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Agricultural technology adoption, productivity, and poverty reduction in Cameroon: A mediating analysis

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ABSTRACT

Purpose — *Often people's hesitation to accept new technology stems from a misconception of what technology truly entails. Pictures of future robots and robotics typically spring to mind when people think of technology. Many poor nations rely heavily on agriculture for their survival. Most of the world's impoverished population works in agriculture and lives in rural regions. Indirectly and directly, it contributes to expanding industries and providing food for the world's population. This paper investigates the effects of agricultural technology adoption on poverty reduction.*

Method — *The study adopted both the survey and causal research designs. The researcher employed purposive and snow ball sampling techniques. A total of 384 households were sampled for the study. Data for this study was gotten with the help of a structured questionnaire from household in Tubah Sub-Division of Cameroon and was analysed using inferential statistics.*

Result — *This study revealed that consumable and durable inputs significantly positively affect agricultural productivity in the sub-division at 1% and 5% degree of significance respectively. The results further showed that agricultural productivity had a mediating positive effect on poverty reduction at 1% degree of significance.*

Contribution — *Most studies on agricultural technology adoption in developing countries only focus on short-term impacts. In contrast, this study provides information on the long-term effects of technology adoption on farmers' livelihoods and the environment.*

Keywords: *technology adoption, agriculture output, productivity, poverty reduction*

INTRODUCTION

It has been stated that in order to end hunger, keep up with population growth, and adapt to climate change, developing nations need to "dramatically" enhance agricultural innovation and the use of technology by farmers. According to World Bank (2021), despite the fact that advancements in communication technology have made it easier to expand small farmers' access to markets, credit, and insurance, these groups still confront substantial challenges like increasing global population, providing a livelihood for farmers, and protecting the environment.

It's a crucial factor in fighting poverty, boosting the economy, ensuring people have enough to eat, and advancing communities in rural areas. Most smallholder farmers still use time-tested techniques that have proven ineffective, reducing overall output. More than 70 percent of the world's corn supply comes from small farmers using time-honored techniques in the vast majority of poor nations (Muzari, Gatsi & Muvhunzi, 2012). Most maize is cultivated in rain-fed settings; irrigation is utilised mainly in certain places; extremely limited usage of chemical fertilisers and insect control results in a very low yield. Insights like this may help policymakers develop new approaches to boosting output and productivity by using cutting-edge technology that are also user-friendly for farmers.

However, whereas grain yields have grown six-fold in East Asia over the last 40 years, helping to significantly reduce poverty in China and other East Asian nations, they have barely doubled in Sub-Saharan Africa and portions of South Asia, leading to correspondingly modest reductions in poverty (Shiferaw, Prasanna, Hellin, & Bänziger, 2011). It is also highlighted that there is a "growing R&D expenditure discrepancy". In 2011, investment in agricultural R&D amounted to 3.25 percent of agricultural gross domestic product (GDP) in rich nations, but just 0.5 percent in poor ones. As a percentage of agricultural GDP, Africa and South Asia had the lowest expenditure on agricultural R&D compared to Brazil and China. Research and development budgets have been cut in half of Africa's nations. Some causes of low research and development in developing countries include limited funding, lack of infrastructure, brain drain, political instability and conflicts, weak Intellectual Property Rights, etc. Addressing these challenges requires sustained investment in research and development in developing countries, building infrastructure, investing in education and training, and creating a supportive policy environment.

There has been a lot of talk about how a farmer adopting new technology and methods is a "key driver" in improving agricultural output and financial success. In this setting, farmers may increase yields, better control inputs, try out novel

crops and production methods, and improve product quality all while saving resources and adjusting to climate change (Wreford, Ignaciuk & Gruère, 2017).

About 80% of Cameroon's GDP comes from its primary sector, which includes agriculture, which employs about 70% of the country's working population. It brings in 15% of the government's overall income, accounting for a third of the country's export earnings. Despite this promising background, Cameroon's agricultural industry is beset by several challenges that jeopardise the country's capacity to satisfy its rising food needs (WWF, 2022). Although Cameroon has low-middle income, poverty and inequality are worsening in the north, notably in the North-West, which is plagued by violence.

The foundation of Cameroon's agricultural production system is the pursuit of ever-increasing productivity and efficiency in output. Food production is steadily falling despite rising food demands and its importance in meeting the nutritional needs of a growing global population facing more difficulties due to climate change (GHI, 2017). However, a recent Global Agricultural Productivity study update predicts that just 8% of SSA and Cameroon's food needs would be satisfied by 2030 (GHI, 2017). This worrisome situation necessitates a fresh investigation of the link between agricultural technology adoption and poverty reduction. This study focuses on the effects of agricultural technology adoption on poverty reduction in Tubah Sub-Division of the North West Region of Cameroon. Though technology is highly preached, the fact that farmer continues to be reported in research in Africa as poor may suggest that the adoption is weak or not yielding desired result.

Agricultural technology adoption describes equipment, genetic material, farming techniques, and agricultural inputs that have been developed to improve the effectiveness of agriculture. Poverty reduction means reducing a state of deprivation in which a person cannot meet his or her basic physical and psychological needs due to a lack of adequate economic resources. The effect of agricultural technology adoption on poverty reduction via agricultural productivity is analysed in this study based on the innovation theory of Rogers (1962).

The notion of innovation dissemination served as theoretical foundation for this study. Many people look to the Diffusion of Innovation idea as a useful change paradigm for directing technological innovation, particularly when the innovation is tailored to different levels of users. The new technology's market share will ultimately achieve saturation when successive groups of customers embrace it. How, why, and how quickly new ideas and technology spread across a specific society is the subject of the diffusion of innovation theory by Rogers (1995). In Rogers' view, diffusion occurs when a new idea spreads among a

group of people through time. The notion of invention spread has various antecedents, originating in various fields.

Despite this, there has been some level of failure in spreading. A failure in diffusion is frequently defined as a failure to attain or near 100% adoption because of its inherent limitations, competition from other innovations, or a lack of awareness. It is possible for a failed diffusion to be extensively embraced in certain clusters, but to have little influence on those who are not directly connected to them.

Adopting new agricultural technologies may benefit from the diffusion of innovation, which also helps administrators and IT professionals. Since the idea is linked with strong tactics for implementing novel change, it also helps the intended recipients of the transformation. The theory offers a framework for organising developments in the field of informatics and is a good match for the spread of new technologies.

Most studies on agricultural technology adoption in developing countries only focus on short-term impacts. At the same time, there is limited information on the long-term effects of technology adoption on farmers' livelihoods and the environment. While farmers have successfully adopted some technologies in certain regions, there is limited research on their scalability and replicability in other regions with different agro-ecological and socio-economic conditions. To this end, this paper seeks to investigate the effects of agricultural technology adoption on poverty reduction.

METHOD

The study set out to analyse the effects of agricultural technology adoption on poverty reduction in Tubah Sub-Division of the North West Region of Cameroon. The researcher adopted a mixed research design (survey and causal approaches were used to express future predictions of the phenomenon under study). Data was gotten with the help of a structured questionnaire and analysed using both descriptive and inferential statistics. Data was obtained through a survey of households which elicited information on durable inputs, consumable inputs, agricultural productivity and poverty reduction. The causal relationship between agricultural technology adoption (ATA) and poverty reduction (PA) was specified as follow.

$$PR = f(ATA) \ldots\ldots (1)$$

Equation 1 shows the functional relationship between agricultural technology adoption and poverty reduction. From the functional model we derived an econometric model that shows the relationship between agricultural technology adoption and poverty reduction.

The econometric model of the above functional model is specified as:

$$PR = \beta_1 DI + \beta_2 CI + \beta_3 M_e + \varepsilon_1 \quad .....(2)$$

Where:
Durable Inputs (DI)
Consumable Inputs (CI)
Agricultural productivity (M_e), with M_e mediating variable in the model

The observed variables presented above represent durable inputs (seed drilling, farm weeding, crop spraying, harvesting with the help of machines, vaccination of animal and birds, processing of agricultural harvests, liming, irrigation, etc) and consumable outputs (high-quality seeds, fertilizer, insecticides, herbicides, weedicide, pesticides, animal feed, etc) while the dependent variable poverty reduction was measured using socio-economic dimensions of poverty (standard of living, health and former education). Both the structural and factor loading model is estimated using Smart PLS4 subjecting the hypothesized model to maximum likelihood estimation approach. The models are specified without intercept because the Z score of any constant is zero. The theoretical expectations of the sign of the coefficients apriori are both negative and positive.

RESULT AND DISCUSSION

Construct reliability and validity

According to Sullivan and Niemi (1979), reliability is the fundamental basic property of empirical measurements. The reliability of a measurement technique is determined by how well the ideas being assessed are reflected in the manifest or observable variables or indicators (Thalut et al, 2020). This study used composite and Cronbach alpha coefficient to test the reliability. Fornell and Larcker (1981) and Nunally and Bernstein (1994) both proposed a reliability threshold of 0.7 for items. The composite reliability is the most robust measure of internal consistency. These tests are commonly used to assess the degree of reliability between the items used in measuring the constructs. The

measurement model adopted in this study was reflexive. The test result is present in the table below:

Table 1. Reliability test result

	Cronbach's alpha	rho_A	Composite reliability
AP	0.825	0.870	0.880
CI	0.920	0.996	0.889
DI	0.831	0.859	0.862
PR	0.852	0.871	0.911

Source**:** field survey (2022)

The result in Table 1 shows strong evidence of internal consistency as the composite reliability for all the constructs was well above the minimum cut-off criteria. The implication of this finding is that, the indicators that were used in measuring the construct; agricultural productivity, consumable inputs, durable inputs and poverty reduction.

Convergent reliability

In terms of the previously described concept of convergent validity, this refers to how well a collection of indicators represents the theoretical latent construct they are meant to assess (Thalut et al., 2020). The convergent validity of the factors was examined by looking at their AVEs (Average Variance Extracted). When the mean variance retrieved is more than 0.5, as stated by Fornell and Larcker (1981), convergent validity is present. Only when using a reflexive measuring strategy with loading factors is convergent validity significant. The test result is presented on the table below:

Table 2. Test result for convergent validity

	Average variance extracted (AVE)
AP	0.647
CI	0.556
DI	0.536
PR	0.773

Source: field survey (2022)

The AVE was statistically significant as it was more than the 0.5 threshold suggested by Fornell and Larcker (1981). It shows that there is convergent validity between the constructs used in the research. This implies that the summated score for the constructs of agricultural productivity, consumable inputs and poverty reduction all reflect the theoretical latent construct they were

designed to measure. In other words, the result of the convergent validity shows strong evidence of construct validity.

Discriminant validity

Table 3. Fornell-Larcker criterion

	AP	CI	DI	PR
AP	0.000	0.000	0.000	0.000
CI	0.193	0.000	0.000	0.000
DI	0.251	0.263	0.000	0.000
PR	0.957	0.280	0.340	0.000

Source: field survey (2022)

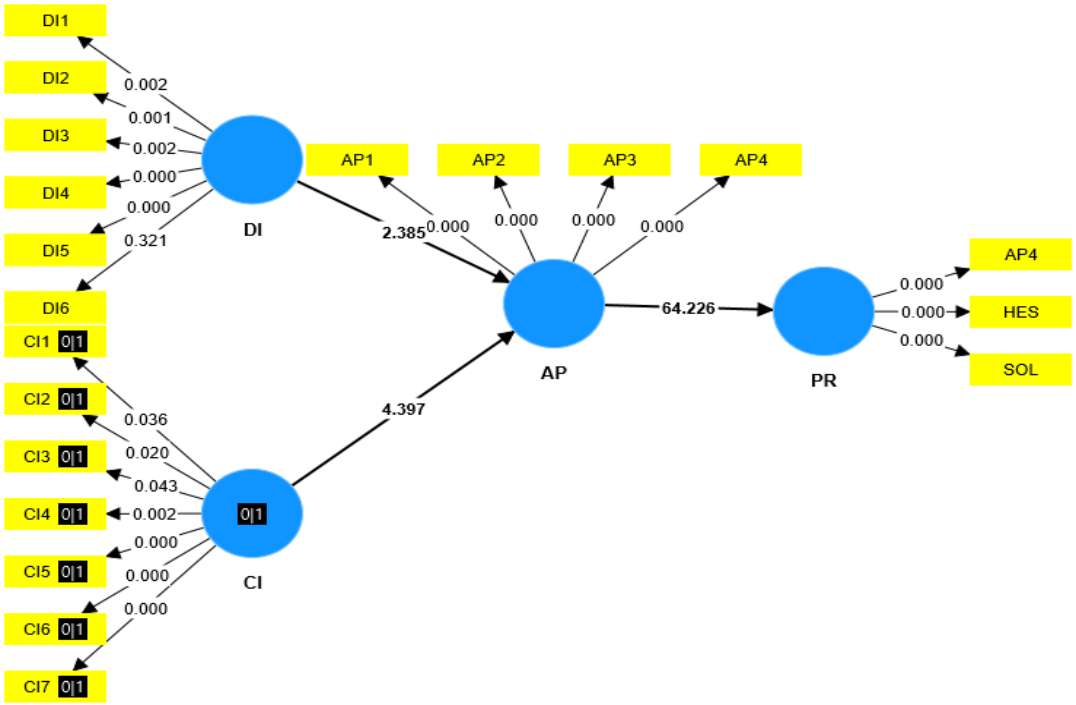
This kind of validity, known as discriminant validity (Carmines & Zeller, 1979), looks at how well different constructs may be distinguished from one another by using indicators that are more strongly connected with their respective latent variables. The diagonal components are the square root of the AVE for each of the construct while the off-diagonal elements are the pairwise correlation between constructs. By comparing the square of the average variance extracted (AVE) and the correlation (r^2) between the two constructs, that is, if AVE squared >r^2, therefore there is of the existence of discriminant validity in the study.

Discriminant validity is strongly supported by the data in table 3. This discovery lends credence to the notion that the construct's indications are one-of-a-kind. That is to say, the indicators serve simply to indicate the theoretical construct under investigation, and not any erroneous readings or other notions.

Bootstrapping construct result

Using a technique called bootstrapping, SmartPLS gives t-statistics to assess the importance of the inner and outer models (Wong, 2013). The endogenous factor in this model is poverty reduction, while the exogenous are durable and consumable inputs. The bootstrapping t-statistics estimates were used to evaluate the suggested model further. It is observed from the construct that durable and consumable inputs were statistically significant at 1%.

Figure 1. Bootstrapping construct results



Source: field survey (2022)

Bootstrapping path coefficients results

Table 7. Path Coefficients (Mean, STDEV, T-Values, P-Values)

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
CI -> AP	0.649	0.658	0.147	4.397	0.000
DI -> AP	0.284	0.284	0.119	2.385	0.017
AP -> PR	0.855	0.857	0.013	64.226	0.000

Source: field survey (2022)

Results from the construct show that durable inputs are positive meaning that there is a direct or positive effect of durable inputs on agricultural productivity in Tubah Sub-Division of the North West Region of Cameroon. The result is statistically significant at 1%. This finding is in line with our priori expectation and good for policy implication.

The coefficient consumable inputs have as coefficient a positive value meaning there is a direct effect of consumable inputs on agricultural productivity in Tubah

Sub-Division of the North West Region of Cameroon. In terms of marginal value, a unit increase in consumable inputs will result in a 0.284 unit increase in agricultural productivity in Tubah Sub-Division of the North West Region of Cameroon. The result is statistically significant at 5%. This finding is also in line with our priori expectation and good for policy implication.

Lastly the mediating effect of agricultural productivity was found to exert a positive effect on poverty reduction in Tubah Sub-Division of the North West Region of Cameroon. Everything being equal, a unit increase in agricultural productivity will bring about a 0.855 increase in poverty reduction in Tubah Sub-Division of the North West Region of Cameroon. This finding is also in line with our priori expectation. The finding was found to be statistically significant.

Discussion

Results from the construct show that consumable inputs are positive (0.649) meaning that there is a direct or positive effect of consumable inputs on agricultural productivity in Tubah Sub-Division of the North West Region of Cameroon. The result is statistically significant at 1%. This finding is in line with the our priori expectation and good for policy implication. This is inline with that of Minten and Barrett (2008) who found that communes with higher rates of implementation of improved agricultural technology and, as a result, higher crop yields had lower food costs, higher actual incomes for unskilled labour, and better health metrics after adjusting for geographical and physical characteristics. Yamta and Midala (2014) showed that new agriculture technologies and inputs were given to citizens in the state through this program and job opportunities were developed for unemployed youth in the state. At $p>0.05$, the effect of this software was found to be statistically important. Finally, the poverty alleviation program has had a significant positive effect on the residents of Borno State. Adekambi, Diagne, Simtowe, and Biaou (2009) indicated that accelerating the adoption of NERICA varieties by farmers could help to alleviate poverty. Feleke, Manyong, Abdoulaye, and Alene (2016) discovered that non-poor and female-headed households benefited from technological adoption rather than poor and male-headed households. The findings provide compelling proof that cassava technology should be promoted in a focused manner as part of a successful poverty mitigation and long-term agricultural development policy in Africa. Ihek and Nwaru (2013) revealed that the use of inorganic fertilizer, enhanced seed, terracing, crop residue recycling, crop rotation, and the use of animal waste were the most widely accepted innovations/technologies, according to data review.

The coefficient durable inputs have as coefficient a positive value (0.284) meaning there is a direct effect of consumable inputs on agricultural productivity in Tubah Sub-Division of the North West Region of Cameroon. In terms of marginal value, a unit increase in durable inputs will result in a 0.284 unit increase in agricultural productivity in Tubah Sub-Division of the North West Region of Cameroon. The result is statistically significant at 5%. This finding is in line with the our priori expectation and good for policy implication. This finding is inline with that of Dhrifi (2014) who revealed that agricultural development would result in a 32 percent reduction in poverty. It also stipulated that the government would intervene to invest in modern technologies in order to enable farmers to reap the benefits of technical progress by increasing agricultural production and, as a result, lowering poverty rates. Umaru and Tende (2013) indicated that the use of management technologies in small business operations could aid in the reduction of poverty in Nigeria. Asfaw and Shiferaw (2010) Adoption of advanced agricultural technology had a substantial positive effect on crop income, but the impact on consumer spending was mixed, according to the report. Shaw (2014) showed that access to credit, agricultural records, and membership in a farmer's cooperative are the factors most closely correlated with adoption decisions in all three countries. Fertilizer adoption was strongly affected by access to credit in the technology-specific models, but it was also favourably correlated with farmer education and farm size. The most important influences in irrigation adoption were farm size, access to credit, and access to agricultural technology. Improved storage adoption was closely linked to farmer schooling, land ownership, and credit availability.

Lastly the mediating effect of agricultural productivity was found to exert a positive (0.855) effect on poverty reduction in Tubah Sub-Division of the North West Region of Cameroon. Everything being equal, a unit increase in agricultural productivity will bring about a 0.855 increase in poverty reduction in Tubah Sub-Division of the North West Region of Cameroon. This finding is in line with our priori expectation. The finding was found to be statistically significant. That research has been conducted on the connection between population productivity, agricultural growth, and poverty reduction is consistent with the findings of Bhutto and Bazmi (2007). It was expected that agriculture will remain one of Pakistan's primary economic drivers for the foreseeable future. Since adoption has a positive and significant effect on adopter salaries, this suggests that the role of indigenous agricultural innovation in 'directly' contributing to poverty reduction has a lot of potential to grow. Sebaggala and Okello (2010) showed that there is an important but limited link between poverty and access to agricultural extension and agricultural technology adoption, with poor households having the least access to agricultural extension services and the

lowest adoption of agricultural technology. According to the simulation findings and access to agricultural extension and use of agricultural technologies reduces the likelihood of being bad. Susilastuti (2018) revealed that agricultural land productivity and wetland area productivity had a very close association with agricultural production. Agricultural land productivity was the most important aspect, with a major impact on agricultural production. Agricultural production had no impact on the rate of GRP output. Agricultural production has failed to alleviate hunger. The pace of GRP growth has a major impact on poverty reduction and was the most important factor. Mesele (2019) showed that adopters of either of the study's technology packages have higher per adult food and overall consumption per year, confirming that agricultural technology adoption has a clear and substantial effect on household consumption and poverty reduction for Ethiopia's rural poor. Sahu and Das (2016) observed that sample homes in rural India benefited greatly from the adoption of agricultural-related technologies in the form of increased per capita consumer spending and a decrease in poverty. Productivity development and poverty reduction are facilitated by better rural utilities, irrigation networks, livestock management, permanent properties, access to education, secure land tenure, and equitable access to extension programmes.

CONCLUSION

This study set out to determine the effects of agricultural technological adoption on poverty reduction in Tubah Sub-Division of the North West Region of Cameroon. The results of the survey conducted in this regard on households in the sub-division revealed agricultural technological adoption statistically affect poverty reduction in Tubah Sub-Division of the North West Region of Cameroon. From a policy perspective a number of recommendations emerge from this study. Firstly, there is need to intensify and popularize the effective use of consumable inputs by the households in the Sub-Division by expert/consulting services. Through farmers groups and cooperatives more awareness should be created on the importance of the use of weedicides and insect traps (which are not yet popular amongst households) in agricultural productivity. Again, it would be cheaper for households to acquire consumable inputs such as good quality seeds, new fertilisers (liquid) and insecticides at lower prices if they buy as groups. Also, households should adopt modern techniques of animal breeding as well as diversify their activities.

As concerns durables inputs, it is important for households to step-up the use of machinery in their production activities. Where machinery such as tractors are expensive to be bought by individual households, they can buy as groups or these

equipment can be rented. Also, households need to be educated and sensitized on the use of machinery in weeding, harvesting and irrigation amongst others.

The foregoing measures will increase agricultural productivity and in turn contribute to poverty reduction as farm and non-farm incomes increase, health and nutrition improves, food prices fall, wage employment increases, agriculture becomes a surplus generating sector via rural-urban migration and demand is stimulated in the non-farm sector.

It is suggested that other studies could be conducted to identify the factors that influence the adoption of agricultural technologies in Cameroon. Another study could focus on identifying the specific barriers that prevent farmers in Cameroon from adopting new agricultural technologies.

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