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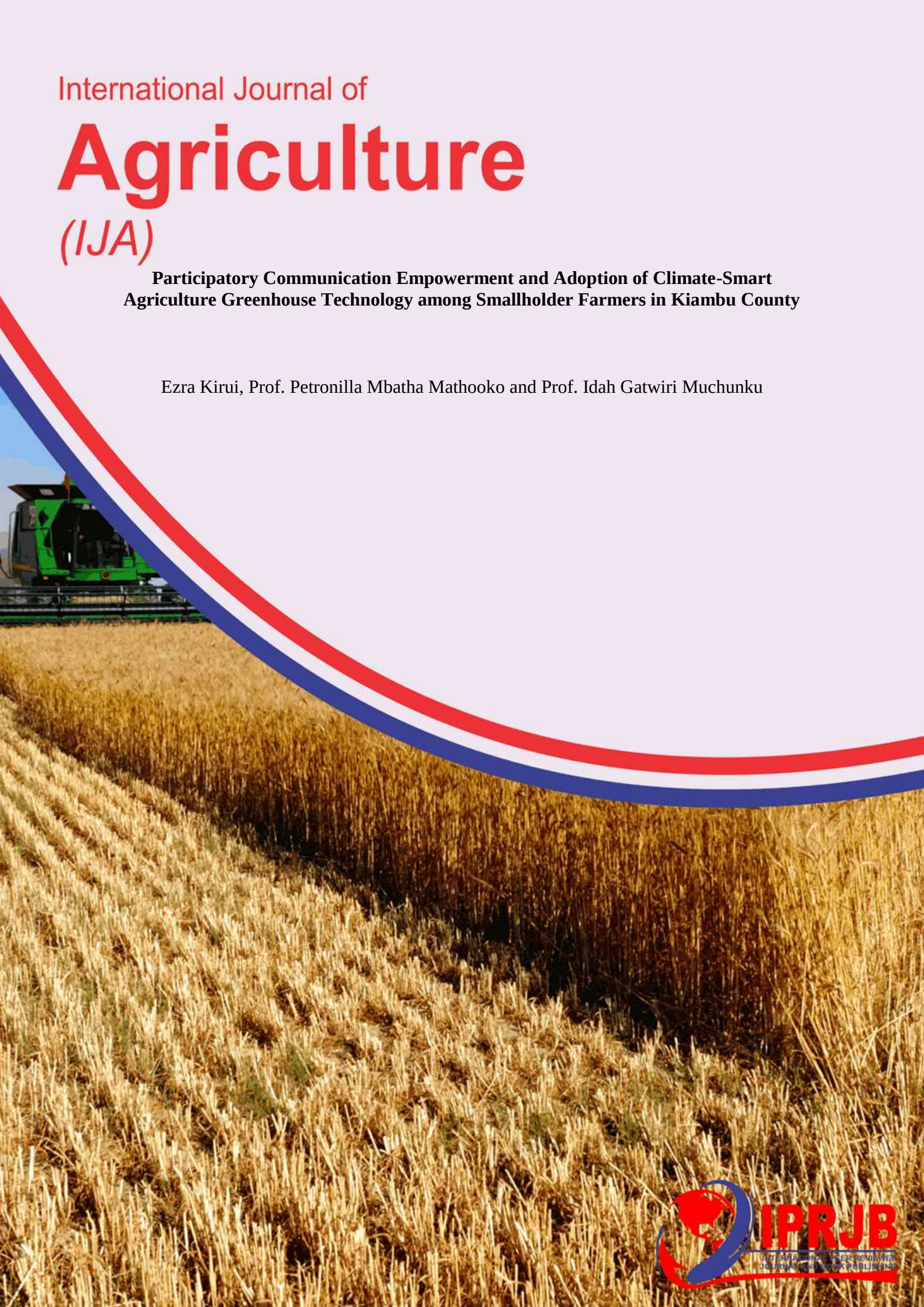

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Participatory Communication Empowerment and Adoption of Climate-Smart Agriculture Greenhouse Technology among Smallholder Farmers in Kiambu County

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Abstract

Purpose: This study sought to examine the influence of participatory communication empowerment on the adoption of climate-smart agriculture greenhouse farming technology among smallholder farmers in Kiambu County. Climate Change has exacerbated food insecurity and malnutrition, despite the stakeholder interventions to end hunger by 2030 as enshrined in the second Sustainable Development Goal. One of communication's main roles is to empower individuals through access to information to liberate themselves from their current predicament.

Methodology: The study was conducted using a mixed-method research design, with data collected through questionnaires, in-depth interviews, and focus group discussions. Quantitative data was collected from 387 smallholder farmers in Kiambu County, Kenya, while qualitative data was obtained from 50 key informants comprising of in-depth interviews and focus group discussions. Quantitative data was analysed using descriptive and inferential statistics, while qualitative data was analysed using emerging themes as narratives.

Findings: The study established that smallholder farmers were empowered through access to information on smart greenhouse farming through various participatory communication channels. It also established that empowerment influenced the adoption of climate-smart agriculture in that farmers have full control of their greenhouse farming (sig. =.006) because they can easily access and utilise climate-smart greenhouse farming information (sig. =.050) through various channels of communication. The study concludes that access to greenhouse information, having practical experience, working as collective and taking control influence the adoption of greenhouse farming.

Unique Contribution to Theory, Practice and Policy: The study recommends that policymakers and communication experts should integrate farmers' ideas and opinions with participatory approaches during the agricultural message development, the formulation of communication policy and the communication strategy.

Keywords: *Communication, Media, Interactions, Climate, Agriculture, Technology, Innovation, Diffusion Processes, Agricultural Technology, Agricultural Extension Services*

INTRODUCTION

Participatory communication is a dynamic, interactional, and transformative process of dialogue between individuals, groups, and institutions that empowers them to realise their full potential (Singhal, 2001). The highest form of participatory communication is empowerment (Melkote & Steeves, 2021). Participatory communication for sustainable development has become an important area of scholarly discussion in recent years (Ali & Sonderling, 2017).

As a process, the need for participatory communication is usually triggered by someone or an event that brings up the issues of concern and acts as the catalyst in calling for action (Nechansky, 2008). The catalyst may be in the form of affected members of the community, external stakeholders or even the media who drive the stakeholder groups to define the problem, plan and coordinate the flow of information and discussions for collective action. While empowerment is the core of all development, communication is the key to empowerment because it raises awareness among stakeholders to coordinate dialogue and information dissemination to stimulate citizen action (Cahyono, 2019).

Thus, people's empowerment can be achieved through self-consciousness or awareness of their condition through reflection and action (Freire, 1997). Empowerment is one of the pillars of communication (Freire 1997) as well as a principle of participatory communication (Kloppers & Fourie, 2018). In this case, this principle enables farmers and facilitators to discover untapped strengths and gain control over the looming food crisis to set their agenda and bring about social change (Kamruzzaman, 2020) through communication exchange and consensus building between the facilitator and the farmer. Faced by low agricultural productivity, the farmer critically reflects on their vulnerability and takes action to control the situation by adopting climate-smart agriculture greenhouse farming technology as a solution.

The elements of empowerment include access to information, putting local people in control, working as a collective and hands-on experience (Bessette, 2021; Susilowati et al., 2023). Empowerment enables farmers individually or collectively to actively contribute their views and opinions in the decision-making process within the development programmes for transformation (Melkote & Singhal, 2021; Tufte & Mefalopulos, 2009; Anani-Bossman & Blankson, 2023).

Empowerment and development involve a holistic process among stakeholders to enhance the self-determination, ability and technological capacity to set their own agenda and change the course of their current state (Servaes, 2020; Anani-Bossman & Blankson, 2023; Susilowati et al., 2023). The predicament of the marginalised farmer can be linked to climate change, which has adversely affected agriculture, prompting development agents and beneficiaries to be innovative to liberate themselves and understand that development is a participatory process of social change.

The two-way communication for empowerment takes a departure from the mere transfer of information in a linear manner to a participatory approach to achieve development. Despite the implementation of several empowerment programmes, marginalised members of the society rarely receive true development due to dependence on government and non-governmental organisations (NGOs) for piecemeal handouts (Ugbada & Ushie, 2014).

In developed regions, the adoption of agricultural innovation among farmers has been facilitated by established communication structures. Greek farmers, for instance have adopted smart farming technologies directly in the cultivation of their sixty thousand (60,000) acres of greenhouses. This has led to increased production and prior commercial agreements and market

needs that determine the types of crops grown in a season (Kavga et al. 2021). Elsewhere, the Chinese government promoted precision agriculture like greenhouse farming production through the creation of awareness, demonstration projects, engagement with research and demonstration centres, and government-sponsored annual training programs (Karanisa et al. 2022). Although this adoption can also be affected by a lack of knowledge and qualified personnel to acquire new knowledge. Greenhouse farming in the Mediterranean region is affected by several factors such as lack of knowledge and qualified personnel to acquire new knowledge and fragmentation of the farms.

The conventional open-field land farming technique which has dominated agricultural systems in Africa is gradually paving way to greenhouse farming which is gaining popularity (Sanzua et al., 2018) addressing the need for the 500 million small farms to feed close to two billion people (FAO, 2021) affected by the prevailing climate variability (Muriithi et al., 2021).

To actualize this, people-centred communication strategies should be incorporated into the message design when disseminating agricultural information for acceptance of technology because they are responsive to farmers' felt needs (Bessette, 2021). This approach emphasizes two-way communication at the grassroots level and positions individual farmers and the community at the core of development in that communication is made common through sharing meanings, perceptions, or knowledge in a community setup (Melkote & Singhal, 2021). The local community should be involved in the decision-making process of their development. For instance, during the implementation of the Kenya Slum Upgrading Program (KENSUP) in Kibera, Kenya, (Kimetto & Somba 2017) emphasised the need to incorporate the empowerment principle of participatory communication during the design and implementation of a communication strategy to amplify the community's voice.

The diffusion and adoption of technologies among farmers are facilitated by access to climate-smart agriculture information and knowledge through participatory communication pathways like extension officers, Farmers Field Schools (FFS), neighbours, radio and television (Waaswa et al., 2021). Thus, this study sought to find out the influence of empowerment on the adoption of climate-smart agriculture greenhouse technology.

The preference of Kiambu County as the study site was due to its agricultural productivity potential, anthropological details, unique physiographic and natural conditions characterised by the Upper Highlands, Lower Highlands, Upper Midlands and Lower Midlands topographical zones that influence climate change adaptability. With an estimated population of 2.4 million people, land sizes in Kiambu County (CIDP, 2023). The population growth has exerted pressure on the land sizes that have been subdivided and diminished (County Government of Kiambu, 2021; MoALFC, 2021). Despite its productiveness, Kiambu County has not been spared by the vagaries of climate change and the unpredictability of the rainfall timing prompting farmers to become innovative and food reliant though embracing climate-smart agriculture greenhouse farming technologies. The County is considered the breadbasket due to its proximity to major outlets in Nairobi, Kajiado, Machakos, Murang'a, Nyandarua and Nakuru counties (CIDP,2023). Kiambu County played a key role as a major food supplier to Nairobi residents and red-zone neighbouring counties during the COVID-19 pandemic lockdown (TMG, 2020). The County has a high concentration of greenhouses, having trained over 5,000 farmers in greenhouse technology; it has 82 greenhouses set up as demonstration tools. Its Agriculture Department has documented 154 individual greenhouses constructed by individual farmers. (CIDP, 2018).

Statement of the Problem

Development agents have widely used the notion of empowerment in an attempt to explain the improvement of the livelihoods of the farmers. Despite the implementation of various agricultural programmes, the adoption of climate-smart agriculture greenhouse technology farming remains low. This is mainly due to the top-down communication strategy which considers communication as a mere transmission of information or persuasion rather than as a means of empowerment (Ali & Sonderling 2017). As a result, the agricultural interventions against climate change do not solve the looming food crisis.

The application of top-down communication approaches to solve issues has not been effective. For instance, communication workers in North Wollo Zone, Ethiopia unsuccessfully used this approach to shape programmes or texts resulting in little involvement from stakeholders (Eshetie & Chanie, 2024). Similarly, the strategies used by the Institute of Agricultural Research (IAR) and the implementation of the organization for rehabilitation and development in Amhara (ORDA) by the Ethiopian agricultural researchers failed because it was controlled, planned and executed without involving the target individuals (Kassa & Degnet, 2004, cited in Eshetie & Chanie, 2024; Ali & Sonderling, 2017).

Most agricultural programmes in Kenya have also failed due to the application of top-down communication strategies and information dissemination models by government ministries, departments and research institutions which are overloaded, technical and outdated (Kathula, 2023; Muriithi et al., 2021). Low adoption of greenhouse farming can also be attributed to poor message development and lack of access to information (Munyua, 2000; Eshtie & Chanie, 2024). Greenhouse farming has failed in Nyandarua County due to lack of information among smallholder farmers (Muriithi, et al., 2021) and in Kisii County where farmers lacked prior training on greenhouse technology, (Wayua, et al., 2020). Therefore, development experts should emphasize the application of the empowerment component of participatory communication during the implementation of community projects to amplify the farmer's voice in the decision-making process as a communication strategy (Kimetto & Somba, 2017).

On the other hand, successful adoption of greenhouse technology has been associated with participatory empowerment communication approaches. Akhtar and Jullandhry (2020) pointed out that farmers prefer interpersonal communication, particularly face-to-face interaction. Empowerment-focussed communication thrives when awareness is created through the learning processes of extension services and empowerment of the local community to manage their own development (Mwakisisya et al., 2020). For instance, the implementation of the Small Farmers Empowerment Program (SFEB) in Kenya by the International Fund for Agricultural Development and Food and Agriculture Organisation (IFAD-FAO) and Central Food Security Agency was successful because farmers actively interacted with facilitators in the program from the village, district and provincial levels (Aminah, 2016).

Although most studies recommend participatory communication for adoption at local, national, and international levels of decision making, development communication experts advocate for new studies to discuss strategies of putting participatory communication theory into practice (Tufte & Mefalopulos, 2009). The knowledge gap on greenhouse farming has created the need for a comprehensive and context-appropriate decision to guide farmers through the preparation, planting, nurturing and harvesting of greenhouse productions (Bseiso et al., as cited in Bashir et al., 2024). While literature acknowledges that participatory communication is effective, there

is a lack of empirical evidence on how specifically 'empowerment-focused' communication interventions influence the adoption of technical infrastructure like greenhouses in Kiambu.

Conceptual and Theoretical Framework

Theoretical Framework

This study was informed by the following theories: Participatory Communication Theory and the Unified Theory of Acceptance and Use of Technology (UTAUT) which were discussed below.

Participatory Communication Theory

Participatory communication theory is a dynamic, interactive and transformative process of dialogue between people, groups and institutions that enables people, both individually and collectively, to realize their full potential and be engaged in their welfare (Singhal, 2001). In development communication, the cumulative experiences of development efforts over the past half-century have revealed the indispensable role that communication plays (Ali & Sonderling, 2017).

According to Tufte & Mefalopulos, as cited in Guuru & Adede, (2022), this theory ensures free flow of information because it encourages trust and openness in a communication setting thus facilitating empowerment for social change. It provides a communication framework using appropriate technology and recognizes the role of two-way communication for the empowerment of the poor and the marginalised as opposed to the conveyance of information in a linear manner or top-down to achieve development often associated with modernisation and dependency paradigms (Melkote & Singhal, 2021; Servaes, 2020).

Participatory communication empowerment is intended to make communication common through sharing meanings, perceptions, worldviews or knowledge in a community. According to Freire, (1970) participatory communication proposed the replacement of the pedagogical system with a more liberating type of communication that is dialogic, receiver-centred and more conscious of social structure. People's empowerment can be achieved through awareness "conscientization" which implies reaching critical consciousness where the oppressed become aware of their condition through a totality of reflection and action (Freire, 1997). Affected by the food crisis, smallholder farmers actively interact with facilitators and agitate for sound policies and reforms in the agriculture sector, including adopting climate-smart greenhouse farming to liberate themselves. There is a need for development agents to apply participatory communication for the adoption of greenhouse farming at all levels of decision-making, as well as new studies to discuss methods or strategies for putting theory into practice (Tufte & Mefalopulous, 2009).

The Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed by (Venkatesh et al. in 2003) by reviewing, integrating and mapping constructs of the Innovation Diffusion Theory (IDT), the Motivational Model (MM), The Technology Acceptance Model (TAM), the Model of Personal Computer Utilization (MPCU), the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB), a combined Theory of Planned Behaviour/Technology Acceptance Model (C-TPB-TAM) and the Social Cognitive Theory (SCT) to explain user intentions for using technology and subsequent usage (Venkatesh et al. in Momani, 2020).

This theory has been widely used in innovation diffusion and technology adoption research including agriculture among others and has taken place in different theoretical perspectives, such as cognitive, affective, motivational, behavioural intentions and the reactions of individuals. It conglomerates technology acceptance theories and models to study the method of understanding and accepting new technologies, their usage and their influence. It explains how smallholder farmers opt to adopt and use climate-smart agriculture greenhouse technology.

The constructs of UTAUT include performance expectancy, effort expectancy and social influence. The performance expectancy is the degree to which an individual expects that utilising new technology would enable them to improve gains in job performance. It predicts the degree to which a smallholder farmer expects that utilising climate-smart greenhouse technology would enable them to improve their food productivity, especially at such a time when climate change is adversely affecting communities. It predicts farmers' behavioural intentions to adopt climate-smart agriculture greenhouse technology and the degree to which the farmers expect that using greenhouse technology would empower them to improve productivity.

Framers' skepticism towards the adoption of new technology stems from distrust and a lack of innovation culture due to perceived uncertainty of capacity building and benefits of technology (Kavga et al. 2021), however, the climate-smart greenhouse technology's perceived usefulness, performance and farmers' extrinsic motivation influence adoption of the technology. Kiambu County farmers easily adopt greenhouses because they understand the benefits that are associated with greenhouse farming, including increased productivity in the wake of climate change. In the process, farmers are empowered economically and information-wise.

Effort Expectancy is the degree of ease associated with using new technology, in this case climate-smart agriculture greenhouse technology. The usefulness, ease of use and social influence affect the users' decision against the use of technology. Similarly, the adoption of agricultural technologies in Africa can be enhanced by educating farmers in technology dissemination and climate change adaptation (Nyoni et al., 2024). The greenhouse technology is user-friendly across all generations, easy to teach, learn and adopt and requires minimal technical expertise.

The social influence is the degree to which users (farmers) perceive that important others believe they should use the new system (greenhouses). The farmers' perception that facilitators influence the adoption of climate-smart agriculture greenhouse technology to improve their status in their community set-up (Momani, 2020). Kiambu farmers have strong family and kinship ties making recommendations and opinions from trusted highly influential individuals such as pioneer farmers, extension officers, government and non-governmental organisation officers, and media personnel. This theory therefore lays the foundation for understanding greenhouse farming technology adoption in Kiambu County because it captures both individual perceptions (usefulness and ease of use) and the social context that shapes decision-making. Value-added technologies are easy to use, and are supported by trusted social networks substantially enhancing adoption.

Research Gaps

The existing literature mostly discusses challenges that affect the adoption of agricultural interventions such as linear models of communication, outdated models of disseminating information and lack of training and interactions between farmers and facilitators. However,

there is a research gap on participatory empowerment communication in relation to the adoption of climate-smart agriculture greenhouse farming technology in Kenya. Past studies have been done in the coastal region, Gilgil, Nyandarua and Kisii in Kenya. Mburu, as cited in Awuku (2022), cited socio-economic factors such as age and education as influencing farmers' access to agricultural information. The study investigated factors influencing access to agricultural information by smallholder farmers through ICT channels in Deiya location, Kiambu County. Jepkorir & Tobias (2022), studied the factors affecting the adoption of Internet of Things (IoT) in selected greenhouse farms in Kenya and established that farmers' perception of technology and environmental factors had a positive and significant relationship with the adoption of IoT Technology. The interpersonal component in participatory communication plays a key role not only in imparting agricultural knowledge to the farmers, but also in the adoption of new farming practices.

Conceptual Framework

The independent variable is represented by participatory communication empowerment. The attributes of empowerment are access to information, hands-on experience, working as a collective and local people in control. This principle is drawn from the participatory communication theory. The dependent variable is represented by adoption of climate-smart agriculture greenhouse technology. This variable is drawn from the Unified Theory of Acceptance and Use of Technology (UTAUT).

The moderating variable in this study is represented by the socioeconomic factors which include; age, gender, education and income. Similarly, the moderating variables under the UTAUT model include gender, age, experience and voluntary use.

The constructs of empowerment under Participatory Communication Theory and constructs of the Unified Theory of Acceptance and Use of Technology (UTAUT) not only identify and operationalise the variables but also propose relationships that form a context for interpreting and explaining the study findings. They are represented in the conceptual framework (Figure 1).

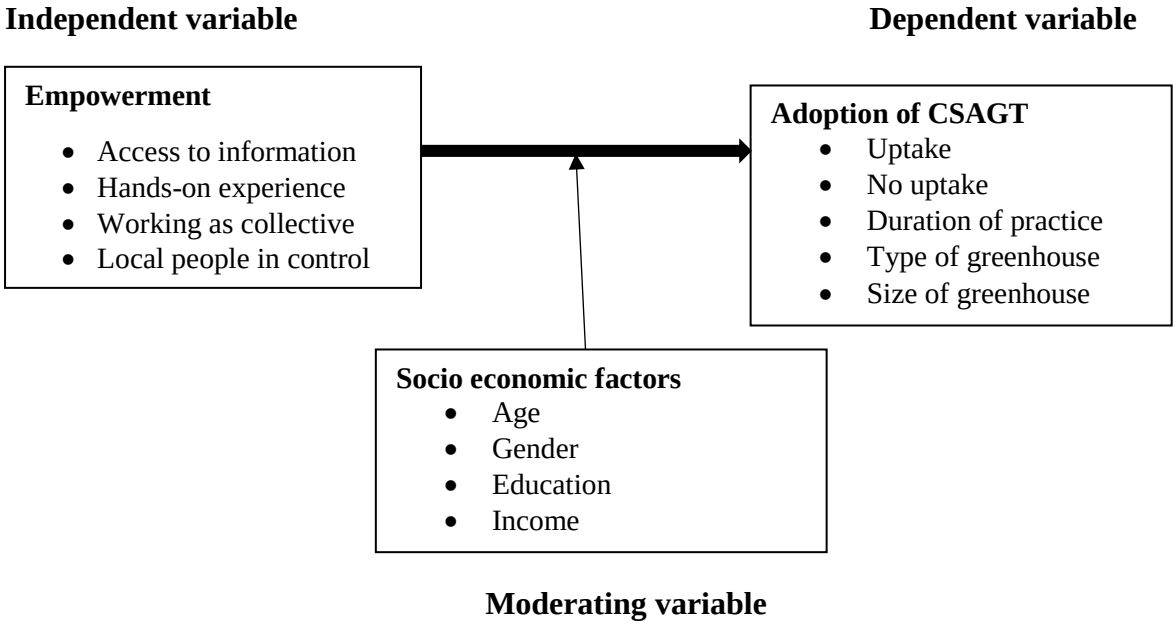

Figure 1: Conceptual Framework

METHODOLOGY

Study Design

The study applied a mixed-methods research design. Quantitative data was collected using questionnaires and analysed using descriptive statistics (mean, mode, median, cross-tabulations, and percentages) as well as inferential statistics (correlation coefficients, regression analysis, and ANOVA). Qualitative data was collected using in-depth interviews and focus group discussions and analysed using emerging themes as narratives. Triangulation of quantitative and qualitative data was carried out.

The study population was climate-smart greenhouse technology smallholder farmers in Kiambu County. The sample size for quantitative research was 387 smallholder farmers and 50 key informants for qualitative research. The sample size was determined using Fischer *et al* (1991) formula.

Where;

$$\mathbf{n = Z^2. p. q/d^2}$$

n = sample size (if the target population is > 10,000).

z = the value at the chosen confidence interval (1.96 for a confidence interval of 95%)

p = estimated population with attributes of interest where infinite p = 0.5,

q = 1-p, and

d = degree of accuracy set; 0.05 confidence level corresponding to 1.96.

Sampling

A multistage sampling technique was used for quantitative research (Creswell & Creswell, 2022) and purposive sampling was used to sample qualitative respondents for qualitative research. Before carrying out the main study, the researcher did a pilot test by administering questionnaires to 20 smallholder farmers in Lari and Ruiru Sub-Counties in Kiambu

County to test the validity and reliability of the research instruments. The researcher collected 387 questionnaires representing 80% response rate, which was sufficient and acceptable, and thus used for data analysis. The in-depth interviews were done with 26 key interview informants and 24 respondents for focus group discussions that comprised of between 6-8 respondents per group.

RESULTS AND DISCUSSION

Participatory Communication Empowerment

The study sought to examine the influence of participatory communication on the adoption of climate-smart agriculture greenhouse technology. The attributes under empowerment are: access to information; hands-on experience; working as a collective and local people in control.

Table 1: Empowerment through Participatory Communication

Empowerment Communication	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I have access to smart greenhouse farming information through my participation in a farmers' group	0%	4%	5%	58%	32%
I have acquired full practical knowledge and gained enough experience to manage greenhouse farming technology on my own	0%	6%	13%	59%	22%
I have realized high productivity through participation in greenhouse farming	0%	7%	7%	66%	20%
My community farmers' group has realized high productivity through participation in smart greenhouse farming	0%	10%	9%	64%	17%
I am now confident and have full control of my greenhouse as a farmer	1%	5%	8%	65%	20%

Findings in Table 1 show that more than fifty-eight (58%) of farmers agree that they have access to smart greenhouse farming information through their participation in a farmers' group. Fifty-nine (59%) of them also agree that they have acquired full practical knowledge and gained enough experience to manage greenhouse farming technology on my own. Sixty-six (66%) agree that they have realised high productivity through participation in greenhouse farming. Sixty-four (64%) agree that their local farmers' group has realised high productivity through participation in smart greenhouse farming. Sixty-five (65%) agreed that they are now confident and have full control of their greenhouse as a farmer.

Access to Information

Table 2: Access to Information or Training on Greenhouse Farming

		Frequency	Percent
Have you ever tried to gather any information or training on greenhouse farming?	No	18	4.7
	Yes	369	95.3
	Total	**387**	**100.0**

Findings in Table 2 show that the majority (95.3%) of smallholder farmers have taken the initiative to seek information on greenhouse farming, while 4.7% of them have not actively sought greenhouse information although they have been exposed to information through availability of various channels at their disposal. These findings imply that there is a greater urge by farmers to actively seek beneficial information to solve their agricultural challenge of low productivity to improve their livelihoods. When farmers take own initiative to seek for beneficial information to liberate themselves from food insecurity and malnutrition, it affirms that empowerment communication influence adoption of agricultural innovation rather than farmers waiting to be assisted.

Table 3: Motivational Factors for the Adoption of Smart Greenhouse

	Yes	No	Total
Easy access to greenhouse farming information	69%	32%	100%
Frequent interaction with extension officers on greenhouse farming	35%	65%	100%
Availability of understandable greenhouse farming information	52%	48%	100%
Relevant training in greenhouse farming that I acquired	30%	70%	100%
Other	3%	97%	100%

Findings in Table 3 show that sixty-nine (69%) of farmers have been motivated to adopt smart greenhouses due to easy access to greenhouse information. Fifty-two (52%) were encouraged by the availability of greenhouse farming information which was easy to understand. However, sixty-five (65%) responded that there was no frequent interaction with extension officers on greenhouse farming and less relevant training on greenhouse farming as represented by seventy (70%) of the farmers. The other factors cited by the three (3%) of the farmers include: seeking an alternative source of income, availability of space in the farm for a greenhouse, *ciama* (self-help group) interactions and support, frequent interaction with a KALRO officer, and being a pioneer farmer to practice greenhouse farming in their area. Specific personal needs, therefore, drive a few farmers to venture into greenhouse farming. The following are views and opinions from some key informants.

> *Farmers need to access the right information about greenhouse farming. Because at the end of the day the farmer is still poor due to lack of information. I have practiced greenhouse farming for 3 years and now I am fully empowered with knowledge and information which I am ready to share with fellow farmers. I have been interviewed by K24 TV's Kilimo na Biashara presenters.* Farmer 2 (Key interview informant)

> *I often watch KTN Farmers and Muriimi of Inooro because they are very informative agricultural programmes.* Farmer 14 (FGD 3)

> *My favourite programmes are Murimi and Magetha Smart because I have learned more about greenhouse farming especially drip irrigation. It comes three times weekly.* Farmer 2 (FGD 2)

> *We engage the extension officer on need basis. When we need him, we call him to join our chama meetings. We have a Whatsapp group and a moderator. We also used to receive advisory messages on climate from the satellite, but it has since stopped. Sometimes we use Google when in a group.* Farmer 10 (FGD 2)

We still need access to information, market information and how to access credit managers. Farmer 19 (FGD 4)

Our first greenhouse was affected by rain which we did not manage well by draining the water, we did not put enough ventilation, we also noticed white coloration on the plants and which posed a challenge. But now having done my research and interacting with fellow farmers, I am now knowledgeable on the harmful nematodes on my crops as well as the benefits of spacing during planting, soil health, and lack of nutrients. Farmer 4 (Key interview informant)

In my opinion, there are two kinds of empowerment: Communication and Economic empowerment. On the former, the counties face a challenge in extension services and this prompts farmers to seek alternative means to empower themselves with information from KALRO for instance Information on pest and disease management such as absoluta tuta and white flies. Counties do not have extension services programme. They are not there, instead they are outsourced - on their capacity or consultancy. KALRO 4

Greenhouse farming is the best way because of its convenience. Our customers (farmers) are empowered with enough knowledge because we teach them how to take care of their farms. We mostly interact with them including those from Kiambu County, through our Whatsapp, TikTok, Facebook and Instagram channels. Agron 3

I want to abandon open farming to venture into greenhouse fully because it has more benefits; control of pesticides is minimal, and water use is controlled. Farmer 24 (FGD 4)

In my opinion, the extension officer is the best channel of communication for farmers because the farmer gets to learn about best agricultural practices one-on-one and the feedback is instant. If a farmer wants to construct the greenhouse, they come to the extension officer directly and get the preferred designs. AEO 1

We are currently developing a platform to collate all the information resources from KALRO, KEPHIS, and AFA. Now the platform will give farmers a "shelf in a supermarket". When someone gives you content it is not free. We are working towards monetization of the Knowledge economy. We will be able to harvest these resources….. We have a production studio where we record and package programs including greenhouse information. We produce our in-house programs and partner with Radio Taifa to air our production. Our YouTube channel has 1.5 million views on our greenhouse video, however, we may not have the capacity to reply to every comment because we don't have enough human capital. KALRO 3

Farmers are now empowered with information based on the strides we have made in research enabling them to farm for subsistence and Income. We provide market linkages through Kilimobora and Kenya Management Information System (KAMIS). https://kalro.org/kiamis/index.html National Agricultural Dashboards (NAD). The KAMIS platform shows market fluctuation systems. Farmers who do not have smartphones receive advisories from KALRO through SMS and toll-free numbers and database sharing of advisories. KALRO has 50 centers and 16 satellite centers that organize field days. Centers serve specific areas. We encourage farmers to register in our platforms. Some groups have been formed such as common interest groups (CIGs) and Vulnerable Interest groups (VIGs). We have been able to develop Apps with the incorporation of information from KALRO scientists. KALRO 1

Hands-on Experience

The study sought information on the hands-on experience sub-construct of participatory Communication's empowerment to determine if it influenced the uptake and adoption of climate-smart agriculture greenhouse technology. Farmers were asked to tick off the reasons that led to their adoption of the greenhouse technology. The results are summarised in Table 4.

Table 4: Reasons for the Adoption of Greenhouse Technology

		Percent %
1	To improve the nutrition of my family	58%
2	To make my family food secure	56%
3	To control pests on my farm effectively	41%
4	To reduce the effects of climate change on my farm	67%
5	It is less labour intensive	25%
6	To earn more income	65%
7	To keep up with the modern technology in agriculture	48%
8	To reduce and control diseases in my farm	36%
9	It makes it easier to use organic fertilizers	30%
10	It requires less amount of water (drip irrigation) than open field agriculture	40%
11	It makes it easier to recycle organic waste	27%
12	i do it as a hobby	11%
13	I was forced into it	0.5%
14	Other- organic though it sips a lot of water nowadays	0.5%

Findings in Table 4 show that sixty-seven (67%) of farmers chose to embrace greenhouse farming in order to reduce the effects of climate change, sixty-five (65%) were motivated by the urge to earn more income. Fifty-eight (58%) of farmers adopt greenhouse farming due to the need to improve the nutrition of their families. Fifty-six (56%) are motivated by the need to make their families food secure

> *I still prefer greenhouses to open-field farming because it is more beneficial. I have done enough research on most crops and I have a ready market outside Kenya. I am planning to do it on a large scale. Now I am fully equipped with knowledge.* Farmer 4 (Key interview informant)

> *I can plant for 9 months but can harvest three times. I apply fertilizer and water. I have a knapsack sprayer that has stayed for 20 years without breaking. For drip irrigation, I have improvised my old water pipes by perforating holes at intervals to allow water to drip into the surface of each plant.* Farmer 8 (Key interview informant)

> *After purchase, we install and train them how to operate and maintain. Training is done every month for six months depending on the crop in the greenhouse.* Agron 3 (Key interview informant)

This implies that farmers must have hands-on experience to operate and maintain greenhouses on their own after deliberating seeking greenhouse information from facilitators and practicing this type of farming for their liberation from hunger and malnutrition.

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Working as Collective

Participatory communication is more effective when all stakeholders work together to strengthen individual farmers, farmers' groups or farmers' organisational networks. The following excerpts are some of the views and opinions from the key informants:

> *In my previous group, we had Amiran, U-Farm or Seed Co, they send agronomist and they come to teach us because they have the required knowledge.* Farmer 2 (Key interview informant)
>
> *I am a member of GDC Sacco where I access credit only. Sometimes they train us at the market.* Farmer 8 (Key interview informant)
>
> *In our group, we need frequent extension support.* Farmer 17 (FGD 3)
>
> *I urge the Ministry of Agriculture and the county government to recruit more extension officers especially in Kiambu county because agriculture is a good response to the lack of employment. As they say "Kilimo ni uti wa mgongo". Also, the government should provide us with modes of transport e.g. motorbikes. In the past, we used to have motorbikes that facilitated our movements across the County as we imparted knowledge on farmers and it was fruitful. Also, per ward, give us two officers such that when one is not available the other will be available thus smooth operation of extension services.* AEO 1
>
> *We conduct crops research and has gene banks for all crops that have ever been planted. We participate in National Stakeholders Forum.* KALRO 2

Wayua et al., (2020) observed that greenhouses owned by individuals had a significantly higher probability of being functional, than those owned by groups and institutions (p=0.05). To enhance the contribution of greenhouses to food security, smallholder farmers should undergo capacity building on greenhouse crop production, and linking them to markets.

Local People in Control

Five options were presented to the farmers who were asked to tick off how frequently they interacted with their information sources. The results on Greenhouse Information source frequency were also obtained in a Likert scale (1-5) where: 5 =Daily, 4 =Weekly, 3 =Monthly, 2 = Quarterly, 1=Never.

Table 5: Frequency of Seeking Information

	Information source (n=387)													
Information Frequency	**Radio**	**TV**	**Social media**	**Internet sources**	**Family sources**	**Fellow farmer**	**News paper**	**NGO**	**Comm group**	**County EO**	**Farmers college**	**MOA**	**KALRO**	**Village adviser**
Daily	21%	21%	19%	18%	10%	3%	3%	1%	1%	0%	0%	0%	0%	0%
Weekly	26%	36%	24%	25%	32%	59%	20%	4%	6%	6%	1%	3%	6%	4%
Monthly	11%	13%	15%	14%	29%	27%	13%	15%	51%	27%	12%	10%	23%	20%
Quarterly	13%	10%	11%	12%	4%	4%	15%	29%	24%	37%	42%	15%	31%	31%
Never	17%	8%	11%	8%	3%	1%	28%	26%	10%	7%	20%	49%	16%	21%
Non response	12%	13%	21%	23%	23%	5%	22%	25%	8%	24%	24%	24%	25%	24%
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Findings in Table 5 show that the electronic media, social media and family sources are the common sources of information used by the farmers to learn more about greenhouse farming on daily basis as confirmed by twenty-one (21%), nineteen (19%) and ten (10%) of farmers respectively. On weekly basis, fellow farmers fifty-nine (59%), television thirty-six (36%), family sources thirty-two (32%), were the key sources of information. On monthly basis, community group fifty-one (51%), family sources twenty-nine (29%), fellow farmer and county extension 27% were the key sources of information. On quarterly basis, Farmers College forty-two (42%), County extension officers thirty-seven (37%), Village adviser and KALRO thirty-one (31%) and NGO twenty-nine (29%), were the key sources of information.

This frequency of seeking information from various channels and applying the knowledge gained is made possible through ownership and easy access of internet-enabled communication devices by smallholder farmers in Kiambu County.

> *I have practiced greenhouses for the last 19 years after being introduced by Amiran. The structure is still strong though the cover material ought to be replaced. My greenhouse which is 8 by 15 meters has yielded better produce like sugar cabbage, sukuma wiki, managu, spinach, tomatoes and terere. I not only consume the produce but also sell both at the farm and the Soko.* Farmer 8 (Key interview informant)

> *I sought information from various sources, looked for a builder and constructed my two greenhouses. The government needs to do a lot, especially in terms of market linkages. Take for instance the Seed Act that seeks to limit production because it would mean the farmer is restricted from distributing seeds unless he or she is licensed. The seeds are already expensive I don't have the money to buy the seed now when I have the license, I won't get the seed I will just stay in the house. The seeds are expensive, the government should look into the chemicals coming in. The government also has to look into the issue of chemicals. They are many unscrupulous traders out there exploiting farmers. Farmers need to be more knowledgeable about infiltration of seeds some are fake. The seed act currently in Parliament is punitive.* Farmer 2 (Key interview informant)

> *It is my joy to see when a farmer is empowered with the right information. When we can eliminate challenges like crop diseases in cabbages, it is my joy. And so when I see other people coming to benchmark here in Githiga, Agriculture is the backbone of our economy. I do not see the need for our residents to buy food yet we can obtain the same from our vast agricultural lands. We are currently recruiting farmers from different value chains.* AEO 2

> *Farmers have money but lack the technical know-how and training. 40 per cent are failing. Amiran offers greenhouses and net houses depending on the locality. Farmers in Mombasa, Wajir and Turkana for instance, they get net houses because of the humidity - they allow more aeration.* Agron 1

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Frequency of Interaction with Information Sources

Table 6: Information Source on the Duration/Longevity of Practicing Greenhouse Farming

	For how long have you practiced greenhouse farming?	Correlation Coefficient	Sig. (2-tailed)	N
1	Television	-.197**	0.000	338
2	Radio	-.228**	0.000	339
3	Newspaper	-.268**	0.000	303
4	Social media	-.211**	0.000	306
5	Internet sources	-.169**	0.003	299
6	Non-Governmental Org. officer	-0.033	0.582	289
7	Ministry of Agriculture extension officer	-.250**	0.000	294
8	KALRO officer	-0.023	0.690	291
9	Kiambu County Agricultural extension officer	.140*	0.016	295
10	Fellow farmer	-0.007	0.895	368
11	Family sources	-0.106	0.066	299
12	Community organisation group	0.029	0.588	358
13	Farmers Training College	0.109	0.061	293
14	Village based adviser	-0.070	0.230	293

*** Correlation is significant at the 0.01 level (2-tailed).*

** Correlation is significant at the 0.05 level (2-tailed).*

Findings in Table 6 show that there was a statistically significant (Sig. <0.05) correlation between the duration of practicing greenhouse farming and the following information sources namely: Television, radio, newspaper, social media, internet sources, Ministry of Agriculture extension officer, and Kiambu County Agricultural extension officer. These sources significantly influenced the uptake and longevity of greenhouse farming practices among the respondents.

Adoption of Climate-Smart Agriculture Greenhouse Technology

In this study, the adoption of greenhouses is represented by the duration of practicing greenhouse farming, the size of greenhouse, and type of greenhouse. The study found that 257 (66.5%) of farmers owned greenhouses, 59 (15.2%) used to own but abandoned due to various reasons 71 (18.3%) who did not own greenhouses were willing to start practicing this type of farming. Among the factors that motivate farmers into adopting greenhouse farming include: the desire to reduce the effects of climate change (67%) of the farmers, the need to improve nutrition in their families (58%), the need to make their families food secure (56%), the need to remain abreast with modern food production methods (48%). In some instances, where farmers stated they had abandoned greenhouses, 59(15.2%) of the farmers stated the lack of information on greenhouse farming, 18(4.7%) stated lack of information on food security, 59(15.2%) stated high costs of managing and operating the greenhouses and 37(9.6%) stated high costs of constructing greenhouses. However, they indicated that they resume the practice.

These study's findings agree with Sanzua et al. (2018) and Wayua et al. (2020) findings that low productivity, lack of technical knowledge of greenhouse crop production, lack of information on appropriate structures, and high initial costs for establishing and operating the greenhouses hamper the adoption of greenhouse farming technology. With increased technical support, greenhouse farming can be a more viable economic booster, especially in urban and non-traditional agricultural areas. Therefore, the adoption of climate-smart agriculture depends on the potential of technology, its performance at the field level, and farmers' acceptance (Bhattacharyya et al., 2020). The greater the availability of technical support, the more farmers tend to adopt green agricultural production technology (Kexiao et al., 2022).

Collinearity Test for the Dependent Variable

A correlation test was conducted to determine the results. The data was ordinal and as such Spearman's rho rank correlation statistics were employed and generated using the SPSS computer program. The test was conducted at a ninety-five (95%) confidence level where the significance was set at 0.05.

Table 7: Collinearity Test for the Dependent Variable

	Type of greenhouse owned	Duration practiced greenhouse farming	Size of your greenhouse
Type of greenhouse owned	1.000	.567**	**.614****
Duration practiced greenhouse farming	.567**	1.000	**.615****
Size of your greenhouse	**.614****	**.615****	1.000
Average farm size	.086	.180**	.417**
Income from greenhouse farming	.507**	.541**	.485**

There was a strong positive correlation between the duration of practice, type and size of greenhouse. The findings showed that a majority of the respondent farmers, 219(56.6%) practiced greenhouse farming between 1-5 years and 95(24.5%) practiced between 6-10 years. These findings imply that the practice of greenhouse farming has taken shape for some time now and is being gradually embraced. Kiambu County has distributed greenhouses to farmers' groups (CIDP, 2023) although ownership of greenhouses has majorly been individually based thus the farmer-to-farmer interaction between farmers serves as a source of agricultural information to solve their food security needs for subsistence and economic purposes. There is a high likelihood that farmers' experience in greenhouse farming influences their adoption as (Wayua et al., 2020) argue that the number of years of operation significantly influences the functionality of the greenhouses.

In some instances, land ownership influenced the type, size and duration of the greenhouses to be constructed. 155(40.1%) of farmers owned 1/4 of an acre and 153(39.5%) own an eighth of an acre, 40(10.3%) owned half an acre and 14(3.6%) each owned an acre piece of land. These findings imply that due to land subdivisions and the rise of commercial residential activities, land sizes have diminished. However, farmers are practicing smart farming for subsistence and economic purposes.

In Kiambu County, land ownership is 95% private, 0.01% communal, and approximately 5% public. 85% of landowners have title deeds to their land (MoALFC, 2021). The population growth and the cultural practice of land inheritance subdivision have decreased average farm

sizes in Kiambu County (ASDSP II, 2021). This has compelled smallholder farmers to adapt to the reality of climate change by embracing smart agricultural farming technologies such as greenhouse farming. Climate change in the county is coupled with the unpredictability of the timing and amount of rainfall received.

The study findings showed that 268 (69.3%) of farmers owned wooden greenhouses, 18 (4.7%) owned metallic greenhouses, 29 (7.5%) owned both wooden and metallic greenhouses. These findings imply that despite the prevailing food insecurity, farmers were determined to solve their food crisis through local solutions facilitated by information available to them for instance, the locally available materials that eventually yielded high productivity. Pronti et al., (2024) observe that African farmers are the world's most productive and inventive agriculturalists thus their inventiveness should be supported by educational and technical assistance. This in part is highlighted in the definition of participatory communication which is a dynamic, interactional, and transformative process of dialogue between farmers, both individually and collectively, to realise their high productivity and address food insecurity (Singhal, 2001). Most wooden greenhouses are owned by individual farmers, most probably because of their economic advantage and practicability.

In terms of the size of greenhouses, the findings also showed that 165(42.6%) operated greenhouses on an 8 by 15m, 119(30.7%) operated 8 by 30m greenhouses, 21(5.4%) operated a 15 by 30m greenhouses, 7(1.8%) 24 by 30m greenhouses. These findings imply that with the diminishing land sizes in Kiambu County, smallholder farmers are becoming innovative by venturing into greenhouse farming due to the rising trend of urban farming. Wayua et al., (2020) established that greenhouses owned by individuals had a significantly higher probability of being functional, than those owned by groups and institutions. It proposed the need to enhance adoption of greenhouses to achieve food security by training smallholder farmers on greenhouse crop production and linking them to appropriate sources of funding.

Correlation Analysis between Empowerment and Adoption of Climate-Smart Greenhouse Technology

Correlation analysis was done to examine the influence of empowerment on adoption of climate-smart agriculture greenhouse technology. Correlation techniques were used to generate Spearman's Rank Correlation Coefficients that was used to conclude. The study showed that there was a positive correlation between empowerment communication and the adoption of greenhouse farming. The correlation analysis between empowerment and adoption of greenhouse farming is shown in Table 8 below.

Table 8: Correlation between Empowerment and Adoption of Greenhouse Technology

Participatory Communication variables	Spearman's rho	Duration of greenhouse farming	Type of greenhouse adopted	Size of greenhouse adopted
I have access to smart greenhouse farming information through my participation in a farmers' group	Correlation Coefficient	.336**	.371**	.283**
	Sig. (2-tailed)	.000	.000	.000
	N	387	387	387
I have acquired full practical knowledge and gained enough experience to manage greenhouse farming technology on my own	Correlation Coefficient	.365**	.339**	.365**
	Sig. (2-tailed)	.000	.000	.000
	N	387	387	387
I have realized high productivity through participation in greenhouse farming	Correlation Coefficient	.337**	.302**	.339**
	Sig. (2-tailed)	.000	.000	.000
	N	387	387	387
My community farmers' group has realized high productivity through participation in smart greenhouse farming	Correlation Coefficient	.158**	.224**	.109*
	Sig. (2-tailed)	.002	.000	.032
	N	387	387	387
I am now confident and have full control of my greenhouse as a farmer	Correlation Coefficient	.364**	.371**	.365**
	Sig. (2-tailed)	.000	.000	.000
	N	387	387	387

Table 8 shows that there was a significant correlation between the duration of greenhouse farming and the following participatory communication empowerment strategies: access to smart greenhouse farming information through participation in a farmer group (r= 0.336, Sig. <0.05); acquisition of full practical knowledge and adequate experience to manage greenhouse farming technology (r= 0.365, Sig. <0.05); individual high productivity through participation in greenhouse farming (r= 0.337, Sig. <0.05); community groups high productivity through participation in smart greenhouse farming (r= 0.158, Sig. <0.05) and, confidence and full control of their respective greenhouses (r= 0.364, Sig. <0.05). This finding implies that participatory empowerment strongly determined adoption of the smart greenhouse technology in Kiambu County.

Correlation Analysis of Empowerment and Socio-Demographic Factors

Correlation analysis between empowerment and moderating variable was done and results are shown in the table below:

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Table 9: Correlation between Empowerment with Moderating Variable

		Level of education	Knowledge of greenhouse farming	Age	Gender	Income
I have access to smart greenhouse farming information through my participation in a farmers' group	Correlation Coefficient	.146**	.213**	.539**	.554**	.549**
	Sig. (2-tailed)	.004	.000	.000	.000	.000
I have acquired full practical knowledge and gained enough experience to manage greenhouse farming technology on my own	Correlation Coefficient	.051	.155**	.335**	.353**	.566**
	Sig. (2-tailed)	.320	.002	.000	.000	.000
I have realized high productivity through participation in greenhouse farming	Correlation Coefficient	.086	.197**	.238**	.311**	.586**
	Sig. (2-tailed)	.091	.000	.000	.000	.000
My community farmers' group has realized high productivity through participation in smart greenhouse farming	Correlation Coefficient	.042	.088	.096	.185**	.380**
	Sig. (2-tailed)	.408	.083	.060	.000	.000
I am now confident and have full control of my greenhouse as a farmer	Correlation Coefficient	.073	.213**	.299**	.367**	.556**
	Sig. (2-tailed)	.149	.000	.000	.000	.000

Table 9 shows that there was a significant correlation between the empowerment sub-constructs: access to information, practical knowledge, high productivity through working as collective, full control as well as the moderating variable represented by socio-economic factors that include education, knowledge, age, gender and income.

Regression statistics

Regression analysis was conducted to determine the extent to which empowerment has influenced the adoption of climate-smart agriculture greenhouse technology. Regression modelling was adopted to assess the influence of the four sub-constructs of empowerment considered by the study on the adoption of greenhouse technology. The study first performed the regression analyses of the variables and the results are summarized in Table 10 below.

Table 10: Model Summary (Regression Model Summary)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.396[a]	.156	.145	.651

a. Dependent Variable: For how long have you practiced greenhouse farming?
b. Predictors: (Constant), Access to smart greenhouse farming, Practical knowledge and experience, Participation in greenhouse farming, Membership in Community farmers' group and Confident and full control of a greenhouse

The regression analysis in Table 10 shows that the relationship between the dependent variable and all the independent variables pooled together had a model correlation coefficient = 0.396a the adjusted R-squared (R2Adj = 0.156), further indicates that the model could explain up to 15.6% variations in the adoption of greenhouse farming in Kiambu County, Kenya. The Coefficient of Determinant (R2) was 0.156, suggesting that the explanatory power of the independent variables over the dependent variable was 15.6 % and that the remaining 84.4% of the variations in the model were taken care of by the error term. Findings therefore, were that the five variables studied contributed up to 15.6% of the variations in the uptake of greenhouse technology by the farmers. Further investigations are therefore necessary to identify the other empowerment identity variables that lead to the uptake of greenhouse technology among farmers.

Summary of ANOVA

Hair et al., (2021) state that the appropriateness of the multiple regression model as a whole can be tested using the F-test. Therefore, the study also performed an ANOVA on the independent and dependent variable and the results are summarized in Table 11 below;

Table 11: ANOVA Results

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29.928	5	5.986	14.132	.000[b]
	Residual	161.364	381	.424		
	Total	**191.292**	**386**			

The ANOVA section of Table 11 presents the goodness of fit of the model and show an F value of 14.132 which was associated with $p<0.05$ which signifies a statistically significant model. This result therefore confirmed that a significant causal effect existed between the dependent and independent variables.

Summary of Coefficients

The SPSS computer software was used to generate the regression statistics at a 0.05 level of significance and the results are as shown in Table 12

Table 12: Coefficients Summary

Model	Coefficients[a] Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.520	.230		-2.264	.024
Access to smart greenhouse farming info	.110	.056	.114	1.969	.050
Practical knowledge and experience	.070	.065	.076	1.088	.277
High productivity through my participation in greenhouse farming	.154	.065	.165	2.358	.019
High productivity through Membership in a community farmers' group	.114	.050	.132	2.281	.023
Confident and full control of a greenhouse	.182	.066	.192	2.767	.006

The coefficients summary in Table 12 indicates "Access to smart greenhouse farming, Practical knowledge and experience, Participation in greenhouse farming, Membership in Community farmers' group and Confident and full control of a greenhouse were associated with P <0.05, revealing that the model was statistically significant in the variations of the dependent variable. They were therefore retained in the model. The resultant model from the coefficients was therefore as follows:

The variables were: The regression model developed as follows:

$$Y= B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4+ B_5X_5 + \varepsilon$$

$$Y= 0.110X_1 + 0.154X_3 + 0.114X_4 + 0.182X_5 – 0.520 + \varepsilon$$

Where:

Y= Adoption of climate-smart agriculture greenhouse technology (Dependent Variable)

B_0 = Constant of Regression

X_1 = Access to smart greenhouse farming

X_2 = Practical knowledge and experience

X_3 = High productivity through Individual participation in greenhouse farming

X_4 = High productivity through membership in Community farmers' group

X_5 = Confident and full control of a greenhouse

ε. = Error term

The SPSS computer software was used to generate the regression statistics at 0.05 level of significance and the results were as shown in Table 11. The promoters of the greenhouse technology should therefore adopt these four empowerment strategies to promote the uptake of smart greenhouses among farmers in the study area.

Correlation between empowerment and moderating variable

Correlation analysis was done to examine the influence of Empowerment and moderating variables using the Spearman's Rank Correlation Coefficient that was used to draw conclusions. The results were as shown in Table 9.

CONCLUSION AND RECOMMENDATION

Conclusion

Kiambu County smallholder farmers under study are well informed about climate-smart greenhouse farming through access to information, leading to empowerment. This awareness is facilitated by farmers' access to various channels of participatory communication, such as television, radio, social media, internet sources and agricultural extension officers. Utilising these participatory communication channels influences farmers' adoption and practice of climate-smart greenhouse farming for self-reliance and increased productivity. In the process, they get empowered and have full control of greenhouse farming.

Empowerment is realized through self-awareness and also through market access using participatory communication channels where they get market information on the greenhouse products from various communication sources at their disposal for instance, cooperative societies, self-help groups, fellow farmers, KALRO website, TV and radio. Farmers can get farm produce for subsistence as well as economic empowerment. Smallholder farmers make a living off greenhouse farming as indicated by the majority of them who earned more than Ksh fifty thousand (50,000) per seasonal harvest of greenhouse farming.

Age, gender, levels of education and income of the farmers also influence the empowerment of farmers towards adoption and practice of climate-smart greenhouse technology. Smallholder farmers with a college level of education and above are more likely to invest in greenhouses for longer durations than other levels. Their knowledge of greenhouse farming has sustained their practice of greenhouse farming. This study concurs with the Participatory Communication Theory (Melkote & Singhal, 2021) that two-way communication is necessary for the empowerment of the poor and the marginalized as opposed to the mere conveyance of information in a top-down manner to achieve development which is often associated with modernisation and dependency paradigms (Servaes, 2020).

The study agrees with (Bessette, 2021) that people-centered communication strategies should be incorporated into the message design when disseminating agricultural information for acceptance of technology because they are responsive to farmers' felt needs as the local community is involved in the decision-making process of their development. The study findings address farmers plight in agricultural production thus the need to learn how to implement effective and sustainable participatory farming to transform farmers' livelihood. This could promote the mainstreaming of participatory farming into development efforts and influence decision-making policies on farming that will shape the development agenda.

Recommendations

The study recommends that to forge greater empowerment of small-scale farmers, there is a need for facilitators (extension officers, journalists, farmers, and village-based advisors) to always ensure that participatory communication approaches are incorporated into messaging and dissemination of agricultural information when developing communication policy and strategy. They should ensure that climate-smart greenhouse information is available and easily accessible through various participatory communication channels that farmers use to interact. These channels should be more engaging, where feedback is instant, as opposed to linear communication that limits the voice of the farmer in the development process.

The study also recommends that policymakers and communication strategists should integrate the ideas and opinions obtained during public participation when drafting the county integration development plan (CIDP) and recommend appropriate participatory communication channels that address farmers' needs. There is also a need for farmers to use these participatory communication tools to access greenhouse information in their quest to liberate themselves from low productivity.

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