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Farm Management and the Production Efficiency of Rice Farmers in the Western Highlands of Cameroon: Evidenced from a Tobit Analysis Approach

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Authors' contributions

This work was carried out in collaboration among all authors. Author PZN conceived the idea, wrote the introduction, developed the data tools, and collected data. Author TDM did the literature review while author FEM did the methodology. All the authors carried out the analysis. Author FEM did the first review while author TDM did the second. Author PZN did the final review and submitted the manuscript for consideration. All authors read and approved the final manuscript.

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ABSTRACT

The main objective of this study was to examine the effect of farm management on the production efficiency of rice farmers in the Western Highlands of Cameroon. Using a survey research design, data was collected from a sample frame of 260 farmers with the use of a questionnaire. Simple random sampling technique as well as snowball sampling technique was used to collect the needed data for this study where a TOBIT regression was used to analyse the data. Results from the analysis showed that planning exerts a negative significant (1%) effect on rice production efficiency. Contrary to planning, organizing, staffing, directing and control were all seen to exert a positive effect on rice production efficiency. However, organizing, staffing and control were all seen to be insignificant while directing was significant at the 1% level. Generally, the overall model was significant at 5% given that the p-value of overall significance was below 0.05. Thus, it can be concluded that farm management significantly affect rice production efficiency in the Western Highlands of Cameroon. Given these results, the study recommended that the government should partner with some higher institutions in the regions like the Universities of Bamenda and Dschang, given their different agricultural colleges, to help train farmers on rice management tactics. Also, based on the negative coefficients between planning and rice production efficiency, it was recommended that farmers, with help from the local meteorological station should look at the dictates of the weather for the current year before indulging in planting rice. This is to avoid misinterpretations of weather which can compromise efficiency.

Keywords: Farm management; production efficiency; planning; organizing; staffing; directing; control.

1. INTRODUCTION

The word 'farm management' takes precedence from twentieth-century writers in the likes of Butterfield, Heady and Jensen, Dexter and Barber, Barnard and Nix amongst others. For instance, [1] viewed farm management as the process of how a farmer arranges the resources of land, labor, and capital on his farm, while adjusting his practices to suit his specific environment. The goal is to sell his products in a way that maximizes his profits, all while ensuring the sustainability of his land and equipment. Heady and Jensen [2] approach farm management as a branch of economics that focuses on how limited resources are allocated within an individual farm. They see it as a science of making choices and decisions to optimize resource utilization on the farm. Dexter and Barber [3] view farm management as the organization and utilization of resources within a farm business. They emphasize the importance of effectively deploying resources such as land, capital, and labor, as well as highlighting the critical role of the farmer's abilities and skills in the success of the farm operation. Barnard and Nix [4] offer a contrasting perspective on farm management, defining it as the process of making decisions that impact the profitability of the farm business. Their focus is on the strategic and tactical choices made by farm managers to ensure the financial success and sustainability of the operation. In fact, one of the latest definitions of this concept was by Kay [5] who defined farm management as a decision-making process that revolves around the allocation of limited resources such as land, labor, and capital among various alternative and competing uses. They emphasize that this allocation process compels farm managers to establish clear goals that serve as a compass for guiding and directing their decision-making activities. By defining specific objectives, managers can effectively prioritize tasks and make strategic choices to maximize resource utilization and improve the overall performance of the farm operation.

It is worth noting that the earliest definition from 1910 is quite similar to the most recent one from 1994. A common theme among most of these definitions is "decision making regarding resource allocation." While these definitions come from respected authorities, they are considered insufficient. The inadequacy lies in the fact that none fully encompass all the key elements of farm management, particularly by failing to emphasize labor or people as much as other resources. Therefore, we propose a more comprehensive definition of farm management as the process by which the farm manager manipulates resources and situations over time, with incomplete information, to achieve their goals, including production efficiency. This definition not only captures the complexity and dynamism of farm management but, with the removal of the word "farm," can also serve as an excellent definition of management in general. This aligns with broader definitions of general management, which is an appendage of this work.

Drawing from Pareto [6], efficiency in rice production is achieved when no further rice output can be gotten without a corresponding increase in the amount of inputs such that the proceeds from production are at the lowest possible cost per unit. To the Neo-classical economists, the analysis of efficiency in peasant economics and agricultural economics in general, concerns the ability of the farm household to produce a given optimal level of output from a given combination of resources or a bundle of resources at the least cost (least cost combination of factors or resources). They reiterated that something is optically efficient if no one is made better-off without making someone else worse-off which is known as Pareto efficiency [6]. Therefore, the efficiency of production units such as rice-producing households is the ability of the household to produce more output of rice from a limited quantity of inputs [7]. Rightfully so as farmers in Cameroon have limited access to these inputs due to different constraints in agricultural production.

Agriculture is the backbone of Cameroons economy. The contribution of agriculture to Cameroon's GDP was above US$ 50 billion in 2017, with 49.8% from agriculture, 18.2% from the industrial sector, and 32% from services [8]. This means the drive for increased production through proper resource distribution in the form of efficiency in agricultural production is one of the government's top development priorities [9]. Rice being a staple food, is receiving much attention given the role it plays in nourishing the people. It plays a vital role in combating food insecurity, as it is widely consumed throughout the country and is one of the staple foods distributed to refugees, internally displaced persons, and disadvantaged households to improve their livelihoods both in Cameroon and globally. Rice consumption per capita in Cameroon has grown enormously during the past years. From its record low in 1961 to its record high in 2015, rice consumption has witnessed untold changes [9].

Extensively, in 1961, the rice consumption per head in Cameroon was estimated at 1.44kgs. This rose to about 11kgs in 1989 though it witnessed a nose dive in the period 1990/1991. This nose dive will then be uplifted from 2011 to about 25.5kg. In 2015, it was seen at 39.3Kg and fell to 36.6kg in 2017 [10]. Looking at it from an expenditure perspective, according to Cameroon's household income and consumption survey [11], in 2007, the average rice consumption per person in Cameroon amounted to FCFA 11,180 in urban areas with populations exceeding 50,000, and FCFA 5,817 in rural areas. The national average was FCFA 7,709. Based on an average rice price of FCFA 300 per kilogram, this equates to approximately 37.3 kg per person in urban areas, 19.4 kg in rural areas, and 25.7 kg per person nationally. Data from the ECAM 4 database in 2014 showed an expenditure of FCFA 10,487 per person, translating to an annual consumption of FCFA 26,200 per person [12]. This shows the high demand for rice in the country.

Even with this high demand, there are just approximately 145,000 farmers who are involved in rice production in Cameroon, with 27,000 households producing about 200,000 tons of rice though the country needs about 600,000 tons to meet up with demand. This therefore leads to a production crisis. Reports from the country's customs administration shows that rice remains the second most imported product after petroleum. This is telling of its importance. No doubt in 2016, the government attempted to encourage local production by reinstating a 5% custom duty on imported rice [13]. This amongst other measures let to the improvement of the production figure from 200,000 tons in 2008 to 300,000 tons per year in 2018. All these while national demand was far over 600,000 tons [9].

In need to offset this significant gap of over 300,000 tons, the country spent about XAF120 billion to import rice per annum. In the first six months of 2021, Cameroon imported 319,330 tons of rice, according to recent data from the National Institute of Statistics [12]. This marks an increase of 59,038 tons (23%) compared to the 260,292 tons imported during the same period in 2020. To import this volume of rice in the first half of 2021 (H1-2021), the country spent XAF 86 billion, a rise of over XAF 15 billion (21%) from the XAF 70.9 billion spent on rice imports in H1-2020. These imports have impacted the country's trade balance and, indirectly, have benefited neighboring countries [14].

Again, in a bit to improve and expand on rice production, the system of rice intensification (SRI), a rice management technique is being implemented in Cameroon. This system proposes the use of less time and expertise in a diligent manner (a pure characteristic of management) in achieving greater results (yields). The system was developed in Madagascar in the early 1980s by Father Henri de Laulanié, who worked with Malagasy farmers and colleagues between 1961 and 1995 to boost rice production. Initially known only within Madagascar until 1999, SRI is now being tested and promoted in over 15 countries across Asia, Africa, and Latin America. This system has shown the potential to double, or even exceed, rice yields without the use of chemical fertilizers or crop protection agrochemicals. SRI has already enabled thousands of farmers in Madagascar to at least double their yields [15]. This system has been copied in rice farming all over the world including Cameroon.

Again, the government through the various rice development corporations such as the Upper Nun Valley Development Authority (UNVDA) and *Sociétéd'Expansion et de Modernisation de la Riziculture de Yagoua* (SEMRY) have trained farmers on different rice production techniques. The adoption of new rice for Africa (NERICA) in rice fields in the NW region, thanks to UNVDA, has helped to narrow the gap in production. Also, the government runs several programs to encourage rice production in Cameroon, often in conjunction with organizations like the International Research for Agricultural Development (IRAD) (which conducts research to develop new species of rice that provide high and large quality returns and are more resistant to threat as well as the Japan International Cooperation Agency (JICA), which came to Cameroon in 2011 with the aim of developing upland rice and rainfed rice. Since 2011, when the project was launched, JICA alluded to have contributed to the training of nearly 10,000 farmers and the distribution of nearly 75,000 tons of seeds [16].

The analysis above clearly demonstrates that there is still a huge deficit in rice production in Cameroon despite all the efforts put in place [16]. This failure of productivity to meet the continuously high demand has been attributed to poor management techniques used by the farmers in rice production. Ngala et al., [17] for example alluded to the use of poor pre and postharvest management techniques in rice production as the cause of limited rice supply in Cameroon. To them, the methods are based on old rice management techniques which do not take in to cognizance the importance of every step involved in rice production. In their study on integrating best management practices for rice with farmers' existing techniques, Alam [18] demonstrated that combining improved crop management practices with traditional methods can significantly enhance rice productivity. Similarly, Kravchenko [19] showed that rice management influenced yield differences between conventional farming and experimental plots. Farms which were greatly managed showed significant increases in productivity unlike the organic farms.

Kalogiannidis and Syndoukas [20] showed that agricultural workshops and training (a characteristic of staffing) positively affect farm productivity. Again, Maneepitak [21] assessed the impact of water and rice straw management on rice yield and water productivity in Thailand. The researcher found that alternate wetting and drying (AWD) increased rice grain yield by 15% in the wet season and 7% in the dry season compared to continuous flooding (CF). This underscores the importance of water management in improving rice production efficiency in the region. A conclusion gotten by Stuart [22] who examined the effect of best management practices on profitability and sustainability in rice farming in Thailand. The key finding was that implementing practices like cost reduction operating principles (CROP), CROP + AWD, and CROP + drum seeder (DS) technology will improve yields compared to standard farmer practices. This highlights the potential of integrated management packages in enhancing rice productivity.

Carrer et al., [23] focused on the role of Farm Management Information Systems (FMIS) in improving the technical efficiency of citrus farms in Brazil and found that the adoption of FMIS tools like planning and control was a significant determinant of technical efficiency, with each additional tool increasing efficiency by 1.88%. The study emphasized the need for wider adoption of FMIS to improve farm management in citrus farming. A study by Alama [24] on the integration of best management practices (BMP) with farmers' crop management techniques to reduce rice yield gaps in Bangladesh found that integrating BMP with nitrogen management techniques, like LCC-aided N management or USG, showed the potential to increase rice yields, profits, and total rice production. This suggests that such practices should be encouraged among rice farmers in Bangladesh.

As a matter of fact, Alem [25] studying the effect of farm management practices and socioeconomic factors on the economic performance of Norwegian crop farms concluded that proper planning and socioeconomic factors significantly influenced the economic outcomes of crop farms in Norway. The study reinforces the importance of well-organized management strategies for improving farm profitability.

Drawing inspiration from the theoretical model of Rougoor [26], while concentrating on management variables and technical efficiency in flower production in the Netherlands, Trip [27] discovered that producers who excelled in data collection, monitoring, and performance evaluation demonstrated higher levels of technical efficiency. This suggests that strong decision-making processes and management practices are key factors that drive farm efficiency. Ajah and Chukwumah [28] on the socio-economic determinants of Small-scale Rice Farmers' Output in Abuja concluded that socio-economic variables play a substantial role in rice production, despite an R^2 value of 0.376, which indicates that other unexplored factors also contribute to output variability. On the other hand, Oonyu [29] in his study focusing on management practices and rice output in small-scale paddy farms in Uganda found that rice output varied depending on the management practices used by farmers, indicating the importance of proper farm management in increasing productivity, particularly in challenging environments like the Doho wetlands.

A further look at, Winata [30] using secondary data obtained from Central Bureau of Statistic (BPS), and analysing using stochastic frontier showed that age, formal education, participation in agricultural extension programs, and the use of certified seeds were significant factors impacting technical efficiency. This highlights the importance of education, training, and access to quality inputs in improving farm performance. Similarly, Houngue [31] found that factors such as age, gender, education level, and access to credit were identified as key determinants of technical inefficiency. This suggests that addressing socio-economic barriers can play a crucial role in reducing inefficiencies in farming. Again, Nyounibe [9] on rice production efficiency in the western highlands of Cameroon: A Data Envelopment Analysis Approach found that rice producers in the Western highlands of Cameroon exhibit substantial inefficiencies in their production, as evidenced by the overall efficiency rate of 26.4%. The researchers also found that there is a significant difference in the efficiency of rice farmers in the Western highlands of Cameroon with farmers in the West region performing significantly higher (39.4%) than those in the North West region (18.4%). As a check on inefficiency, they recommended that the government should subsidize the prices of farm inputs as a whole in a bit to enable farmers to purchase these inputs, consequently increasing their efficiency.

In line with the above, a study by Jirarud [32] propounded that educational level was negatively associated with technical efficiency, implying that despite being educated, farmers continued using traditional farming methods. This suggests that education alone may not lead to increased efficiency without the adoption of modern or improved techniques. Orlando et al., [33] on their part saw that farmer know-how and adaptive management strategies were essential in managing time and space variability, leading to yield improvements and reduced variability. This underlines the importance of experiential knowledge and skill enhancement in sustainable farming practices. As a matter of fact, a study by Vortia [34] found from Tobit regression that farming experience, age, and levels of mechanization were significantly associated with technical efficiency. This implied that more experienced farmers and those who employ mechanization tend to operate more efficiently. A similar conclusion from a study by Chandio [35] who through a cross-sectional survey on the Nexus of Agricultural Credit, Farm Size and Technical Efficiency in Sindh, Pakistan found that Credit, farm size, fertilizer use, and labor were significant factors influencing rice productivity. Access to financial resources, larger farm sizes, and proper input use were seen as being crucial for enhancing technical efficiency in rice farming.

Njikam and Alhadji [36] analysed technical efficiency among smallholder rice farmers across three agro-ecological zones in Cameroon. The key findings were that technical efficiency varied significantly across zones, with different factors contributing to efficiency. For example, age, experience, and land ownership influenced efficiency in the Sahel; in the western highlands, distance to farm and land ownership were key; while in the humid rainforest zone, agricultural training was crucial. This demonstrates the context-specific nature of the factors affecting efficiency and the need for tailored interventions in different agro-ecological zones. Stressing on the importance of staffing in rice productivity, Samarpitha [37] investigated technical, economic and allocative efficiencies of rice farms in Nalgonda district of Telangana state. Human labor was identified as a major determinant of rice productivity. Additionally, factors such as a farmer's education, experience, cooperative membership, and access to institutional credit significantly influenced technical efficiency. This highlights the importance of both labor and human capital in rice productivity. Findings by Rapu [38] stressed the need for governments to address management-related issues, such as post-harvest losses, degrading irrigation systems, and ineffective rural development policies. These are major constraints to productivity in Nigeria, primarily due to poor management practices.

Chang and Mishra [39] on technical efficiency of dairy farms using Data Envelopment Analysis (DEA) in the US had it that management practices, farm size, and human capital significantly impacted technical efficiency in dairy farms. This reinforces the idea that strong management practices are essential for improving farm efficiency across sectors, not just in crop production. No doubt [40] employed the practice of product stocking as a proxy to measure the level of production planning of potato farmers in the United Kingdom (UK) and found positive relationship between production planning (measured by product stocking) and technical efficiency. This confirms the hypothesis that effective management planning significantly enhances farm efficiency. In a further study, Wilson [41] on the effects of personal attributes and decision-making on wheat farm technical efficiency in England, the authors found that maximizing profits and protecting the environment were linked to higher technical efficiency. Additionally, farmers who actively sought information and had more years of managerial experience also demonstrated higher technical efficiency. This study underscores the importance of management experience, goal-setting, and access to information in driving farm efficiency.

According to the theory of management by objective, farm system management relies on sequential management functions: planning, organizing, staffing, directing, and controlling. This structured approach ensures that farms operate efficiently by setting clear goals, aligning resources, and regularly monitoring performance. Perusing through literature, the authors could not find a single study which borrows from the ideas of Barnard [4] to align the management by objective theory to the rice production processes and see how it affects production efficiency. Establishing this phenomenon in this study will not only help in identifying areas for improvement in farms' productive capacities, such as a more efficient allocation of available resources but will also help to close a large scientific gap hitherto available. And so the moot question is, to what extent does farm management affect rice production efficiency in the Western highlands of Cameroon?

2. MATERIALS AND METHODS

2.1 Research Design and Data

This study was carried out in the Western highlands of Cameroon encompassing the North West and the West regions of Cameroon. Areas under consideration in the North West region were; Lower Bamunka, Upper Bamunka, Bangolan area, and the Babungo area. In the West region, the Santchou area in the Nkam Rivers as well as the Tonga area were considered. The survey research design was deemed suitable for this study due to the large population and the need to collect data remotely. This design is effective for cross-sectional studies [42] and allows for the extraction of data that accurately reflects the target population, minimizing researcher bias [43]. The unobtrusive nature of the survey design also ensures that responses are less influenced by the researcher's presence or intervention.

The study adopted the use of primary data collected with the help of a questionnaire. The sample for the study was calculated using the [44] formula for when the population is unknown.

$$n = \frac{z^2}{4e^2}$$

$$n = \frac{(1.96)^2}{4(0.05)^2} = 384.16$$

Where;

n = sample size
e = acceptable sampling error (e =0.05)
z = Z value at reliability level or significance level.

Reliability level 95% or significance level 0.05; Z = 1.96

This formula gave a target population of 385 rice farmers. However, this sample was later reduced to 260 due to inconsistencies found in the responses.

Probability and non-probability sampling methods through a multi-stage technique was used to collect the needed data. For the probability sampling technique, a simple random sampling was used. This was used in the farms and participants recruited randomly. Snowball sampling technique, a non-probability method was used to avoid missing out on relevant personalities that are concerned with rice production that the researcher may not be aware of. Here, all it took was for the researcher to identify one farmer, who then identified another and the process continued. It was commonly used in the quarters. The researcher uses more than one sampling technique to limit omission errors, missing members and provide data representativeness (that is to ensure precision) as well as the respect of the data triangulation technique.

2.2 Estimation Technique

In order to examine the effect of farm management on the production efficiency of rice farmers in the Western Highlands of Cameroon, this work employs the Tobit model. The Tobit model is a statistical method commonly used to analyse data with censoring. This is a model which provides a powerful method for simplifying and analyzing categorical data. By converting categorical variables into continuous indexes, it enables the use of linear regression techniques like OLS to estimate relationships and model outcomes.

To maximize the likelihood function, we employ numerical optimization techniques such as the Newton-Rap son algorithm method. These algorithms iterate to find the parameter values that maximize the likelihood of the observed data. It should be noted that production efficiency scores range in the interval [0 – 1] which implies that there is no zero efficiency score. As such the tobit model is not operational. Thus, to ensure that the data is continuous in the range 0 inclusive to 1, we rather transform the dependent variable to be inefficiency by taking 1 – efficiency. As such inefficiency score ranges between [0 – 1] and thus, the tobit model becomes suitable for the estimation.

Note should be taken that prior to the tobit model estimation, all farm management indexes were constructed with Multiple Correspondence Analysis (MCA). Multiple Correspondence Analysis (MCA) is indeed an extension of Correspondence Analysis (CA) and a generalization of Principal Component Analysis (PCA) when dealing with categorical variables. MCA is performed on an indicator matrix, which is a binary matrix with entries of either 0 or 1. This matrix reflects the presence or absence of specific categories for each observation. For instance, if you're analyzing several survey questions, each possible answer is represented in the indicator matrix. It should also be noted that the constructed indexes were normalised using the following formula:

$$Normalised\ index = \frac{Raw\ index - Minimum}{Maximum - Minimum}$$

The normalised index therefore ranges between 0 and 1.

Therefore, the following model is specified by augmenting that of Winata [30].

$$\begin{aligned} INEFF_i = \alpha_0 + \alpha_1 PLAN_i + \alpha_2 ORG_i + \alpha_3 STAF_i \\ + \alpha_4 DIR_i + \alpha_5 CON_i \\ + \alpha_6 HHS_i + \alpha_7 EXP_i + \alpha_8 CIG_i \\ + \alpha_9 SFIN_i + \varepsilon_i \end{aligned}$$

INEFF is inefficiency score measured by 1 minus efficiency score
PLAN is planning index
ORG is organising index
STAF is staffing index
DIR is directing index
CON is controlling index
HHS is household size measured by the number of household members
EXP is farming experience measured by number of years of rice cultivation
CIG is Common Initiative Group membership dummy
SFIN is main source of finance of farmer

3. RESULTS AND DISCUSSION

3.1 Reliability of Constructs

Results from Table 1 indicates that nearly all the correlations were weak given that they do not exceed 0.6 except between planning index and organising index which may signal the existence of multicolinearity. As such, a formal test of multicolinearity is needed to ascertain that multicolinearity is not a major problem in the study. Therefore, the Variance inflation Factors (VIF) test is conducted for that purpose.

Table 1. Pairwise correlation matrix

	Plani	**Orga**	**Staf**	**direc**	**Cont**	**Ineff**	**Hhs**	**Exp**	**cigb**
Plani	1.0000								
Orga	0.6654 (0.0000)	1.0000							
Staf	0.2209 (0.0003)	0.4059 (0.0000)	1.0000						
Direc	-0.2016 (0.0011)	-0.2005 (0.0012)	0.0424 (0.4961)	1.0000					
Cont	0.3098 (0.0000)	0.3088 (0.0000)	0.2128 (0.0006)	-0.2722 (0.0000)	1.0000				
Ineff	0.3354 (0.0000)	-0.1836 (0.0030)	-0.0194 (0.7552)	-0.4104 (0.0000)	-0.1492 (0.0160)	1.0000			
Hhs	0.2644 (0.0000)	0.1657 (0.0074)	0.1264 (0.0417)	-0.1526 (0.0138)	0.3895 (0.0000)	0.1285 (0.0383)	1.0000		
exp	0.1881 (0.0023)	0.2546 (0.0000)	0.1243 (0.0453)	-0.1354 (0.0290)	0.3493 (0.0000)	0.0519 (0.4050)	0.4751 (0.0000)	1.0000	
cigb	-0.0366 (0.5572)	-0.0203 (0.7451)	-0.1450 (0.0193)	-0.0182 (0.7705)	0.0300 (0.6303)	0.1167 (0.0603)	0.0810 (0.1927	0.0204 (0.7440)	1.0000

Source: Author's computation (2024)

Table 2. VIF results for multicollinearity

Variable	VIF	1/VIF
Planning index	2.53	0.395308
Organising index	2.18	0.458658
Staffing index	1.35	0.742135
Directing index	1.40	0.715524
Controlling index	1.42	0.703044
Inefficiency score	1.37	0.729022
Household size	1.81	0.553594
Farming experience	1.95	0.513326
Belonging to a CIG dummy	1.23	0.811659
Main source of finance		
Relatives and friends	1.29	0.774370
Bank	1.86	0.538758
MFI	1.75	0.573052
Njangi (tontine)	1.43	0.697309
Cooperative	1.26	0.792267
Mean VIF	**1.63**	

Source: Author's computation (2024)

Table 3. Tobit results of the effect of farm management on rice production inefficiency

Variables	**Categories**	**(1) Overall**	**(2) North West**	**(3) West**
Farm management	Planning index	0.212***	0.138***	0.896**
		(0.0500)	(0.0425)	(0.447)
	Organising index	-0.0636	0.0162	0.0428
		(0.0591)	(0.0557)	(0.337)
	Staffing index	-0.0574	-0.195*	0.236
		(0.0971)	(0.118)	(0.169)
	Directing index	-0.362***	-0.263***	-0.628***
		(0.0516)	(0.0537)	(0.154)
	Controlling index	-0.0329	0.0502	-1.521
		(0.0498)	(0.0418)	(1.491)
Household size	Number of members	0.00469	0.00388	-0.0289
		(0.00508)	(0.00459)	(0.0193)
Farming experience	Years of farming	-0.00194	-0.00245*	-0.00105
		(0.00163)	(0.00147)	(0.00597)
CIG membership	1 if yes & 0 if not	0.0979**	-0.00259	0.383***
		(0.0399)	(0.0429)	(0.0774)
Main source of finance	Relatives and friends dummy	-0.0130	0.00996	-0.0375
		(0.0581)	(0.0391)	(0.272)
	Bank dummy	-0.100	-0.0763	0.143
		(0.0637)	(0.0562)	(0.224)
	MFI dummy	-0.0331	0.0233	0.104
		(0.0552)	(0.0549)	(0.201)
	Njangi (tontine) dummy	-0.00382	0.0479	0.00794
		(0.0597)	(0.0593)	(0.222)
	Cooperative dummy	-0.0968**	-0.0535	
		(0.0432)	(0.0478)	
Constant		0.934***	0.982***	0.988***
		(0.0500)	(0.0485)	(0.332)
Sigma		0.240***	0.166***	0.301***
		(0.0160)	(0.0149)	(0.0268)
Observations		**254**	**156**	**98**

***Note**: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

Source: Author's computation (2024)

Results from the Variance Inflation Factors (VIF) test reveal that the mean VIF is 1.63 which is far below the 2.5 critical value which indicates that there is no issue of multicolinearity. This is further confirmed by the fact that no individual VIF exceeded 10. Therefore, the results were reliable and valid and thus predictable.

Results from Table 3 indicate that the coefficient of planning index in the overall model is positive (0.212) which implies that an increase in the planning quality will lead to an increase in inefficiency of rice farmers. This result is significant at 1% level. Thus, there is a negative effect of planning activities of farmers on the efficiency of rice farmers in the western highlands of Cameroon. In consistence with the overall result, the coefficients of planning index is also positive in the North West and West equations which indicate that planning also compromises the efficiency of rice farmers in both regions. Furthermore, these results are significant at 1% and 5% levels respectively. However, it should be noted that the negative effect of planning on rice production efficiency is more important in the West than in the North West.

The results from planning function is contrary to expectation and shows that planning activities as carried out by rice farms both in the West and North west regions of Cameroon are not enhancing efficiency. In effect, the average rice farmers planning quality index in the area of study stands at 0.26 which is far below average indicating that the planning activities are still not well mastered by farmers. Poor planning may lead to improper anticipation of various needs in terms of human resources (labour force) and financial resources (capital) required for a successful farming season. This will go a long way to hinder a smooth farming season. Consequently, rice farmers may not be able to meet up with the farming requirements on due time thereby causing delays that compromises effective yields. Poor planning as well exposes the farmers to more costly alternative such as borrowing from more expensive external sources of finance to address contingencies arising in the farming process and therefore a cause of inefficiency.

The negative effect of planning on production efficiency can also be explained by the fact that, particularly in agriculture, plans are seldom completed as originally expected due to the constant vagarity of the weather, markets and other risk factors such as the availability of suitable labour. With regards to the weather, though strange, climate change has made it impossible for farmers to plan properly. Because of climate change, farmers are not sure when to plant again. Usually, the month of June/July is set for the planting of rain-fed rice so that harvesting can be done from November. But it has been noticed that in some years, rain is absent for many parts of the western highlands. A situation which calls for the delay of the planting time. Therefore, those who plant earlier, are at risk of getting poor yields since their rice fields are water deficient for the most important two weeks of their lifespan; that is, the two weeks it takes for the roots to deepen in to the ground. It can therefore be seen that farmers in an attempt to plan well in order to be productively efficient, rather end up being productively inefficient.

Oonyu [29] in a study on rice growing: a potential solution to declining crop yields and the degradation of the Doho wetlands, Butaleja district-Uganda established that rice yields were quite higher during the long rainy season (March to June) than in the short rainy season (August to October). They researcher saw that farmers in Doho Rice Scheme had significantly higher yields than those of the out-growers (OGS) and farmers in the Nambaale Wetland. Therefore, suggesting that rice is planted at different times depending on the climate and the yields are different. A successful farmer must therefore recognize this dynamic process, and always be prepared to re-analyse and change plans and actions. This result corroborates the finding of Njikam [36] who found that agricultural training is a significant determinant of technical efficiency of rice production in the bimodal humid rain forest zone in Cameroon. This training is capital in the implementation of management functions in the rice farming process. This result also conform to the finding of Winata [30], Houngue [31] and Rapu [38] in Indonesia, Benin and Nigeria respectively who found that education and post-harvest management were crucial factors affecting the technical efficiency of rice farmers. In a sharp contrast, a study by Alem [25] on the effect of farm management practices and socioeconomic factors on the economic performance of Norwegian crop farms concluded that proper planning and socioeconomic factors significantly influenced the economic outcomes of crop farms in Norway. Wilson et al., [40] also measured the level of production planning of potato farmers in the United Kingdom (UK) and found a positive relationship between production planning (measured by product stocking) and technical efficiency.

Contrary to planning, organising was found to exert a negative effect on rice production inefficiency given that the coefficient of organising index was found to be negative (-0.0636). In other words, proper organisation reduces production inefficiency score by about 0.06 point of rice. However, this result is statistically insignificant. Thus, there is a positive but insignificant effect of organising on rice production efficiency in the western highlands of Cameroon. This result is further confirmed in the regional analysis as no significant effect of organising was found on rice production efficiency though the coefficient turn up to be positive in both regions.

This finding was in line with our a priori expectation and is justified on the premise that if farmers identify the various activities involved in rice production before the beginning of every cropping season, broke down and grouped these activities in to units so as to ease cultivation, attend training and workshops about rice production and always make sure that the necessary equipment are available for the different processes before and during the farming season, they will be efficient in production. The process of organizing within a farm system is critical for ensuring that the farm's plan is executed effectively. Organizing involves translating the farm's production plan, which outlines the goals, methods, and expected outputs into actionable steps. To achieve this, several key tasks must be managed. A study by Ajah [28] found that farm preparation and size, cost of chemicals and fertilizer application were all significant in influencing rice output at 5% among small scale rice farmers output in Abuja Nigeria. Chang and Mishra [39] on technical efficiency of dairy farms using Data Envelopment Analysis (DEA) in the US had it that management practices, farm size, and human capital significantly impacted technical efficiency in dairy farms. This reinforces the idea that strong management practices are essential for improving farm efficiency across sectors, not just in crop production. In a further study, Wilson [41] underscores the importance of management experience, goal-setting, and access to information in driving farm efficiency.

Further results shows that the coefficient of staffing is negative (-0.0574) which implies that staffing practices by rice farmers in the western highlands of Cameroon exert a negative effect on production inefficiency. Said otherwise, there is a positive effect of staffing on the production efficiency of rice farmers in the Western highlands of Cameroon. In fact, a unit point increase in the staffing index will lead to a fall in the inefficiency score by 0.06 point everything being equal. However, this result is statistically insignificant. In line with the overall result, there is a negative effect of staffing on rice production inefficiency in the North West whereas staffing was found to increase production inefficiency in the west. However, it should be noted that only the results from the North West was found to be significant at 10% level. Thus, there is a significant positive effect of staffing on the production efficiency of farmers in the North West Region.

This is justified on the basis that the planting of rice is a careful activity. The seed has to be planted in a way that respects the spacing. If a farmer is not present on-sight, workers might tend to space the fields to gain much given that they will use a short time to plant more. In this case, the yield will be small. This is in agreement with the a priori expectation for this variable. Therefore, the management of workers is a very important factor for rice production. The management of these workers could also entail giving them skills in rice production so as to enhance productivity. Kalogiannidis and Syndoukas [20] showed that agricultural workshops and training (a characteristic of staffing) positively affect farm productivity. Also, Njikam [36] found that agricultural training is a significant determinant of technical efficiency of rice production in the bimodal humid rain forest zone in Cameroon. In addition, Winata [30], Houngue [31], Jirarud [32] and Vortia [34] all found that skills of the workers contribute a lot in influencing rice productivity. Lastly, Orlando [33] in his study suggested that improvements in the farmer' know-how and skills can lead to further yield increase and variability reduction.

In terms of directing function, results from the tobit model indicates that directing relates negatively with rice production inefficiency in the western highlands of Cameroon. In effect, a unit point increase in directing index will lead to about 0.36 point fall in inefficiency score everything being equal. Moreover, this outcome is statistically significant at 1% level. Thus, there is a significant positive effect of directing function on production efficiency of rice farmers in the western highlands of Cameroon. Going by the regional analysis, results from the North West and West remain consistent with the overall result as directing affects production inefficiency of rice farmers in the two regions negatively and significantly at 1% level. In fact, directing significantly reduces production inefficiency among North West rice farmers by 0.26 while the effect is more important in the West region as it reduces production inefficiency by 0.63 point. Thus, directing has a significant more positive effect on rice production efficiency in the west than in the North West.

The result above made sense given that proper instructions and guidance of workers in achieving organisational task will help improve on productivity. The coordination of information from top to bottom makes it possible for farmers to have the rightful information which is beneficial for rice production. A study by Carrer [23] found that the adoption of Farm Management Information Systems captured in terms of planning and directing were significant determinants of technical efficiency in citrus farms in Brazil. The marginal effect of the variable calculated for the sample mean indicated that each additional management tool used by a farmer increases the technical efficiency score of his or her farm by 1.88%. Likewise, Alama [24] showed that the integration of Best Management Practices alongside the farmers' management techniques has the potential to boost rice total rice production in Bangladesh.

The coefficient of controlling index is also negative (-0.0329) which indicates that controlling associates negatively with rice production inefficiency. In effect, a unit point increase in the controlling index of rice farmers will result in about 0.03 point fall in inefficiency in rice production of farmers in the Western highlands. However, this result is not significant. Therefore, there is no significant effect of controlling function on rice production efficiency of western highlands farmers. Looking at the regional analysis, results indicate that there is a positive effect of controlling on rice production inefficiency in the North West while the effect is reversed in the West Region. However, just like the overall result, both regional findings are statistically insignificant.

Though not significant, the negative relationship between these two variables makes sense given that the control of water system through the use of canals and drainage, effective system to control weed and pest as well as control in every part of the production process ensures that standards are respected and breeds an atmosphere of order and discipline which helps to minimize dishonest behaviour and therefore affect productivity positively. In their study, Chang [39] found a significant effect of management practices on the technical efficiency of dairy farms. Also, Trip [27], based on data from flower producers in the Netherlands, opined that producers who display higher quality in collecting and monitoring data (control) and in the evolution of the operational performance of their farms operate with higher levels of technical efficiency. The authors concluded that decision-making (management) variables are of fundamental importance in explaining the differences in the efficiencies of farms.

Going by the control variables, results from Table 3 indicate that the coefficient of household size is positive (0.00469) which implies that the higher the number of family members the higher will be the level of inefficiency of the farmers. In effect, an additional household member will lead at about 0.005 point increase in production inefficiency. This result is however statistically insignificant. Consistently, there is a positive effect of household size on rice production inefficiency in the North West while household size was found to reduce production inefficiency in the west. However, none of these results are statistically significant. Thus, there is no significant effect of household size on rice production efficiency in both regions.

Further results shows that rice farming experience (measured by the number of years of rice cultivation) reduces rice production inefficiency of farmers in the western highlands of Cameroon as the coefficient of farming experience is negative (-0.00194). Precisely, an additional year rice farming experience will reduce production inefficiency by 0.002 point ceteris paribus. However, it should be noted that this result is insignificant. In line with the overall result, regional analysis indicates that there is also a negative and significant effect of rice farming experience on production inefficiency of farmers in the North West and West Regions of Cameroon. However, only the result from the North West was found to be significant at 10%.

Contrary to expectation, being a member of a Common Initiative Group (CIG) has a positive effect on production inefficiency given that the coefficient of CIG membership is positive

(0.0979). In fact, belonging to a CIG increases production inefficiency score by 0.098 point everything being. In addition, this outcome is significant at 5% level. Thus, there is a negative and significant effect of CIG membership on production efficiency of rice farmers in the Western Highlands of Cameroon. Unlike the overall result, CIG membership was found to compromise the inefficiency of production in the North West whereas, the effect is positive in the West Region. However, this result is insignificant in the North West but significant at 1% in the West Region.

All the coefficients of sources of finance are negative which implies that having as main source of finance family and friends, bank, MFI, Njangi or cooperative has a negative effect on production inefficiency of rice farmers as compared to those who had as main source of finance their own savings. Put differently, rice farmers whose main source of funds are family and friends, commercial banks, microfinance institutions, Njangi or tontine and cooperative are more likely to be productively efficient than those who use their own savings as main source of finance. However, the source of finance result is statistically insignificant except cooperative source of finance which is significant at 5% level. In a nutshell, only rice farmers whose main source of finance is cooperative are significantly more likely to be efficient (less likely to be inefficient).

It should be noted that the overall models were all globally significant at 5% given that the p-value of overall significance are all below 0.05. Thus, farm management significantly predict rice production efficiency in the western highlands of Cameroon when controlling for households size, farming experience, CIG membership and main source of finance.

4. CONCLUSION AND POLICY IMPLICATIONS

This study has attempted to shed some light on whether farm management affect rice production efficiency in the Western highlands of Cameroon. The analysis showed that contrary to our a priori expectation, the coefficient of planning was negative signifying that farm planning compromises the efficiency of rice farmers in the Western highlands of Cameroon. A controversial conclusion yet, valid as seen from the preceding discussions. Yet generally, it was seen that the overall models were all significant at 1% given that the p-value of overall significance are all below 0.05. Thus, farm management significantly predict rice production efficiency in the western highlands of Cameroon when controlling for households size, farming experience, CIG membership and main source of finance.

Granted that rice cultivation is of prime importance in Cameroon and West and North West regions in particular given the quantity of rice served on tables every morning at breakfast, afternoon at launch and evening at dinner. Therefore, to ameliorate the current rice import emanating from high demand as well as to increase production efficiency, the following policy recommendations can be made;

There is no denial that the process of rice production involves a lot of management. In this light, the government should partner with some higher institutions in the regions like the University of Bamenda with its College of Technology and the University of Dschang with its faculty of agricultural sciences (FASA) to help train farmers on rice management tactics; from the respect of the cropping calendar, the management of the land preparation, the management of rice farmers (human resource management), to the management of their water systems. A knowledge of these management practices will definitely improve on rice yields. Based on the negative coefficients between planning and rice production efficiency, it is recommended that farmers with help from the local meteorological station should look at the dictates of the weather for the current year before indulging in planting rice. This is to avoid misinterpretations of weather which can lead to low yields.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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