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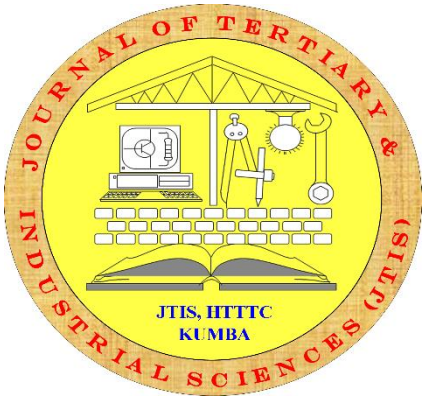

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AGRICULTURE

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THE ADOPTION OF AGRICULTURAL INNOVATIONS: THE CASE OF IMPROVED MAIZE SEEDS

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Abstract
Maize is an important food crop cultivated for food and income but traditional seed practices cause low productivity. This study examines the sources of improved maize seeds, factors influencing the adoption of improved seeds and the adoption challenges faced by farmers in Meme Division, Cameroon. A sample of 248 farmers were investigated using a questionnaire. Analyzed data revealed that IRAD and the Delegation of MINADER were the principal sources of improved seeds. The social and farm characteristic investigated did not significantly influence adoption of improved seeds. However, non-social and farm factors examined like access to extension services, availability of improved seeds and farmer-to-farmer extension influenced their adoption. Common adoption constraints were inadequate capital, inadequate cultivable land and inadequate storage facilities. Awareness is an important stage in the adoption process and agricultural extension has key roles to play to enhance production and income of farmers in Meme Division.

Keywords: Adoption, Agricultural production, Improved seeds, Innovation

1- Introduction

Apart from facilitating economic growth, agriculture also plays a vital role in achieving other developmental goals, such as ensuring food security, promoting employment creation and improving the living standards of people by lifting them out of extreme poverty (Rafael, 2023). Agriculture is an important activity in Cameroon; a country endowed with fertile soil favouring the growth of a wide variety of food crops like maize, cassava, groundnuts,

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cocoyam, plantain, vegetables and cash crops like cocoa, coffee, oil palms, rubber for subsistence and commercial purposes. Maize (*Zea mays*), a food crop cultivated by most smallholder farmers contributes significantly to food security and income of many households in Cameroon. The crop is cultivated in monoculture and mixed cropping systems. The fact that production activities linked to the cultivation of the crop is not labour intensive motivates female farmers to engage in the production. In addition maize constitutes the principal staple for over 15 million people in Cameroon and it is the principal raw material for food processing, brewery, livestock feed, and agro-based industries (Mbah et al., 2023). In 2020, Cameroon produced about 2,088,000 tons of maize (FAOSTAT, 2020).

Agricultural innovations enhance production to meet the ever-rising food needs of the growing population. Agricultural innovation encompasses the development and application of new technologies, practices, and products aimed at improving agricultural productivity, sustainability and efficiency (Kimani, 2024). The adoption of innovative technologies in the agriculture sector provides the benefits of transforming the sector into a viable economic impetus and a means of propelling rural development (Kapari et al., 2023). In developing countries, improving the livelihoods of rural farm households through agricultural productivity would remain a mere wish if agricultural technology adoption rate is low (Yokamo, 2020).

Agricultural productivity is highly dependent on improved practices and improved seed is one of the many agricultural innovations disseminated by agricultural extension to farmers. The state of Cameroon, through the Ministry of Agriculture and Rural Development (MINADER) provides improved seeds to farmers through projects like Maize project or through IRAD (Agricultural Research Institute for Development) which is the engine of agricultural research and innovations in Cameroon. Acquisition of improve seed can also be by purchase from agricultural shops. Sinyolo (2020) opined that adoption of improved maize varieties would improve food security of smallholder farming households. Marfo-Ahenkora (2023) reiterated that sustaining and improving maize productivity would reduce smallholder farmers' food insecurity and poverty. If the productivity of farmers will improve, efforts would need to be made by concerned authorities and stakeholders in agriculture to find means through which farmers' efficiency in the use of modern/improve farm implement would be enhanced to make farmers more productive (Umar et al., 2022). The choice to embrace a new technology is based on a thorough examination of a variety of technical, human, geographical, institutional, and socioeconomic aspects (Amante, 2023). Agricultural extension services play a crucial role in training and skill development, which is vital in ensuring that farmers are well equipped to adopt modern and efficient farming

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methods (Rai et al., 2023). Research, extension and farmers' linkages are essential for the diffusion and adoption of agricultural innovations.

Maize is an important food crop cultivated for food and income in Meme Division. It is observed that farmers are still embedded in the traditional seed practice of saving some of the previous maize harvest as seed for future planting which could be the primary cause of low productivity. Improved maize seeds trigger higher yields and knowledge on where to source them is important likewise factors which influence their adoption. There is need for farmers to adopt improve maize seeds in order to enhance agricultural production to meet the increasing food demands of the ever rising population and increase farm revenue. This study identifies the different sources of improve maize seeds used by farmers and further examines factors influencing the adoption of improve maize seeds likewise the adoption challenges faced by farmers in Meme Division, Cameroon.

2- Methodology

Meme Division is situated in agro-ecological zone IV of Cameroon with an annual rainfall of 2200mm and an average temperature of 31°C (IRAD Barombi, 2013). Data was collected through questionnaire administration to a sample of 248 registered farmers cultivating maize in Kumba, Meme Division. The questionnaire addressed issues on the social characteristics of the farmers, sources of improved maize seeds, factors influencing the adoption of improved maize seeds and adoption constraints faced by the farmers. The collected data were analysed using the SPSS for descriptive and inferential statistic. The Logit regression model was used to establish the relationship between the likelihood of adoption of improved seed and the social characteristics of the farmers. Other non-social and farm variables like access to extension services, extension method used, resources of the farmer, availability of improved seeds, agent's personal effort and farmer-to-farmer extension we equally investigated to capture their effect on the adoption process. Theoretically, the Logit model was expressed as:

$$\mu = B_0 + B_1X_1 + B_2X_2 + \ldots\ldots\ldots B_nX_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

μ = Likelihood of Adoption, otherwise labeled as ADOPT.

B_0 = intercept;

$B_1 \ldots\ldots B_n$ = estimated parameters;

$X_1 \ldots\ldots X_n$ = Set of independent variables.

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For this research, the Logit regression model equation for the relationship between social and farm characteristics of respondents and the likelihood of adoption was specified as:

$ADOPT=B_0+B_1AGE+B_2SEX+B_3EDU+B_4HHS+B_5FS+B_6XP+ B_7FSyst+B_8FPur +e$….(2)

Where:

AGE = Age of respondents (years).

SEX = Sex of respondents (1 for male and 0 for female).

EDU = Educational level (measured in qualifications obtained).

HHS = Household size (measured in number of persons living under the care of the respondent).

FS = Farm size (total area of land owned and used for production by respondent measured in hectares).

EXP = Farming experience (years as a farmer)

FSyst= Farming system (monoculture or mixed farming)

PPur= Farming purpose (subsistence or commercial)

3- Results and Discussions

Social and farm characteristics of the respondents

The social characteristics of the respondents in relation to sex, age, education and household size are presented on Table 1. A majority of the respondents were male (56%) and 44% were female. Contrary to perceptions that food crops like maize are women's crops, this research reveals that men dominate their cultivation in the study area. This could be justified by the fact that intensive cultivation of the crop is for commercial purpose and those involved are mostly members of Common Initiative Groups (CIGs), an agricultural extension initiative dominated by men in the study zone. Wordofa et al. (2021) observed that farm households who used improved agricultural technologies were majorly male farmers. The dominant age group was 40 - 49 years old (82.7%). The observed age group of 40-49 years comes with responsibility and zeal to be productive and explore potentials in agriculture and its related activities. Most of the farmers had attained secondary education (69%). Education permits farmers to assimilate information, facilitate adoption process, and enhance effective use of the innovation adopted. Moreover, 50% of households had 11 – 15 members. Large households mean that family provides the labour force needed for farm operations. An

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increase in household size increases the number of labour available to work on the farm and by extension labour productivity (Adepoju and Obialo, 2022).

Table 1: Demographic characteristics of the farmers surveyed

Parameter	*Frequency*	*Percent*
Sex ratio		
Male	139	56
Female	109	44
Total	248	100
Age group		
30 - 39	10	4
40 - 49	205	82.7
50 - 59	29	11.7
60 and above	4	1.6
Total	248	100
Level of education		
Primary	31	12.5
Secondary	171	69
High School	28	11.3
Tertiary	18	7.3
Total	248	100
Household size		
1-5	11	4.4
6-10	50	20.2
11-15	124	50
>15	61	24.6
Total	248	100

Source: Fieldwork 2024

Information on farm size, farming experience, farming purpose and farming system are illustrated on Table 2. Most of the farms exploited were of size 6-10ha (62.1%) and a greater proportion of the respondents (73.8%) had farming experience between 10 – 19 years. The number of years engaged in the cultivation of maize by a farmer is considered his experience. Continuous practice of an occupation makes a farmer more efficient and productive (Taku et al., 2020). Agriculture is mostly commercial (81.5%) with monoculture being the dominant practice representing 74.6%. Commercial agriculture adds more value to farmer's income compared to when only excesses are marketed for income purpose.

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Table 2: Farm characteristics of the respondents

Parameter	*Frequency*	*Percent*
Farm size		
<1 ha	3	1.2
2 - 5 ha	13	5.2
6 - 10 ha	154	62.1
> 10 ha	78	31.5
Total	248	100
Farming experience		
<10 years	49	19.7
10 - 19 years	183	73.8
20 years and above	16	6.5
Total	248	100
Farming purpose		
Subsistence	2	0.8
Commercial	202	81.5
Both	44	17.7
Total	248	100
Farming system		
Mixed cropping	63	25.4
Monoculture	185	74.6
Total	248	100

Source: Fieldwork

Sources of improved maize seeds used by farmers in the study area

Figure 1 presents the different sources of seed acquisition. IRAD was the most common source of seed acquisition representing 31.70%. Another 30.40% of respondents said they purchased improved maize seeds from the Delegation of MINADER while 20.60% mentioned the South West Development Authority (SOWEDA) as their source of improved maize seeds. The least mentioned sources were Agricultural shops (12.10%) and State's subsidies to farmers (5.20%). Similar findings were observed in Ifie et al. (2022), where farmers acknowledged the district offices of the Ministry for Food and Agriculture as the source of improved seeds. Dokyi et al. (2020) equally noted that extension agents help producers to access information on productivity-enhancing technologies and link farmers to service providers and input markets.

Seed is a vital input in agricultural production and its availability and knowledge on where to source when needed for planting cannot be over-emphasized. Improved seeds generated from scientific centres, aim to resolve problems of low yields due to pest, diseases, drought and climate related factors. Agricultural research will be of no value if the research-

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generated seeds are not adopted to fulfill their purpose. The Ministry of Agriculture liaise with IRAD to make research induced findings available to the farmers who are the end-users. The Delegation of Agriculture through the extension services facilitate farmers' access to improve seeds and disseminate Good Agricultural Practices (GAP) which enhance productivity of the seeds. SOWEDA, an important actor in agricultural development in Cameroon accompanies farmers through capacity building workshops and also through its production and distribution of improved maize seeds for greater agricultural efficiency, productivity and profitability. State's subsidization in agriculture is an important support system mitigating the cost of production and encouraging farmers in their agricultural endeavour even though there has been a decline in this support system to farmers in recent times.

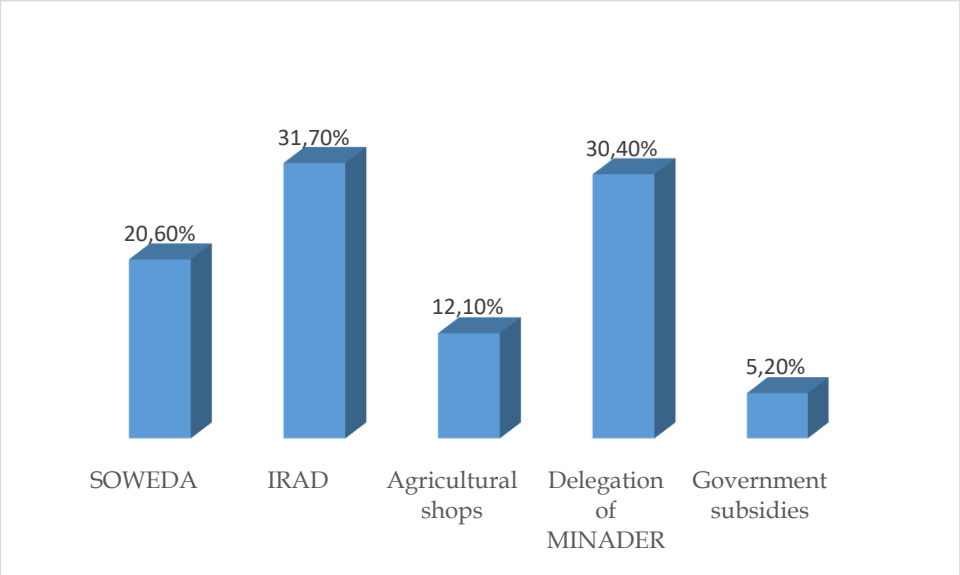

Figure 1: Sources of improved maize seeds

Source: Fieldwork

Determinants of farmers' adoption of improved maize seeds in the study area

The social and farm characteristics tested using the Logit regression were sex, age, level of education, household size, farm size, farming experience, farming purpose and farming system. Results of the analysis as presented on Table 3 revealed that even though the tested variables positively influenced the adoption of improve maize seeds, the effect was statistically not significant for all cases with $p > 0.05$. The finding is at variance with Dokyi et al. (2020) where age, education, farm size, household size and farming experience had a significant influence on the adoption of improved maize varieties.

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Table 3: Socio-economic characteristics determining the adoption of improved seeds

	B	sign	Exp(B)	95% C.I. for EXP(B)	
				Lower	Upper
Sex	.525	.061	.592	.387	.904
Age	.397	.258	.672	.351	1.285
Level of educ	1.950	.090	7.031	.736	67.180
Household size	.125	.835	.882	.272	2.862
Farm size	.205	.279	.814	.472	1.406
Farming exp	2.392	.084	1.335	.447	3.987
Farm purpose	.866	.064	1.52	.222	1.671
Farm system	.149	.515	1.160	.742	1.813

Significant at P<0.05

Source: Fieldwork

The adoption of innovations is influenced by attributes linked to the social characteristics of the farmer, the farm, the innovation itself and the extension agent advocating for its adoption. The fact that the socio-economic variables tested in the study did not significantly influence the adoption of improve maize seeds imply that other variables not considered in the Logit regression but captured through the questionnaire might be responsible for farmers' adoption of improved maize seeds. These variables are: access to extension services, extension method used in dissemination of information, cost of the improved seeds, availability of seeds, personal effort of the extension agent, availability of information on improved seeds and farmer-to –farmer extension as expressed in Figure 2. Results shows that 83.7% of the respondents acknowledged that access to extension services motivated and facilitated the adoption of improved seeds. Agricultural extension is a vital support system to farmers, accompanying them in their agricultural activities to improve production and productivity. Extension disseminate innovations and motivate farmers to adopt them for better agricultural efficiency and livelihood. The role of agricultural extension is to bridge the gap between farmers and research such that research findings are available to the farmers the end users and at same time take farmers problems to research centres so that innovations are tailored to the needs of the farmers (Taku et al., 2020). Similarly, Mohammed et al., (2020) noted that access to extension services significantly relate to famers decision to adopt improved maize varieties. To 81.2% of the farmers, the fact that the improved seeds were available on time was an added advantage for its adoption as the farmers could source seeds whenever it was time to plant. Timing of farm operations in agriculture is vital because when seeds are available and cultivated on time, with respect to the farm season calendar, they perform better compared to when they are planted late. Similarly, Myeni and Moeletsi (2023) noted that availability of seeds and resources at the disposal of the farmer influence

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the adoption of improved seed varieties. In Katel et al. (2020), the unavailability of inputs was perceived as a major problem to adoption rate. Farmer -to -farmer extension was another important determinant of improved seed adoption as noted by 80.5% of the respondents. Farmers share their experiences with one another and active adoption where a farmer takes up an innovation and influence other farmers to do same speeds up the diffusion and adoption rate. Another 79.3% of the farmers opined that the group extension method used in dissemination of information on improved seed was a determinant factor in the adoption of improved maize seed. Watching a demonstration improves awareness, knowledge, and skills. Farmers like to see how a new idea works and demonstrations like result demonstration where farmers can see the outcome of the innovation in comparism with traditional practices easily influence their perception of the innovation and the desire to implement it. This is consistent with Ifie et al. (2022) that awareness creation through activities such as demonstration trials and farmer field schools are drivers of the process of technology adoption among farmers. Chete (2021) asserted that seed availability and observation of experimental trials respond positively to the probability of adopting new maize variety although insignificant. Personal effort of the extension agent was advocated by (78.9%) of the respondents. Adoption necessitates a change in mentality of the farmer about traditional practices in favour of modern technology and sensitization on how to use improved seeds. The tendency is that farmers will always want to continue with the traditional practices and the extension agent must be patient, tolerant and skillful when introducing an innovation. The relative advantage of improved seeds over local seeds is a persuasive message of extension to the farmers that prepares and stimulates the farmers' state of mind to bring about change in mentality about the innovation introduced. Becerra-Encinales et al. (2024) asserted that the dialogic interaction between extension agents and farmers emerges as a core element in the sustainable adoption of agricultural technologies. Another 67.7% of the farmers advocated for the resources of the farmer. Farmers with higher farm income are more likely to adopt improved maize varieties. This is further supported by Mohammed et al. (2020) that the larger the income of respondents, the greater the probability of adoption of maize production technologies among farmers.

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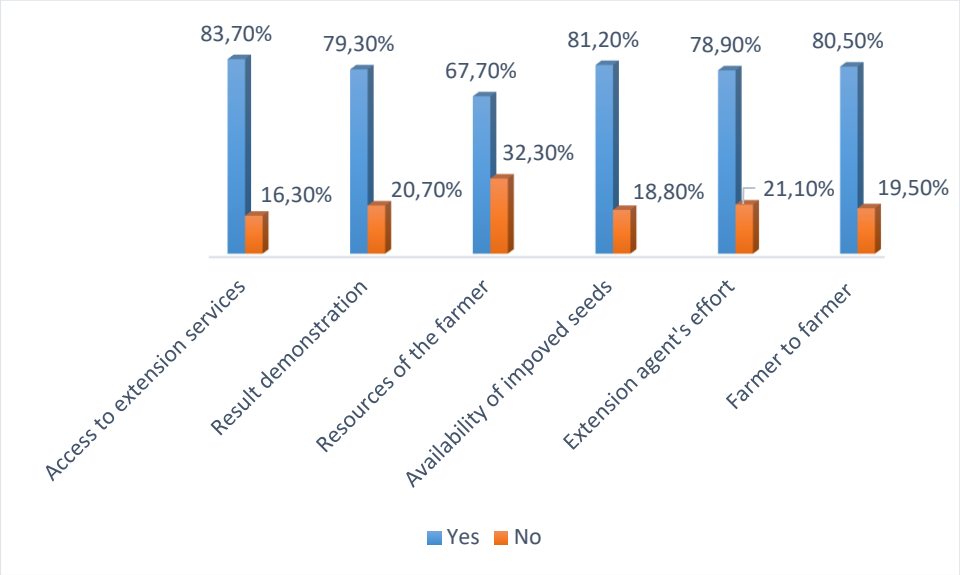

Figure 2: Factors influencing the adoption of improve maize seeds

Source: Fieldwork

Constraints in the adoption of improved maize seeds

Table 4 presents adoption constraints as experienced by farmers. Inadequate capital representing 78.12% ranked 1st as adoption constraint. The second-generation seeds are less vigorous than the first generation ones and if farmers want to attain the goal of increase productivity, they have to purchase improved seeds every planting season thus increasing the cost of production and the need to increase capital. Inadequate cultivable land (71.03%) was ranked 2nd as adoption constraint. Land is an important factor in agricultural production and access influence area cultivated. Land is increasingly growing scarce due to urbanization and population growth, reducing arable land. Farmers are constraint to work almost same area with no possibility of expansion**.** Inadequate storage facilities constituting 70.73% was ranked the 3rd constraint and poor market price of maize (63.30) ranked 4th on the list of adoption constraints. After producing, farmers need appropriate storage facilities for the maize to ensure that it reaches the market and consumers in a good state. Storage facilities preserve the quality of the maize and reduces waste resulting from weevil infestation and spoilage. However, farmers struggle with inadequate storage facilities leading to high post-harvest losses, wastage of time, energy and resources. When the price of maize in the market is high, farmers are motivated to adopt improved seeds to boost their production and increase profits. The prices of commodities in the study area fluctuate and are often low, putting the farmer at the mercy of the consumer. Without better market prices, farmers may be discouraged to adopt improved maize varieties. Derailment of improved seeds by extension agents (55.72%) was of the 5th rank. Some extension agents are

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untrustworthy and derail state's subsidies like improved seeds meant to assist farmers in their agricultural activities for their personal usage or sell them. On the 6th rank was myths associated with improved varieties (53.30%). There is the myth that maize from improved seeds are not palatable making consumers to prefer the local varieties. Similar constraints were observed in Chete (2021), Quarshie et al. (2021) and Mohammed et al. (2020).

Table 4: Constraints to the adoption of improved maize seeds

Variables	Frequency	Percentage	Rank
Inadequate storages facilities	85	70.73	3rd
Inadequate capital	94	78.12	1st
Inadequate cultivable land	86	71.03	2nd
Derailment of improved seeds by extension agents	67	55.72	5th
Myths associated with improved varieties	64	53.30	6th
Poor market price of maize	76	63.30	4th

Multiple responses were recorded

Source: Fieldwork

4- Conclusion

Concerning the summary of findings, IRAD and the Delegation of MINADER were highlighted as the principal sources of improved seeds used by the farmers. Access to extension services, availability of improved seeds and farmer-to-farmer extension are the main factors influencing the adoption of improved seeds in the study area. The main adoption constraints identified were inadequate capital, inadequate cultivable land and inadequate storage facilities. The policy implication based on the constraints calls for reconsideration of agricultural reforms like putting in place storage facilities, subsidizing inputs like seeds, revisiting land tenure systems, loan modalities and price control of market products so that farmers whose livelihoods depends on agriculture can have a take home package at the end of the season. It is recommended that agricultural extension agency been the link between research and farmers should make innovations accessible to farmers who are the end-users and create awareness of improved maize seeds and train farmers on recommended agricultural practices that meet their needs and foster productivity. It would be interesting to investigate the role of farmer-to-farmer extension in the diffusion and adoption of agricultural innovations in order to trigger the much-desired agricultural growth given that agriculture is the doorway to food security and income elevation of farmers.

Conflict of interest

Authors declare that no conflict of interest exist.

Authors' contributions

This work was carried out in collaboration among all authors. Author NJT designed the study, performed the statistical analysis, and wrote the first draft of the manuscript. Author NRN and managed literature searches, ECA collected the data of the study and INM wrote the protocol. All authors read and approved the final manuscript.

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