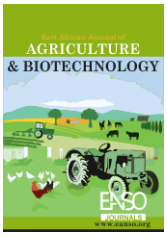

East African Journal of Agriculture and Biotechnology
eajab.eanso.org
Volume 6, Issue 1, 2023
p-ISSN: 2707-4293 | e-ISSN: 2707-4307
Title DOI: https://doi.org/10.37284/2707-4307

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Knowledge, Attitude and the Practice of Climate-Smart Agriculture among Smallholder Farmers in Isingiro District, South Western Uganda

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Article DOI: https://doi.org/10.37284/eajab.6.1.1154

Date Published:

30 March 2023

Keywords:

Knowledge, Attitude, Practice, Climate-Smart Agriculture.

ABSTRACT

Climate Smart Agriculture (CSA) can sustainably increase productivity, improve resilience, and reduce emissions of greenhouse gases from agricultural systems. The current study aimed to establish the existing knowledge, attitude, and practice of CSA among smallholder farmers in the Isingiro District. An exploratory survey was conducted to collect data from 126 farmers randomly selected from three Sub counties. Key informant interviews were conducted with three extension workers for more information. Data was analysed using Stata 14 to generate summary tables and the Chi-square test of independence. The results revealed a high level of knowledge about CSA among the farmers, with intercropping and crop rotation as the most popular (99%) whereas rainwater harvesting was least known (71.4%). Farmers' knowledge about CSA was significantly related to different sources of information and knowledge ($P<0.05$). Farmers showed a positive attitude towards the use of CSA practices except for inorganic fertilisers with 45%. The dominantly used CSA practices were Intercropping (85.7%), mulching (75.4%) and the use of contour bunds (74.6%). Several limitations that hindered the adoption of CSA practices included limited finances, extension services, availability of CSA inputs, high prices of CSA inputs, price fluctuations and land scarcity, among others. The farmers' awareness, attitude and practice of CSA were mainly shaped by their local knowledge with limited influence of technical knowledge. Furthermore, the practice of CSA among smallholder farmers is hampered by many limitations. Therefore, there is a need for policymakers to prioritise and enact pro-CSA-relevant policies that address the barriers hampering its adoption.

APA CITATION

Aturihaihi, C., Tumwesigye, T., Opio, F. & Beyihayo, G. A. (2022). Knowledge, Attitude and the Practice of Climate-Smart Agriculture among Smallholder Farmers in Isingiro District, South Western Uganda. *East African Journal of Agriculture and Biotechnology*, *5*(1), 82-97. https://doi.org/10.37284/eajab.6.1.1154

Article DOI: https://doi.org/10.37284/eajab.6.1.1154

CHICAGO CITATION

Aturihaihi, Christine, Wycliffe Tumwesigye, Fina Opio and Geoffrey Akiiki Beyihayo. 2023. "Knowledge, Attitude and the Practice of Climate-Smart Agriculture among Smallholder Farmers in Isingiro District, South Western Uganda". *East African Journal of Agriculture and Biotechnology* 6 (1), 82-97. https://doi.org/10.37284/eajab.6.1.1154

HARVARD CITATION

Aturihaihi, C., Tumwesigye, T., Opio, F. & Beyihayo, G. A. (2023) "Knowledge, Attitude and the Practice of Climate-Smart Agriculture among Smallholder Farmers in Isingiro District, South Western Uganda", *East African Journal of Agriculture and Biotechnology*, 6(1), pp. 82-97. doi: 10.37284/eajab.6.1.1154.

IEEE CITATION

C. Aturihaihi, T. Tumwesigye, F. Opio, & G. A. Beyihayo, "Knowledge, Attitude and the Practice of Climate-Smart Agriculture among Smallholder Farmers in Isingiro District, South Western Uganda", *EAJAB*, vol. 6, no. 1, pp. 82-97, Mar. 2023.

MLA CITATION

Aturihaihi, Christine, Wycliffe Tumwesigye, Fina Opio & Geoffrey Akiiki Beyihayo. "Knowledge, Attitude and the Practice of Climate-Smart Agriculture among Smallholder Farmers in Isingiro District, South Western Uganda". *East African Journal of Agriculture and Biotechnology*, Vol. 6, no. 1, Mar. 2022, pp. 82-97, doi:10.37284/eajab.6.1.1154.

INTRODUCTION

Climate change and variability are major challenges facing the agricultural sector around the world with the potential to affect development goals (Echeverría, 2016). Local communities dependent on agriculture are among those at higher risk of the consequences of global warming of 1.5 ^{o}C and beyond (Intercontinental Panel on Climate Change, 2022). With the recent projected global population growth from a current 7.7 billion to 9.7 billion people by 2050 (United Nations Population Division, 2019), it is challenging to ensure sufficient food production to match the growing population amidst changing climates. This challenge is most acute in developing countries, especially in Africa, which has exhibited the highest population growth (UNPD, 2019). Addressing this scenario will require supporting farmers to increase food production without aggravating the climate change situation (Tumwesigye et al., 2019). Across Uganda, climate change has manifested in erratic weather patterns with expected intense trends and complicated agricultural decisions by 2050 (Uganda Climate Action Report, 2015). According to World Bank (2020), nine (9) events of drought were recorded between 1900 and 2020. With such trends, it will be hard for Uganda to achieve its Vision 2040 and the SDGs unless climate change is addressed. It is predicted that warming may reach up to 2^{o}C increase, which is likely to affect crop production and increase crop pests and diseases (United States Agency for International Development, 2013). Food production is more likely to reduce by 2050 as a result of seasonal changes in weather patterns in Uganda due to a fall in average yields of common food crops (Ramirez-villegas & Thornton, 2015; World Bank, 2020).

In particular, the Isingiro district has experienced severe effects of climate change with increased incidences of drought, changing of crop growing seasons, increased incidences of pests and diseases as well as soil erosion (Nagasha et al., 2019). With the majority of smallholder farmers in the district depending on agriculture for survival (Uganda Bureau of Statistics, 2016), building their adaptive capacity and resilience to climate change is vital to ensure household food and income security. This makes it imperative for farmers to increase their resilience by adjusting their farming practices in order to avoid the feared risks in future (World Bank, 2017).

Climate Smart Agriculture (CSA) is an approach for transforming and re-orienting agricultural production systems to sustain agricultural production under the changing climate (Food and Agriculture Organization, 2014). It involves those practices that have the potential to sustainably

Article DOI: https://doi.org/10.37284/eajab.6.1.1154

increase productivity, strengthen the resilience of farming systems to climate change and reduce emissions of GHG from agricultural fields (De Pinto et al., 2020). It is not a prescription of particular agricultural technologies or practices that are collectively applicable but rather a tool to help farmers locally adjust their farming operations to sustain production under climate change (Lipper & Zilberman, 2018). According to Collins-Sowah (2018) and Lipper et al. (2014), a CSA technology or practice can promote mitigation roles and any other one of the two pillars or both. Njeru et al. (2016) highlighted a number of CSA practices in Uganda. Unpredictable weather conditions and the resultant impacts on agriculture have pushed farmers to adjust their methods of production in order to survive (Uganda Climate Action Report, 2015; Fagariba et al., 2018 & USAID, 2013). However, the knowledge of CSA remains low across most of Africa (Njeru et al., 2016), and the approach is rarely taught, even in Universities. The level of knowledge about CSA practices among farmers positively influences adoption rates (Maguza-Tembo et al., 2017 & Rubongoya, 2019). Due to a lack of access to appropriate information, farmers tend to apply different strategies until an appropriate combination that can sustain productivity is got (Mubiru et al., 2015 & Zizinga et al., 2017). The incorporation of CSA into the extension programs of some countries is still overshadowed by conventional farming techniques that do not conform to CSA pillars (Milder et al., 2011).

Although it is evident that farmers in Isingiro District are applying CSA practices (Tumwesigye et al., 2019), no research has been conducted to ascertain the level of knowledge and the farmers' attitude towards CSA among smallholder farmers in the district. This study was carried out to establish the existing knowledge, attitude, and practice of Climate Smart Agriculture practices among smallholder farmers in the Isingiro District.

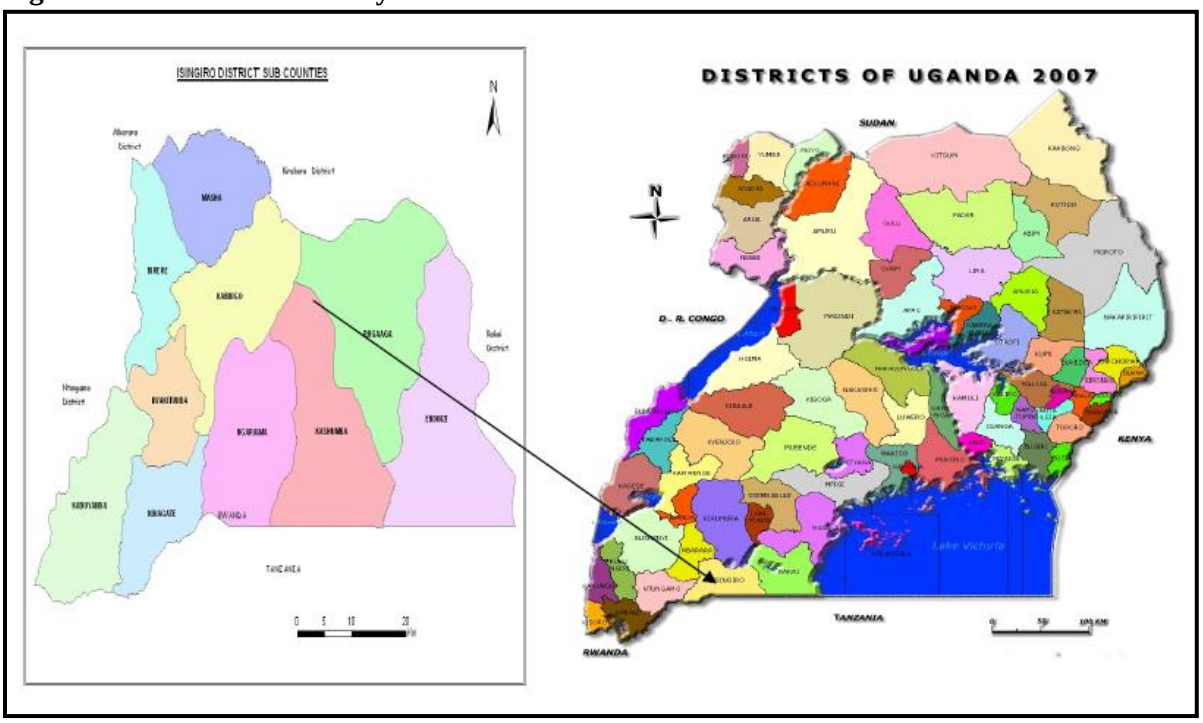
METHODOLOGY

Study Area

The study was carried out in 3 Sub counties of Masha, Birere and Nyamuyanja of Isingiro North Constituency, Isingiro District. The constituency has a population of 122,784 persons and 26,789 households (UBOS, 2017). The study area falls within the dry cattle corridor with two rainy seasons, i.e., March to April and September to November. More than 80% of the district's population of 517,800 depend on rain-fed subsistence agriculture as the main source of livelihood (UBOS, 2016). The nature of the soils, together with frequent droughts, tends to adversely affect crop production with implications on household food and income security. The main crops produced by farmers are bananas, maise, potatoes, beans, pineapples, and coffee with the majority of crop production activities done in the rainy season because agriculture in the district is mostly rain-fed and at the subsistence level.

Article DOI: https://doi.org/10.37284/eajab.6.1.1154

Figure 1: Location of the study area



Household Survey

An exploratory survey was conducted in the study area. Structured questionnaires were used to collect data from 126 households. This sample size was determined from the total population of households in the study area using the formula proposed by Yamane (1967) below.

$$n = \frac{N}{1+N(e^2)}$$

Where n = Sample size, N = Total population of households in the sub-county, and e = error tolerance (was set at 10%). Considering a population of 26,789 households (UBOS, 2017), a sample of 99 households was generated. However, a sample of 126 households was used for the study to easily assess the representativeness of the sample and generalise the results.

Surveyed households were randomly selected from Masha, Birere and Nyamuyanja Sub-counties, which are dominated by crop farmers. Surveys were conducted between September and October 2022. The Sub-counties were purposively selected based on knowledge of the area and agricultural practices, but the selection of farmers within Sub-counties was random. The generated information was backed by personal observations and key informant interviews from three extension workers.

Data Analysis

Data collected from observations and the household survey was analysed using descriptive statistics. Stata 14 was used to generate frequency tables, percentages, and column graphs to summarise and present the survey results.

RESULTS

Demographic Characteristics of Respondents

The current study acquired 100% response since all interviewed respondents were willing to provide the required information. The general characteristics of surveyed farmers are presented in *Table 1.*

Article DOI: https://doi.org/10.37284/eajab.6.1.1154

Table 1: Demographic characteristics of respondents

	Demographics	Frequency	Percent
Sex	M	60	47.62
	F	66	52.38
Age (years)	18-30	11	8.73
	30-40	36	28.57
	40-50	39	30.95
	50 and above	40	31.75
Household head	M	95	76.61
	F	29	23.39
Education level	None	9	7.14
	Primary	67	53.17
	Secondary	41	32.54
	Tertiary	9	7.14
Income level	≤200,000	71	56.35
	200,000-500,000	34	26.98
	≥500,000	21	16.67
Source of income	Farm	88	69.84
	Farm & business	26	20.63
	Farm & Employment	12	9.52
Farm size	≤ 1 acre	47	37.3
	2 acres	64	50.79
	3 acres	15	11.91

The results indicate that the majority of the respondents (66%) were females, dominated by older farmers of 40-50 years (30%) and above 50 years (31%). The sampled households were mainly headed by males (77%). The state of literacy of the farmers indicated that most of them (53%) had attained primary-level education. The majority of the sampled farmers (56%) earned less than 200,000 Uganda shillings per month, mainly generated from farming. The majority of the farmers (51%) owned approximately 2 acres of farmland on which they did agricultural activities.

Level of Knowledge, Attitude and the Practice of CSA

The second objective of the study was to find out the existing knowledge, attitude, and practice of Climate Smart Agriculture among smallholder farmers in the Isingiro District. The results in *Table 2* indicate which of the CSA practices farmers are knowledgeable about, their general attitude towards applying them and those which they are already practising in the study area. This was intended to establish smallholder farmers' ability to implement CSA practices at their disposal as well as establish possible barriers towards the adoption of some within their interest.

Article DOI: https://doi.org/10.37284/eajab.6.1.1154

Table 2: Knowledge, attitude, and practice of CSA among smallholder farmers

CSA Practice	Frequency			Percent		
	K	I	P	K	I	P
Use of quality planting materials	118	120	77	93.65	95.24	61.11
Intercropping	124	116	108	98.41	92.06	85.71
Using crop variety mixtures	121	90	68	96.03	71.43	53.97
Crop rotation	125	117	81	99.21	92.86	64.29
Mulching	125	122	95	99.21	96.83	75.40
Rainwater harvesting for crop use	90	100	11	71.43	79.37	8.73
Small scale irrigation	103	81	19	81.75	77.78	15.08
Contour bunds	121	114	94	96.03	90.48	74.60
Use of cover crops	104	90	66	82.54	71.43	52.38
Use of Farm yard manure	124	114	57	98.41	90.48	45.24
Use of compost manure	118	113	63	93.65	89.68	50.00
Use of inorganic fertilisers	117	57	7	92.86	45.24	5.56
Integrated pest management	101	92	62	80.16	73.02	49.21
Improved postharvest management techniques	96	92	46	76.19	73.02	36.51

Notes: K = Knowledge, I = Interested, P = Practicing

The results indicate the CSA practices which farmers are knowledgeable about, their attitude towards their use and those that they are already practising in the study area. This was intended to establish smallholder farmers' ability to implement CSA practices at their disposal and determine possible barriers towards the adoption of those within their interest.

The results show that farmers are very much knowledgeable about CSA practices but mainly mulching and crop rotation (99%) and less aware of rainwater harvesting for crop use (71.4%). However, it is important to note that farmers knew these practices as traditional practices that can improve productivity not as CSA. The concept of CSA was still new to most farmers. Results indicate that the majority of farmers generally portrayed a positive attitude towards the use of most CSA practices with 13 practices scoring more than ranging between 71.43 – 96.8%. However, farmers showed low interest towards the use of inorganic fertilisers (45.2%).

Despite the high level of knowledge and positive attitude, the level of practice for CSA practices was lower. The dominant practices were intercropping (85.7%), mulching (75.4%) and the use of contour bunds (74.6%). The use of inorganic fertilisers (5.6%), rainwater harvesting for crop use (8.7%) and irrigation (15.08%) was low among the smallholder farmers studied.

Sources of CSA information and knowledge among smallholder farmers

The study established the sources of information and knowledge among the farmers. The findings are shown in *Figure 2*.

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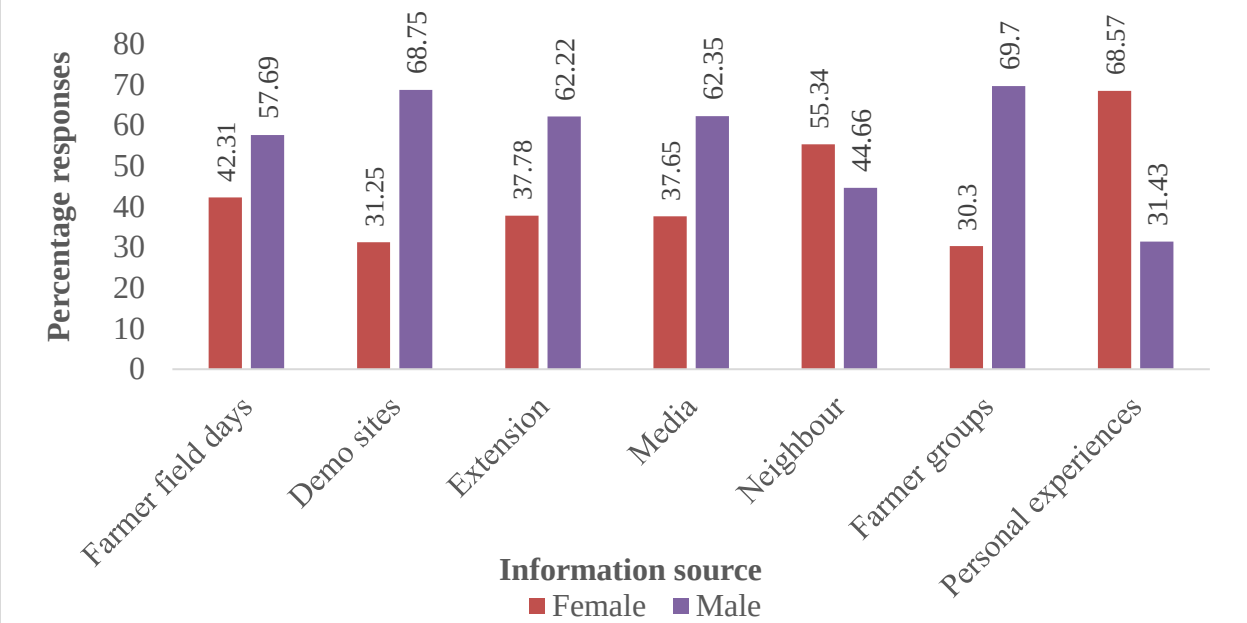
Figure 2: Sources of CSA information and knowledge among farmers

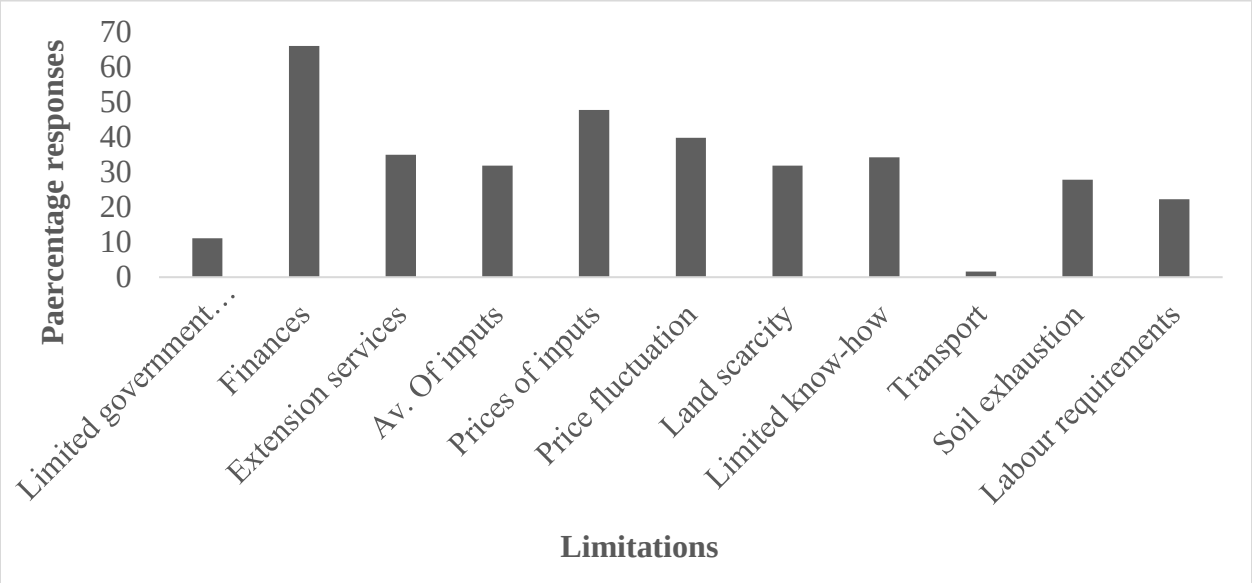


The results revealed that farmers acquired CSA information and knowledge from multiple sources. The major sources of information and knowledge were neighbours (81.75%), media (67.46%) and personal experiences 55.6%. Male farmers had more access to information and knowledge through field days (57.7%), demonstration centres (68.8%), extension agents (62.2%), media (62.3%) and farmer groups (69.7%) than their female counterparts.

Limitations Towards Use of CSA among Smallholder Farmers

The practice of Climate Smart Agriculture (CSA) among smallholder farmers was limited by many factors. The findings are presented in *Figure 3*.

Figure 3: Limitations of CSA adoption among farmers



Article DOI: https://doi.org/10.37284/eajab.6.1.1154

According to the current study, the major limiting factor was finances (65.9%). Other limitations included government support (11%), extension services (34.9%), high prices of CSA inputs (47.6%), availability of CSA inputs (31.7%), price fluctuations of farm products (39.7%), land scarcity (31.8%) technical know-how (34.1%), high labour requirements (22%), soil exhaustion (27.8%) and transportation of agricultural products (1.6%).

DISCUSSION

Demographic Characteristics of Respondents

The current study results show a higher involvement of elderly people in farming compared to the youth. The dominance of older people in farming could be advantageous because they are presumed to have gained more experience regarding the application of CSA practices (Guo et al., 2015). Older farmers are considered to have gained perfection over agronomic practices through trial and modification with the changing climatic conditions. The youths are less engaged in agriculture probably because of more livelihood opportunities at their disposal, which renders agriculture a less attractive option. Nevertheless, youths do not consider agriculture as a source of livelihood. The low involvement of youths in agriculture reported in the current study is in agreement with South Africa; older farmers willingly adopted irrigation as a Climate-smart technology (Serote et al., 2021). This confirms that older farmers are majorly engaged in farming activities than young ones.

The current study depicts a low-income status with the majority of households earning less than 200,000 Ugandan shillings monthly. The low-income levels of farmers conform to the fact that the majority of the farmers depend on agriculture with no alternative sources of income. In the face of climate change and other hindrances to production, the output from their small farms cannot feed the household and also generate income. The dominance of agriculture as a source of income among rural households in the current study is in agreement with the findings of UBOS (2022). The current study results also support the findings by Tumwesigye et al. (2019) regarding low household incomes in the Isingiro district.

It is noted from the results that most households owned small parcels of land of 2 acres and/or less. The small size of land holdings is probably because of the limited financial resources to enable the farmers to acquire large pieces of land. Farmers noted that land was very expensive, and therefore it was not easy for someone to purchase more land for expansion. Also, the traditional practice of sub-dividing land among children results in small land holdings (Niroula & Thapa, 2005). The small land holdings characteristic of farmers in the study area conforms to the statistics of UBOS (2022). The findings by Bagamba et al. (2012) also confirmed that land scarcity is a common challenge in Southwestern Uganda.

Farmers' Knowledge, Attitude and Practice of CSA

Farmers' Knowledge of CSA Practices

High knowledge levels of CSA practices among smallholder farmers ranged between 71.43 and 99.21%. Knowledge of the existence of innovation is the initial step in the journey to its adoption. This is because being aware of the practice and its benefits may encourage or discourage farmers from seeking to learn more about the practice and eventually adopting it (Acheampong et al., 2018). The high level of farmers' awareness about CSA from the study could be attributed to the reality of climate change disasters and the resultant effects, which has left farmers with no choice but to seek knowledge of coping with the situation. In addition, farmers have been exposed to various sources of information, including extension agents, farmer field days, exhibitions, and different forms of media, among others. This has increased information dissemination within rural communities. Increasing awareness of CSA

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processes and technologies in Africa was also reported by Kombat et al. (2021). On the other hand, the low level of farmers' knowledge about rainwater harvesting was also reported by Onwonga et al. (2013) and Oppong et al. (2021) in Kenya and Ghana, respectively.

The attitude of farmers towards CSA practices among smallholder farmers in the Isingiro District

Generally, a positive attitude was portrayed by smallholder farmers towards the adoption of CSA practices which is a good step towards climate change mitigation and adaptation. This shows the concern for farmers to adapt their farming systems to the changing climate for the sustenance of their livelihoods. This positive attitude of farmers could be attributed to the perceived and actual benefits attached to using different CSA practices. The positive attitude and willingness of farmers to adopt climate change adaptation strategies were also reported by Fagariba et al. (2018) and USAID (2013).

Farmers showed a high preference for the use of improved crop varieties, crop diversification, soil water conservation and soil fertility management in the current study. This was also reported by Thornton et al. (2018) and Atube et al. (2021). In the face of climate change, the use of crop varieties that can withstand drought or high temperatures offers a great advantage to farmers. In addition, improved varieties have a high-yielding potential which gives farmers good returns. Such good attributes draw the interest of farmers towards the use of improved crop varieties.

On the other hand, farmers showed a negative attitude towards the use of chemical fertilisers. Farmers' perceptions about a practice can influence them to adopt it or not as reported by Meshesha et al. (2022). Some farmers associated the use of inorganic fertilisers with soil degradation. This poor attitude could be attributed to information gaps among the farmers regarding the proper use of inorganic fertilisers. These can be addressed through improved extension services and training for farmers to impart the right knowledge. The high costs of inorganic fertilisers also make smallholder farmers show less interest towards using them.

The Practice of CSA among Smallholder Farmers in Isingiro District

The results of the current study indicated the dominance of soil water conservation practices mainly mulching and the use of contour bands among the farmers in the study area. The high level of practising mulching and contour bunds confirms the findings of (Tumwesigye et al., 2019). Mulching is a fundamental strategy for enhancing crop system resilience as it protects the soil against moisture losses (Sharpley, 2007). The high use of these practices could be attributed to intense drought and alternate periods of intense rainfall experienced in the area.

The current study reported 5.6% use of inorganic fertilisers among farmers. This could be attributed to limited finances to secure fertilisers. In addition, farmers associated inorganic fertiliser use with the destruction of soil quality, which could have discouraged some farmers from using them. The report of UBOS (2020) also reported the low use of fertilisers among farmers in Uganda. Organic manures, which form an important source of soil nutrients (Sathyanarayana, 2020), showed slightly low levels of practice (compost manure, 50% and farm yard manure, 45.24%). Farmers reported that the use of farm yard manure required continuous application at least once every year in order to realise maximum benefits.

> *"Animal manure is expensive; we cannot afford it; it can be used by rich farmers who have the capacity to buy or have cows at home",* explained one of the farmers in Birere Sub County.

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The current study also showed the dominance of inter and intra-specific crop diversification. The farmers reported the popularity of intercropping, use of crop variety mixtures and crop rotation among smallholder farmers in Isingiro District, with adoption ranging between 54 – 85%. Intercropping involves producing more than one crops on the same piece of land at the same time (Neamatollahi et al., 2013). Farmers testified that when using intercropping and mixed crop varieties, they suffered less risk of losses due to crop failure in case of bad weather.

> *"If one crop or variety fails, I can gain from the alternative crops for sale or consumption",* explained one of the farmers in Rukuuba Parish.

Therefore, crop diversification offers greater adaptation and resilience to climate-related stresses. Similarly, Renwick et al. (2020) also reported that maise and pigeon pea intercrop showed higher tolerance to drought compared to monoculture stands. It also supports the findings that intercropping increases yields in crops (Mousavi & Eskandari, 2011).

The practice of crop rotation was reported at 54.29%. However, based on field observations and interviews with farmers, it was noted that the general design of crop rotation was wrongly done. This could be attributed to land scarcity and the desire to produce food on the available land to feed the family every season.

> *"The land is small, yet every season I have to grow beans for my family; changing crops is not possible",* narrated one of the farmers in Kabaale Parish.

Land size is one of the conditions necessary for the successful design of crop rotation (Vishwakarma et al., 2020).

Inevitable risks as a result of climate change can be minimised by growing crop varieties with improved adaptability to reduce damage and increase yields (Simtowe et al., 2019). The current study results show 19.1% use of improved crop varieties among smallholder farmers in the Isingiro district.

> *"We use local seeds saved from the previous season for planting; improved seeds are expensive",* narrated one of the farmers.

> *"We used to plant improved varieties of maise and beans when the seeds were distributed by the government through its NAADS program",* she further explained.

This result is in line with findings by authors Yameogo et al. (2017) and Raile et al. (2021) that high costs of inputs can limit the adoption of CSA practices.

Sources of Information and Knowledge about CSA among Smallholder Farmers

Information is a powerful tool for enhancing the adoption of innovations and technologies. The availability of reliable information on CSA practices from formal support systems, neighbours or prior experience will determine farmers' ability or willingness to adopt CSA fully or optimally from the start (Gupta et al., 2021). The results of the current study show that farmers had access to information and knowledge about CSA from multiple sources. This is in line with the findings of Raile et al. (2021) in regard to the diversity of agricultural learning sources at the farmers' exposure.

The current study shows farmer-to-farmer interaction as a mode of information and knowledge transfer. Farmers testified

> *"We can learn and copy from our neighbours and implement on our farms".*

Farmers can learn among themselves through farm visits and group or personal interactions. This is considered a convenient and cheap form of learning for farmers since they have the chance to learn from within their communities at their own convenience.

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The use of local farmers to train other farmers proved to increase the adoption of CSA in Malawi, as reported by Amadu (2022).

Farmers' experiences developed over the years on their farms shape their knowledge and perceptions towards agricultural innovations (Osterman et al., 2021). Farmers are able to monitor and evaluate the successes and failures of their practices and make continuous adjustments which may lead to improvement. In this way, the farmer continues to learn by doing and doing through learning. Alternatively, farmer field days involving teaching, presentation and experimentation can create awareness and impart knowledge among farmers (Fabregas et al., 2017).

Mass media is one of the major sources of information and knowledge reported by farmers. Farmers mentioned that they were able to learn different CSA practices from programs broadcast on radios, televisions, through the internet or print media. Examples of media programs and/or sources quoted by farmers were; harvest money (New vision), Seeds of Gold (Daily monitor), *Obuhingyi n'Oburisa* (TV West) and the WeFarm social media Network. The use of media reduces the distance between farmers and researchers as well as markets. This is because, through different forms of media, farmers are able to get information about new innovations and practices developed and applied in distant areas without physically going there. Khan et al. (2020) also confirmed mass media as an important channel of agricultural information flow to the farmers. Also, radio-agricultural shows were appreciated as a source of information among farmers in Tanzania (Nyasimi et al., 2016).

Limitations of Using CSA among Smallholder Farmers

The study results revealed that smallholder farmers were faced with many limitations in their attempt to adopt CSA.

Approximately 66% of the smallholder farmers reported limited access to finances to facilitate the adoption of CSA practices in the current study. Implementation of some CSA practices like the use of improved varieties, inorganic fertilisers, mulching, and farm yard manure, requires a financial investment. Therefore, farmers who cannot meet or afford such costs won't be able to adopt such practices Serote et al. (2021). One of the farmers explained,

> *"A canter lorry of grass for mulching costs a minimum of 100,000 UGX, which I cannot afford. "Improved planting seeds are expensive, so; I use home-secured local seeds from the previous season",* she further explained.

This confirms the findings of Tumwesigye et al. (2019) and Raile et al. (2021) that high expenses on CSA practices are more likely to limit their adoption among smallholder farmers.

The current study findings indicated limited access to extension services among smallholder farmers at 35%. Agricultural extension links researchers and the end-users (farmers). Limitations in agricultural extension and advisory services to farmers can result in information gaps, as reported by Maguza-Tembo et al. (2017), which may lead to poor application of CSA practices. Similarly, Rubongoya (2019) and UBOS (2022) also reported gaps in agricultural extension service delivery in Uganda.

Farmers in the current study reported high uncertainty regarding prices of farm products at 40%.

> *"Prices of planting seeds are higher, and by the time of harvesting, the price of the products have fallen, leading us to losses",* narrated one of the farmers in Nyamuyanja Sub County.

Uncertainty about farm product prices tends to discourage farmers from adopting certain CSA practices.

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> *"I cannot buy expensive high-quality bean seeds or use fertilisers when I am not sure of the market price after harvesting",* explained one of the farmers in Nyamitsindo Parish.

Price fluctuation tends to discourage investment in the use of some CSA practices due to a lack of assurance for profits. In related studies, Rubongoya (2019), Bhattacharyya et al. (2020) and Raile et al. (2021) also reported that low prices were demoralising farmers from increasing investments in agricultural practices.

The current study indicated limited availability of CSA inputs and high prices at 32 and 48% among smallholder farmers. Farmers noted that prices for fertilisers, improved seeds, farm yard manure and mulches were high and unaffordable. Farmers were discouraged from using such CSA practices whose accessibility and prices were not in their favour. This supports the findings by Yameogo et al. (2017) and Raile et al. (2021). Higher input prices are likely to increase the costs of CSA technologies and may limit the adoption levels (Khatri-Chhetri et al., 2017; Suleman,2017; Thornton et al., 2018).

The limited supply of agricultural land was recorded as a limitation to CSA adoption by 31.8% of the farmers under the current study. This is in line with the findings of Bagamba et al. (2012) who also reported land scarcity in western Uganda. Land is an important resource for agriculture. The size of the farmland owned by the farmer is more likely to determine the CSA practices a farmer can adopt (Ren et al., 2019). Farmers with larger land holdings have a more likelihood of applying different CSA practices. According to Atube et al. (2021) and Serote et al. (2021), land scarcity was also highlighted as a limiting factor towards CSA adoption.

CONCLUSIONS

This study was aimed at establishing the level of knowledge, attitude, and practice of CSA among smallholder crop farmers in the Isingiro District. From the findings, there was a high level of knowledge about climate-smart practices among smallholder farmers as traditional practices that can enhance resilience and improve productivity. Farmers acquire information and knowledge about CSA practices from multiple sources like mass media, extension agents, neighbours, farmer field days, farm field trials and through personal experiences. The knowledge of the concept of CSA was still low among smallholder farmers. Farmers portrayed a positive attitude towards the adoption of CSA practices.

There was the average practice of CSA among smallholder farmers in the Isingiro District. Traditional low/no cost practices such as crop rotation, intercropping, using mixed varieties of crops, cover cropping, mulching, and contour bunds had relatively higher adoption rates than modern practices like irrigation and the use of improved crop varieties. The farmers' efforts to adopt different CSA practices were hampered by a number of limitations including finances, extension services, availability of some CSA inputs, high prices of CSA inputs, fluctuation of farm product prices, land scarcity and soil exhaustion.

Recommendations

Strategies that build household resource bases to improve the adoption capacity of farmers should be sought. One such strategy is providing farmers with financial incentives to enhance their capacity or support their initiatives to invest in sustainable CSA innovations that have greater adaptation and mitigation potentials but have high initial costs.

More efforts in extension service delivery to the farmers should be emphasised to impart knowledge to the farmers and bridge the existing information gap about CSA. This will help farmers break the bias about certain CSA practices and improve on adoption.

Farmer-to-farmer information dissemination needs to be supported by organising training programs for

Article DOI: https://doi.org/10.37284/eajab.6.1.1154

lead farmers. Also, trial and demonstration centres should be established to act as learning centres for farmers. Farmer Field Schools and peer-to-peer farmer visits would help to strengthen CSA adoption rates. Furthermore, there is a need for policymakers to prioritise and enact pro-CSA-relevant policies that address the barriers hampering its adoption.

ACKNOWLEDGMENT

The authors would like to thank Deus Tugeineyo and John Turyasingura, the enumerators for their good work in data collection and most importantly to farmers who patiently gave us their time and responded to our questions.

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