Alwang, 2020). These findings suggest that the availability of credit facilities, subsidies and extension services is essential for interaction amongst players in FRN networks and hence was perceived to influence the adoption of improved groundnut cultivars.

## CHAPTER FIVE

### 6.0 General Conclusions and Recommendations

This chapter presents the conclusions and recommendations derived from the study conducted in the semi-arid Singida District of central Tanzania. The study aimed to identify the determinants influencing the adoption of improved groundnut cultivars amongst beneficiaries of the FRN Project in Singida District.

#### 6.1 Conclusion

These conclusions are drawn in light of the key study findings: Farmers collaboration with various players in the FRN network and participation in participatory on-farm research, demonstrated how the FRN's guiding principles, namely, farmers participation, usefulness of on-farm research, and collaboration amongst players in networks influenced the adoption of improved groundnut cultivars in Singida Rural District. It can be concluded that participation of farmers enhances ownership, success, the adoption of technologies, and sustainability of agricultural and non-agricultural projects. On-farm research provides the environment for farmers to learn by doing, and once the results of the research are usefulness and profitability of the research results encourage farmers to readily adopt the tested and approved technologies. Collaboration amongst actors in the networks is inevitable in the adoption process since, through collaboration, there is an interaction between actors in the value chain development.

Three aspects, including FRN group membership, seed accessibility, and technological qualities including adaptation to agroecological zones, high yields, early maturity, drought tolerance, and pest and disease resistance had a substantial impact on the adoption of improved groundnut cultivars. The lessons learned include the following, there are higher chances of farmers adopting technologies while they are in groups than is the case with individual farmers; since, group dynamics provide the environment for farmers to participate, conduct trials, learn from on-farm research, and

collaborate with different actors in the value chain development process. When there is a seed accessibility with technological qualities that are suitable for farmers, there are high chances of the adoption of the promoted technology by farmers.

The results support the theories that guided this research. Members of the FRN group participated in on-farm studies and worked with other network participants while adhering to FRN ideals. Members of the FRN took part in the project execution that promoted the adoption of improved groundnut cultivars. This is consistent with the social network diffusion theory, which holds that people are embedded in an interactive network and that potential innovators' attitudes are influenced by social inspiration because diffusion follows a complex contagion pattern and farmers tend to adopt new technologies as long as the information, they have about them is based on various sources. Additionally, FRN group members did on-farm research, learned about, and then put into practice effective agroecological practices regarding the growth of improved groundnut cultivars that complement Roger's theory of innovations and innovation systems. According to the perspective of innovation systems, learning happens in networks and spreads to people and farmers, resulting in innovation. Before adopting an innovation, farmers typically learn about its effectiveness and applicability to farming systems, as well as the sustainability of the inputs and the market for the produce, on the farm. Similar to this, Roger's innovation theory contends that innovations will spread faster if they are advantageous, and are considered compatible with the existing habits and beliefs, are simple, are potentially trialable, and are observable.

## **6.2 Recommendations**

The study suggests the following in light of the aforementioned findings:

- (1) RECODA and the District, Ward, and village governments should take deliberate efforts of ensuring that farmers engage in the project conception process by negotiating project proposals

during the preliminary discussions held at these levels. There could be farmers' representatives at those initial meetings in addition to the DALFO headquarters and local government agencies. Other FRN actors who can bring value to improved groundnut cultivars should be included in the network. Consumers, processors, merchants, transporters, quality inspectors, political decision-makers, the media, financial institutions, researchers, basic/foundation seed producers, certified seed producers, breeders, QDS producers, and export aggregators are some examples of these actors. While adhering to agroecological methods and mindful of sustainable energy and environmental preservation, RECODA should make sure that collaboration is reinforced by having regular farmers' meetings with additional participants in a network of the improved groundnut value chains.

- (2) To broaden the adoption spectrum of improved groundnut cultivars, RECODA, the government, and other development actors should make sure that improved groundnut seeds with the qualities preferred by farmers are readily and freely accessible and on time.
- (3) In order to increase farmers' access to education, information, agricultural inputs, credit, on-farm learning, a wider range of external skills, networking, and collaboration amongst various stakeholders, RECODA, the government, and other development stakeholders should encourage more farmers to form and join groups. This will open the door for a broader adoption of agricultural innovations. To encourage farmers to adopt improved groundnut cultivars, RECODA, the government, and other development players should capitalize on farmers' positive perceptions of service accessibility, technological features, and institutional contexts.

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**APPENDICES****Appendix 1: A Questionnaire for Farmers****SOKOINE UNIVERSITY OF AGRICULTURE****COLLEGE OF AGRICULTURE  
DEPARTMENT OF AGRICULTURAL EXTENSION AND  
COMMUNITY DEVELOPMENT**

**Chilewa Humphrey Shadrack. (MSc-Agricultural Extension)  
Research title: Determinants of adoption of improved  
groundnut cultivars amongst smallholder farmers research  
networks in Singida rural district of the central Tanzania**

**Consent**

My name is Chilewa Humphrey Shadrack, a Master student at Sokoine University of Agriculture. As part of the requirements of the programme, I am conducting a study on adoption of improved groundnut cultivars amongst FRN Project beneficiaries in Singida Rural District. Being amongst the primary stakeholders, I request you to participate in this study through interviews. It is expected that this interview will take about between 30 to 40 minutes and the information gathered will only be used for the purpose of the study. In addition, your identity and answers will be kept **confidential**.

Are you willing to participate in this study? Yes  No

Questionnaire Number: .....

Village: ..... Ward: .....

District:

.....

**PART A: Respondent General Information**

1. Respondent's sex. (Tick ✓)
  - i. Male [ ]
  - ii. Female [ ]
  
2. Respondent's age (in years).....
  
3. Education level of respondent. (Tick ✓)
  - i. Primary level [ ]
  - ii. Secondary level [ ]
  - iii. Certificate level [ ]
  - iv. Diploma level [ ]
  - v. Degree level [ ]
  - vi. Never attended school [ ]
  
4. Respondents' marital status. (Tick ✓)
  - i. Married [ ]
  - ii. Single [ ]
  - iii. Divorced [ ]
  - iv. Widow [ ]
  - v. Widower [ ]
  
5. Respondents' occupation (Tick ✓ all applicable)
  - i. Farmer [ ]
  - ii. Livestock keeper [ ]
  - iii. Public servant [ ]
  - iv. Petty business [ ]
  - v. All of the above [ ]
  - vi. Others [ ] Specify: .....
  
6. What is your major sources income? (Tick ✓)
  - i. Agriculture [ ]

- ii. Employment [ ]
- iii. Business [ ]
- iv. Casual labour [ ]
- v. Others [ ] (specify) \_\_\_\_\_

7. For how long have you been involved in farming activities?  
(Tick√)

- i. Less than 2 years [ ]
- ii. 3 to 5 years [ ]
- iii. 6 to 10 years [ ]
- iv. Above 10 years [ ]

8. Do you own agricultural land?

- i. Yes [ ]
- ii. No [ ]

9. If yes from question 8, how many plots do you own?.....

10. What is the size (in acres) of each plot?

Plot	Size (in acres)	Plot	Size (in acres)
1		6	
2		7	
3		8	
4		9	
5		10	

11. If you don't own land, how do you get access to land for agricultural activities?

-----  
 -----  
 -----

**PART B: FRN guiding principles in enabling farmers' adoption of improved groundnut cultivars**

12. Do you know FRN project implementation guiding principles?  
(Tick√)

- i. Yes [ ]
- ii. No [ ]

13. If yes from question 12 what are those FRN guiding principles?  
(Tick√ all applicable)

- i. Farmer participation [ ]
- ii. Usefulness of crop research [ ]
- iii. Collaboration amongst players in networks [ ]

14. How did you participate during introduction of FRN improved groundnut project? (Tick√)

- i. Manipulation = educated/made to believe the project is good [ ]
- ii. Therapy = convinced there is a problem to address [ ]
- iii. Informing = no negotiation meeting [ ]
- iv. Consultation = our ideas/concerns not taken into account [ ]
- v. Placation = limited degree to influence decisions [ ]
- vi. Partnership = Negotiate better ideas/share funding [ ]
- vii. Delegated power = some degree of control/management [ ]
- viii. Citizen power = govern a program/project to take full charge [ ]

15. Mention how did you participate during implementation of FRN improved groundnut project.

-----  
-----  
-----

16. What is your opinion with regard to farmer participation in enhancing adoption of improved groundnut cultivars?

i. During introduction process of improved groundnut project

.....  
.....  
.....

ii. During implementation and evaluation of improved groundnut project

.....  
.....  
.....

17. Is research on improved groundnut cultivars useful in enhancing adoption? (Tick✓)

i. Yes [ ]

ii. No [ ]

18. If yes from question 17, state the reasons why.

.....  
.....  
.....

19. If no from question 17, state the reasons why.

.....  
.....  
.....

20. How do you collaborate/interact with other key players in networks of FRN improved groundnut project?



21. Do you receive any agricultural inputs from the sustainable sources? (Tick✓)
- i. Yes [ ]
  - ii. No [ ]
22. If yes from question 21, from whom do you receive agricultural inputs? (Tick✓)
- i. Government Institutions [ ]
  - ii. NGOs [ ]
  - iii. Agricultural inputs company [ ]
  - iv. From the Project [ ]
  - v. Others [ ] (mention):.....
23. What type of Resources do you receive? (Tick✓ all applicable)
- i. Agricultural credits [ ]
  - ii. Seeds [ ]
  - iii. Manure [ ]
  - iv. Agricultural equipment [ ]

**PART C: Relationship between access to improved seeds and adoption of improved groundnut cultivars**

24. Did you initially receive improved groundnut seeds from the project for multiplication? (Tick✓)
- i. Yes [ ]
  - ii. No [ ]
25. If yes from question 24, have you given out the improved groundnut seeds to other farmers?
- i. Yes [ ]
  - ii. No [ ]
26. Do you currently grow improved groundnut cultivars? (Tick✓)
- i. Yes [ ]
  - ii. No [ ]

27. If yes from question 26, what groundnut cultivars do you grow? (mention):

-----  
 -----  
 -----  
 -----  
 -----  
 -----

28. If you currently grow improved groundnut cultivars, from whom do you get the seeds? (tick all that apply)

- i. Government Institutions
- ii. NGOs
- iii. Agricultural inputs company
- iv. From the Project
- v. Others (mention):.....

29. If currently you do not grow improved groundnut cultivars, what are the reasons?

.....  
 .....  
 .....  
 .....  
 .....  
 .....

30. Please indicate your agreement or disagreement with the following statements related to access to improved groundnut seeds by putting a tick in the response that reflects the most coincides with your opinions.

S/No	Item	SA	A	N	D	SD
		5	4	3	2	1
1	Improved groundnut seeds are readily available in our project area (availability)					
2	Improved groundnut seeds are sold at					

	fair price I can afford to buy (affordability)					
3	Improved groundnut seeds are tailored to the needs of smallholder farmers (suitability)					
4	I can build a profitable business by venturing in improved groundnut seeds (profitability)					
5	I have the capacity and enabling environment to deal with production of improved groundnut seeds through a diversity of extension services and capacity building (Capability)					
6	I am a farmer who is not only an end user but also a producer of improved groundnut seeds and sources of innovation (Autonomy)					

31. In your opinion do you think if improved groundnut seeds are readily accessible, will more farmers adopt the innovation? (Tick✓)

- i. Yes [ ]
- ii. No [ ]

32. If no from question 30, provide the reasons why?

.....

.....

.....

.....

**PART D: Factors influencing adoption of improved groundnut cultivars**

33. Is there any institution/organization dealing with agricultural issues working with the community in this area? (Tick✓)

- i. Yes [ ]

ii. No

34. If yes from question 32, List all institutions found to this Area.  
(Tick✓ all applicable)

- i. Agro-company
- ii. Religious Institution
- iii. RECODA
- iv. World Vision
- v. SEMA
- vi. Others (mention):.....

35. Is there any institution/company involved in processing of improved groundnuts in this area? (Tick✓)

- i. Yes
- ii. No

36. To where/whom do you sell your farm produce/products from the improved groundnut cultivars?  
.....

37. If you sell to the market in question 35, what is the distance range from your farm/demo plot to the Market? (Tick✓)

- i. 5-10 km
- ii. 10-15 km
- iii. 15- 20 km
- iv. 20-25 km
- v. 25-30 km
- vi. Other: Specify (km):.....

38. Please show how the following influence the adoption of improved groundnut cultivars by indicating your agreement or disagreement opinion.

NB 5: SA= Strongly Agree, 4: A= Agree, 3: N=Neutral 2: D= Disagree, 1: SD= Strongly Disagree

S/No	Item	SA	A	N	D	SD
		5	4	3	2	1
1	I have/have an access to improved groundnut seeds					
2	Access to improved groundnut seeds influences its adoption positively					
3	Multiple connection to improved groundnut seeds influences its adoption positively					
4	I have an access to sustainable agro inputs suppliers					
5	Access to sustainable agro inputs suppliers positively influences adoption of improved groundnuts					
6	I have an access to the market of improved groundnut					
7	Access to the market of improved groundnuts influences its adoption positively					
8	I have an access to on the farm learning regarding improved groundnut cultivars					
9	Access to on the farm learning regarding improved groundnut cultivars influences its adoption positively					
10	I have an access to information regarding improved groundnut cultivars from multiple sources					
11	Access to information regarding improved groundnut cultivars from multiple sources influences its adoption positively					
12	I have an access to broader spectrum of external skills concerned with improved groundnut cultivars					
13	Broader spectrum of external skills concerned with improved groundnut					

	cultivars influences its adoption positively					
14	I have an access to credit facilities					
15	Access to credit facilities positively influences adoption of improved groundnut cultivars					
16	I have an access to extension services					
17	Access to extension services positively influences adoption of improved groundnut cultivars					
18	I have an access to communication channel					
19	Access to communication channel positively influences adoption of improved groundnut cultivars					
20	I have an access to post-harvest infrastructure					
21	Access to post-harvest infrastructure positively influences adoption of improved groundnut cultivars					
22	I actively participated during planning and implementation of FRN project					
23	Active participation during planning and implementation of FRN project positively influences adoption of improved groundnut cultivars					
24	There is collaboration amongst players in networks of FRN project					
25	Collaboration amongst players in networks of FRN project positively influences adoption of improved groundnut cultivars					
26	I have an access to providers of the technology					
27	Access to providers of the technology positively influences adoption of improved groundnut					

	cultivars					
28	Improved groundnuts were/are promoted in our area					
29	More promotion of improved groundnut cultivars is required for more farmers to be aware and adopt					

39. Please indicate your agreement or disagreement with the following statements by putting a tick in the response that reflects the most coincides with your opinions.

NB 5: SA= Strongly Agree, 4: A= Agree, 3: N=Neutral 2: D= Disagree, 1: SD= Strongly Disagree

S/No	Item	SA	A	N	D	SD
		5	4	3	2	1
1	Improved groundnut cultivars were introduced as a demand driven project					
2	Improved groundnut cultivars are adaptive to our agro-ecological zones					
3	Improved groundnut cultivars are more drought tolerant than local cultivars					
4	Improved groundnut cultivars are more diseases and pests resistant than local cultivars					
5	Improved groundnut cultivars mature earlier than local cultivars					
6	Improved groundnut cultivars have higher yields than local cultivars					
7	Farmers prefer improved groundnut cultivars more than local cultivars					
8	Farmer research networks enhance adoption of improved groundnut cultivars					
9	Extension service providers have influence on adoption of improved groundnut cultivars					

10	Contact/lead farmers have influence on adoption of improved groundnut cultivars					
11	Physical distance influence interaction amongst key players in networks					
The influence of institutional environment;						
12	Availability of markets influences interaction amongst key players in networks and hence affect adoption of improved groundnut cultivars					
13	Availability of agro input suppliers influences interaction amongst key players in networks and hence affect adoption of improved groundnut cultivars					
14	Availability of credit facilities influences interaction amongst players in networks and hence affect adoption of improved groundnut cultivars					
15	Availability of subsidies influences interaction amongst players in networks and hence affect adoption of improved groundnut cultivars					
16	Availability of extension services influences interaction amongst players in networks and hence affect adoption of improved groundnut cultivars					

40. In your opinion what do you comment with regard to adoption of improved groundnut cultivars?

.....  
 .....  
 .....

**THIS IS THE END OF THE INTERVIEW AND THANK YOU FOR YOUR COOPERATION**

## **Appendix 2: Checklist for Key Informant Interview (KII)**

### **PART A: Respondent General Information**

**i. Date of interview.....**

**ii. Sex of the key informant.....**

**iii. Position.....**

1. How long have you been working with FRN project in this area?
2. What is your position and roles with regard to FRN project in this area?

### **PART B: FRN guiding principles in enabling farmers' adoption of improved groundnut cultivars**

1. What do you understand by FRN guiding principles?
2. How do you apply these principles in facilitating adoption of improved groundnut cultivars in the project area? (Probe for each principle)
3. Who are the key players in FRN project in this area?
4. What are their respective (key players) roles?
5. How do the key players (stakeholders) above collaborate/interact in networking to enhance adoption of improved groundnut cultivars?
6. What are successes and challenges with regard to the application of FRN guiding principles in the project area? (Probe for each principle)
7. What else can you tell regarding application of FRN principles in facilitating adoption of improved groundnut cultivars?

**PART C: Relationship between access to improved seeds and adoption of improved groundnut cultivars**

1. How improved groundnut seeds were introduced in the project area?
2. How did the seeds spread from the primary recipients to other project beneficiaries?
3. What do you think are the achievements with regard to groundnut seed multiplication and spreading from the primary recipients to other project beneficiaries? (Probe for multiplication and spreading separately).
4. What are the challenges with regard to seed multiplication and spreading from the primary recipients to other project beneficiaries? (probe for multiplication and spreading separately)
5. How can availability of improved groundnut seeds enhance farmers' adoption? (Probe where groundnut seeds are obtained, distance factor etc.)
6. How can affordability of improved groundnut seeds enhance farmers' adoption? (Probe on price, farmers purchasing power etc.)

7. How can suitability of improved groundnut seeds enhance farmers' adoption? (Probe to know whether improved groundnut seeds are tailored to the needs of smallholder farmers or not)
8. How can profitability of improved groundnut seeds enhance farmers' adoption? (Probe the possibility of building profitable business by venturing in improved groundnut seeds)
9. How can capability on improved groundnut seeds enhance farmers' adoption? (Probe on the capacity and enabling environment to deal with production of improved groundnut seeds through a diversity of extension services and capacity building)
10. How can autonomy on improved groundnut seeds enhance farmers' adoption? (Probe to know whether farmers are not only end users but also producers of improved groundnut seeds and sources of innovation)
11. What else do you know regarding access to improved seeds and adoption of improved groundnut cultivars?

**PART D: Factors influencing adoption of improved groundnut cultivars**

1. How do the farmers' characteristics influence adoption of improved groundnut cultivars in the project area?
  - i. Age
  - ii. Gender
  - iii. Level of education
  - iv. Attitude
  - v. Perception
  - vi. Preference
2. How do the techno-ecological characteristics influence adoption of improved groundnut cultivars in the project area?
  - i. Yield/Production
  - ii. Drought tolerance
  - iii. Disease resistance

- iv. Pest resistance
  - v. Climate
  - vi. Lack of optimal and immediate results from experimentation/trials
3. How do the institutional and infrastructural factors influence adoption of improved groundnut cultivars in the project area?
- i. Managerial structure
  - ii. Availability of market
  - iii. Availability of inputs/inputs suppliers
  - iv. Availability of seeds
  - v. Availability of extension services
  - vi. Availability of credit facilities
  - vii. Post-harvest infrastructure
4. How do the socio-economic factors influence adoption of improved groundnut cultivars in the project area?
- i. Income
  - ii. Seed cost
  - iii. Seed price
  - iv. Human capital
  - v. Policy issues
5. How do the informational factors influence adoption of improved groundnut cultivars in the project area?
- i. Access to agricultural information
  - ii. Linkage between knowledge providers and farmers
  - iii. Mass media exposure
  - iv. Human capital
  - v. Policy issues
6. How do the natural resources characteristics influence adoption of improved groundnut cultivars in the project area?
- i. Land/type of the soil
  - ii. Water sources for irrigation

- iii. Vegetation cover/forest/wild flora
- iv. Animals/wild fauna

7. What are the factors influencing adoption of improved groundnut cultivars in the project area?

**THIS IS THE END OF THE INTERVIEW AND THANK YOU FOR  
YOUR COOPERATION**

### **Appendix 3: Checklist for Focus Group Discussion (FGD)**

#### **PART A: Respondents/Group General Information**

##### **i. Date of interview.....**

##### **ii. Name of the group.....**

1. When were the FRN groups formed?
2. How many members does the group have (male/female)?
3. How many were the founding members?
4. How long did it take to have the highest number of members?
5. How many have dropped out since the group started?
6. What are the activities performed in your group?

#### **PART B: FRN guiding principles in enabling farmers' adoption of improved groundnut cultivars**

1. What do you understand by FRN guiding principles?
2. How do you apply these principles in facilitating adoption of improved groundnut cultivars in the project area? (Probe for each principle)
3. Who are the key players in FRN project in this area?
4. What are their respective (key players) roles?
5. How do the key players (stakeholders) above collaborate/interact in networking to enhance adoption of improved groundnut cultivars?
6. What are successes and challenges with regard to the application of FRN guiding principles in the project area? (Probe for each principle)
7. What else can you tell regarding application of FRN principles in facilitating adoption of improved groundnut cultivars?

#### **PART C: Relationship between access to improved seeds and adoption of improved groundnut cultivars**

1. How improved groundnut seeds were introduced in the project area?

2. How did the seeds spread from the primary recipients to other project beneficiaries?
3. What do you think are the achievements with regard to groundnut seed multiplication and spreading from the primary recipients to other project beneficiaries? (Probe for multiplication and spreading separately).
4. What are the challenges with regard to seed multiplication and spreading from the primary recipients to other project beneficiaries? (probe for multiplication and spreading separately)
5. How can availability of improved groundnut seeds enhance farmers' adoption? (Probe where groundnut seeds are obtained, distance factor etc.)
6. How can affordability of improved groundnut seeds enhance farmers' adoption? (Probe on price, farmers purchasing power etc.)
7. How can suitability of improved groundnut seeds enhance farmers' adoption? (Probe to know whether improved groundnut seeds are tailored to the needs of smallholder farmers or not)
8. How can profitability of improved groundnut seeds enhance farmers' adoption? (Probe the possibility of building profitable business by venturing in improved groundnut seeds)
9. How can capability on improved groundnut seeds enhance farmers' adoption? (Probe on the capacity and enabling environment to deal with production of improved groundnut seeds through a diversity of extension services and capacity building)
10. How can autonomy on improved groundnut seeds enhance farmers' adoption? (Probe to know whether farmers are not only end users but also producers of improved groundnut seeds and sources of innovation)
11. What else do you know regarding access to improved seeds and adoption of improved groundnut cultivars?

**PART D: Factors influencing adoption of improved groundnut cultivars**

1. How do the farmers' characteristics influence adoption of improved groundnut cultivars in the project area?
  - i. Age
  - ii. Gender
  - iii. Level of education
  - iv. Attitude
  - v. Perception
  - vi. Preference
  
2. How do the techno-ecological characteristics influence adoption of improved groundnut cultivars in the project area?
  - i. Yield/Production
  - ii. Drought tolerance
  - iii. Disease resistance
  - iv. Pest resistance
  - v. Climate
  - vi. Lack of optimal and immediate results from experimentation/trials
  
3. How do the institutional and infrastructural factors influence adoption of improved groundnut cultivars in the project area?
  - i. Managerial structure
  - ii. Availability of market
  - iii. Availability of inputs/inputs suppliers
  - iv. Availability of seeds
  - v. Availability of extension services
  - vi. Availability of credit facilities
  - vii. Post-harvest infrastructure
  
4. How do the socio-economic factors influence adoption of improved groundnut cultivars in the project area?
  - i. Income
  - ii. Seed cost

- iii. Seed price
  - iv. Human capital
  - v. Policy issues
5. How do the informational factors influence adoption of improved groundnut cultivars in the project area?
- i. Access to agricultural information
  - ii. Linkage between knowledge providers and farmers
  - iii. Mass media exposure
  - iv. Human capital
  - v. Policy issues
6. How do the natural resources characteristics influence adoption of improved groundnut cultivars in the project area?
- i. Land/type of the soil
  - ii. Water sources for irrigation
  - iii. Vegetation cover/forest/wild flora
  - iv. Animals/wild fauna
7. What are the factors influencing adoption of improved groundnut cultivars in the project area?

**THIS IS THE END OF THE DISCUSSION AND THANK YOU FOR  
YOUR COOPERATION**