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RESEARCH ARTICLE

ANALYSIS OF THE STRUCTURE AND MEANS OF PRODUCTION OF AGRICULTURAL VALUE CHAINS: THE CASE OF THE UNION OF RICE FARMS IN MBOUNDOUM BARRAGE IN THE SENEGAL RIVER VALLEY

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Abstract

This study examines the influence of producer organizations and access to production factors on the economic performance of 2,982 rice farms in the Mboudoum Barrage Union, Senegal River Valley, using PCA, HCPC, and linear regression. Producers have an average of 18.6 years of experience, 3.79 ha of land, 208,735 FCFA in credit, and 133,493 FCFA in inputs, yielding an average income of 319,566 FCFA, with wide disparities. PCA reveals three dimensions: intensification, financi ng, and organizational integration. HCPC identifies seven farm profiles. Regression analysis confirms that experience, length of membership,nu mber of plots,credit, and input spending have significant effects on performance. These findings call for strengthening producer organizati ons and improving financing and advisory services.

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Introduction:-

In Senegal, irrigated rice farming plays a central role in food sovereignty policies, with the Senegal River Valley serving as the main production basin (MAER, 2021). Despite the investments made, farm performance remains highly uneven, and the mere availability of productive resources is not sufficient to explain these disparities: performance also depends on organizational and socioeconomic factors such as access to credit, inputs, and agricultural extension services (FAO, 2014). The value chain approach offers a relevant framework for understanding these interactions between value-creating activities (Porter, 1985) and the governance of relationships among actors (Kaplinsky and Morris, 2000). Within this framework, farmers' organizations facilitate access to factors of production, markets, and financing, with the Mboudoum Union serving as a prime example. However, the interactions between organizational structure, access to factors of production, and economic performance remain poorly documented. This study therefore aims to analyze the influence of collective organization and access to factors of production on the performance of rice farms in the Mboudoum Union, combining descriptive analyses, PCA, HCPC, and multiple linear regression to characterize producers, establish a typology of farms, and identify the determinants of their performance.

Methodology:-

The study was conducted within the Mboudoum Barrage Union, in the Senegal River Valley, the country's main rice-growing region. Thanks to the hydro-agricultural infrastructure developed by SAED and its well-organized

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farmers' associations, this area which has a Sahelian climate where irrigation is essential provides a suitable setting for studying the links between collective organization, access to factors of production, and economic performance.

Data Sources:-
The data come from the Mboudoum Union's operational database, which tracks rice farmers over the course of one agricultural season (2025). Of the 3,006 registered farmers, 2,982 usable observations were retained after data cleaning. The information collected covers the socioeconomic and organizational characteristics of producers, land tenure, credit, inputs, agricultural services, marketing, and economic indicators for the farms.

Conceptual Framework and Variables:-
The study is based on the hypothesis that economic performance depends both on organizational characteristics (agricultural experience, length of service within the organization, membership in a group) and on access to factors of production (land, financing, inputs, agricultural services). Economic performance, the dependent variable, is measured by reported annual income, which is transformed into a logarithm (Log_Income) due to its high asymmetry.

Data Processing and Statistical Analysis:-
The analyses were conducted in R (v. 4.5.1), using the tidyverse, FactoMineR, factoextra, corrplot, and cluster packages, in four steps:-
Descriptive analysis: standard statistics (mean, median, standard deviation, coefficient of variation) for quantitative variables; counts and frequencies for qualitative variables. The income distribution was examined using histograms, measures of skewness and kurtosis, and the Shapiro-Wilk test.
Principal Component Analysis (PCA): applied to quantitative variables (experience, tenure, credit, inputs, area, number of plots, logarithmic income, sales price), after verifying the suitability of the data (KMO, Bartlett's test). The selected axes have eigenvalues greater than 1.
Farm Typology (HCPC): Applied to the factor coordinates of the PCA to identify homogeneous groups of farms, with differences between classes tested using ANOVA and Tukey's post-hoc test. Multiple linear regression: used to identify the determinants of economic performance, according to the model: Y_i = \beta_0 + \sum_{j=1}^{k}\beta_j X_{ij} + \varepsilon_i where Y_i is the logarithm of annual income and X_{ij} are the explanatory variables. The model's assumptions were tested using residual analysis, the variance inflation factor (VIF), and the coefficient of determination (R^2).

Results and Discussion:-

Organizational Structure of Producers:-
Irrigated rice farming in the Senegal River Valley relies on a structured collective organization that facilitates the management of agricultural water infrastructure, access to inputs, and the marketing of paddy rice. Within the Mboudoum Union, this organization manages irrigation and drainage, maintains communal equipment, and markets paddy rice to cover water fees. It also receives support from several institutions, including SAED, CNCAS, and the Federation of Self-Managed Irrigation Districts (FPA). The organization is structured hierarchically, from village groups to umbrella organizations, promoting the coordination of activities, the representation of producers, and the pooling of resources (Figure 3). The survey of 2,982 producers highlights a high level of organizational integration (Table 1). Producers have an average of 18.64 ± 11.09 years of agricultural experience, with a median of 18 years, reflecting a solid mastery of rice-farming practices. The median length of membership in farmers' organizations is 26 years, demonstrating the producers' long-standing involvement in collective arrangements.

Table1: Organizational Characteristics of Producers

	n	Average	Median	min	max
Number of years in business	2,982	18.64	18	0	200
Year of Membership	2,982	1974.44	2000	0	2018
Former organization	2,982	51.56	26	8	2026

Sales Organization: Seeking Buyers

Difficult	Easy	Impossible	Very difficult	Very easy
58.79380054	24.25876011	0.03369272	6.46900270	10.44474394

Agricultural Services Access Organization

ANCAR	None	Other
14.333782	6.763122	78.903096

Despite this strong organizational structure, marketing remains a challenge: 58.8% of producers find it difficult to find buyers, compared with only 10.4% who find it very easy. With regard to agricultural services, 78.9% of producers receive support from local organizations, 14.3% from ANCAR, and 6.8% receive no technical assistance. The breakdown of producers by group reveals a high concentration within a few major organizations: GIE MCA dominates with 342 producers (11.47%), followed by Aéré Lao (6.67%), Guédé Village (5.80%), Guédé Chantier (4.66%), and Ndiawar (3.96%), with the top ten groups accounting for the vast majority of the producers surveyed. Agricultural experience confirms the maturity of the producers, most of whom have been active for 10 to 30 years, though a few outliers reflect a certain heterogeneity in their career paths. Overall, the Mboudoum Union has a solid farmer organization and experienced producers, but difficulties in accessing markets and disparities in technical support remain potential obstacles to farm performance.

Access to Factors of Production:-

Organization of the Supply of Inputs and Means of Production:-

The supply of inputs within the Mboudoum Union is based on a collective system involving producer organizations, private suppliers, and financial institutions. Village groups are responsible for planning needs, negotiating with suppliers, receiving and distributing inputs, and monitoring repayments when inputs are purchased on credit. This system promotes access to certified seeds, fertilizers, plant protection products, and mechanized services, while helping to ensure the quality of inputs and reduce procurement costs.

Producers' Level of Access to Factors of Production:-

Analysis of data collected from 2,982 producers reveals significant heterogeneity in access to factors of production (Table 2).

Table2: Descriptive statistics for factors of production

	n	Mean	Median	min	Max
Number of plots	2,982	1.82	1.0	0	30
Total area	2,982	3.79	0.9	0	90
Average loan amount,	2,982	208,735.21	100,000.0	0	16,000,000
Loan rate	2,982	731.19	5.0	0	2,000,000
Current Expenditures Inputs	2,982	133,492.86	89,880.0	0	4,950,000

On average, farms have 1.82 ± 1.79 plots, with an average area of 3.79 ha. However, the median of 0.90 ha highlights a highly asymmetrical land distribution, characterized by the predominance of small farms and the existence of a limited number of large farms (90 ha). The average amount of agricultural loans is 208,735 CFA francs, with a median of 100,000 CFA francs, reflecting an uneven distribution of financing among producers. Expenditures on inputs average 133,493 CFA francs, indicating significant differences in investment capacity.

Table 3: Access to Financial and Technical Resources Among Surveyed Producers

Variable	Details	Sample Size (n)	Valid Percentage (%)
Access to cooperative credit	Never	1,381	46.37
	Sometimes	1,051	35.29
	Always	546	18.33
Access to credit through a third party	Never	1,648	55.45
	Sometimes	1,183	39.80
	Always	141	4.74
Access to bank loans/MFIs	Never	1,076	36.43
	Sometimes	765	25.90
	Always	1,113	37.68
Access to agricultural services	ANCAR	426	14.33
	None	201	6.76

	Other services	2,345	78.90
Use of agricultural inputs	At recommended rates	2,623	89.04
	Half the recommended dose	184	6.25
	Sometimes	65	2.21
	Not at all	66	2.24
	Very little	8	0.27
Interest in agricultural insurance	Yes	1,831	61.59
	No	732	24.62
	Maybe	410	13.79

Source: Field survey, 2025.

Access to financial resources and technical services also varies (Table 3). Nearly 46.4% of producers report never receiving cooperative credit, compared with 18.3% who access it regularly. Conversely, 37.7% of producers regularly receive credit from a bank or a microfinance institution. Agricultural advisory services are relatively accessible: 78.9% of producers receive support from various support structures, 14.3% from ANCAR, while 6.8% do not receive any agricultural services. The use of inputs is high, with 89.0% of producers reporting that they apply the recommended doses. Furthermore, 61.6% of respondents say they are in favor of agricultural insurance, compared to 24.6% who are opposed and 13.8% who remain undecided.The distribution of land area confirms a high degree of land-use heterogeneity, with the majority of producers farming small areas while a small number own large farms. Correlation analysis reveals positive relationships between cultivated area, the number of plots, loan amounts, and input expenditures. Farms with more productive resources thus have greater investment capacity, which justifies the use of multivariate analyses to explain the observed performance differences.

Performance of Rice Farms:-

The performance of rice farms depends not only on the availability of production inputs, but also on the efficiency of harvesting, storage, processing, and marketing operations, which determine the value of production and farmers' incomes.

Organization of Harvesting, Marketing, and Processing:-

Within the Mboudoum Union, the marketing of paddy rice is based on an organized system that integrates harvesting, quality control, storage, and transportation to processing facilities (Figure 1). Production is intended for subsistence consumption, repayment of seasonal loans, and the sale of surpluses in the markets.

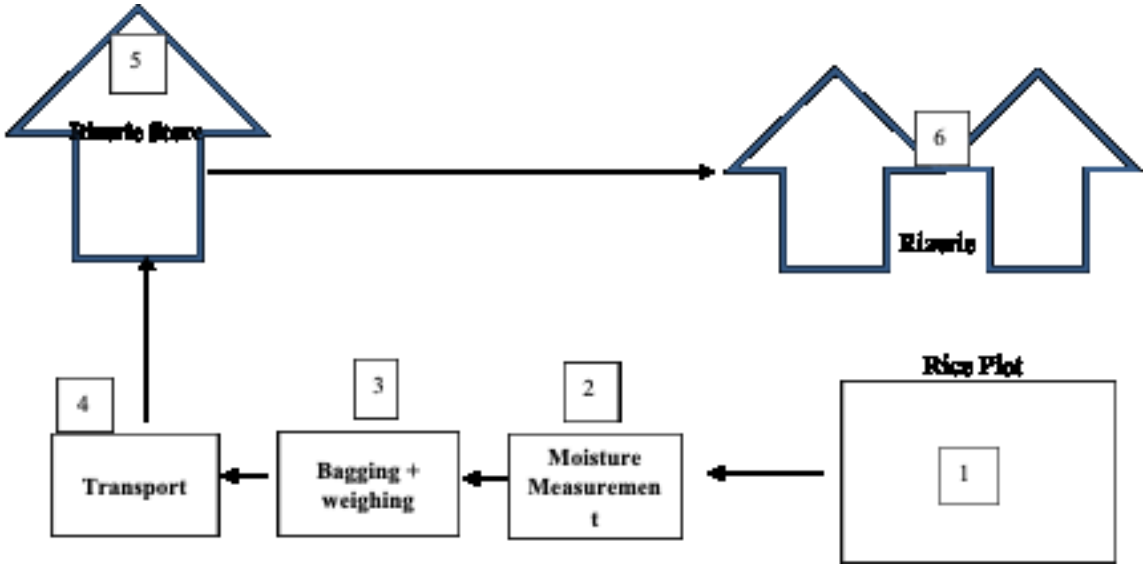


Figure1: Diagram of the rice marketing and processing flow in the Senegal River Valley

The process includes mechanized harvesting, monitoring the moisture content of the paddy, bagging, weighing, transport to storage facilities, reweighing, and then transport to rice mills, where a final inspection is conducted before processing. This system ensures the traceability of crops, minimizes post-harvest losses, monitors the quality

of the paddy rice, and secures transactions between producers and processing facilities. It thus promotes better coordination among stakeholders in the value chain. However, despite progress in rice production, underutilization of processing capacity remains a constraint limiting the value added from local rice.

Analysis of Farm Economic Performance:-

The assessment of farm economic performance is based on two indicators: estimated annual income and the most recent selling price obtained by producers.

Table 4: Farm Performance Indicators

Indicators	N	Avg	Standard Deviation	Median	Min	Max	Skewness	Kurtosis
Estimated annual income (FCFA)	2,982	319,566.19	565,371.54	200,00	80	8,820,0	9.58	110.41
Last selling price (FCFA)	2,982	308.27	6,803.74	125	0	350,00	47.60	2,374.97

Producers report an average annual income of 319,566 CFA francs (± 565,372 CFA francs), with a median of 200,000 CFA francs. The significant gap between the mean and the median, combined with high positive skewness (Skewness = 9.58) and high kurtosis (Kurtosis = 110.41), indicates a highly skewed distribution dominated by a limited number of high-income farms. The latest average selling price is 308 CFA francs/kg, while the median is 125 CFA francs/kg. The very high values for skewness (47.60) and kurtosis (2,374.97) indicate the presence of outliers that may reflect specific market conditions or reporting errors.

Table5: Coefficient of Variation for Farm Performance Indicators

Variables	Coefficient of variation (CV, %)
Estimated annual income	176.92
Most recent selling price	2,207.07

The coefficients of variation reach 176.9% for annual income and 2,207.1% for sales price, confirming a very high degree of heterogeneity in economic performance among producers. The distribution is heavily skewed to the right, with the majority of producers falling into the low- to intermediate-income brackets, while a limited number of farms 531 report incomes significantly above the average.The box plot highlights numerous outliers located in the upper part of the distribution, corresponding to the highest-performing farms.The assumption of normality is rejected by the Shapiro-Wilk test performed on a sample of 500 observations ($W = 0.351$; $p < 0.001$). This non-normality is consistent with the high skewness and kurtosis coefficients observed.Shapiro-Wilk test, Shapiro-Wilk normality test, data:sample(na.omit(Prodsl$`Estimated annual income`), 500), W = 0.3511, p-value < 2.2e-16

Verification after transformation:-

The analysis of the normality of annual income indicates that the distribution does not meet the assumptions of normality. The Shapiro-Wilk test performed on a random sample of 500 observations shows a highly significant deviation from the normal distribution ($W = 0.351$; $p < 0.001$). This non-normality is consistent with the high values of skewness (Skewness = 9.58) and kurtosis (Kurtosis = 110.41) observed in the descriptive statistics.

Table 6: Performance by Group

Rank	Group	Number of Participants (n)	Average Annual Income (FCFA)
1	GIE Diama 2	3	894,000
2	Village Section 10 A Ronkh	14	730,714
3	Village Section 1, Ronkh	18	672,222
4	Ronkh	10	670,000
5	Feggu Ronkh	9	661,111
6	Village Section 10 Ronkh	13	600,000

7	Diawar	45	592,222
8	SV11 Ronkh	20	587,500
9	Village Section 2 C Ronkh	10	585,000
10	SV1 B Ronkh	6	583,333

The highest average incomes are found in the GIE Diama 2 group (894,000 CFA francs), the Ronkh Village Section 10 A (730,714 CFA francs), Section Villageoise 1 Ronkh (672,222 CFA francs), Ronkh (670,000 CFA francs), and Diawar (592,222 CFA francs). Overall, these results highlight significant variations in economic performance among farms, justifying the use of multivariate analyses to identify the main farm profiles and the factors associated with their performance. Principal Component Analysis (PCA) was conducted to summarize the relationships among the variables characterizing rice farms and to identify the main dimensions explaining their variability. The analysis focuses on eight variables: agricultural experience, organizational tenure, average loan amount, input expenditures, number of plots, cultivated area, the logarithm of annual income, and the most recent selling price.

Validation of the PCA:-

Preliminary tests confirm that the data are suitable for factor analysis (Table 6). The overall Kaiser-Meyer-Olkin index is 0.60, while the individual MSA indices range from 0.46 to 0.70. Bartlett's sphericity test is highly significant ($\chi^2 = 995.67$; df = 28; $p < 0.001$), indicating sufficient correlations among the variables to justify the use of PCA.

Structure of the Explained Variance:-

According to Kaiser's criterion, three principal components have eigenvalues greater than 1 (Table 7). They explain 20.95%, 15.56%, and 12.64% of the total variance, respectively, for a cumulative variance of 49.15%. When the fourth component is included, the explained variance reaches 61.13%, reflecting a multidimensional structure of the farms.

Table7: Variance Explained by Principal Components

Component	Eigenvalue	Explained variance (%)	Cumulative Variance (%)
CP1	1.676	20.95	20.95
CP2	1.245	15.56	36.51
CP3	1.011	12.64	49.15
CP4	0.959	11.98	61.13
CP5	0.913	11.41	72.54
CP6	0.810	10.12	82.66
CP7	0.740	9.25	91.91
CP8	0.647	8.09	100.00

Relationships Between Variables

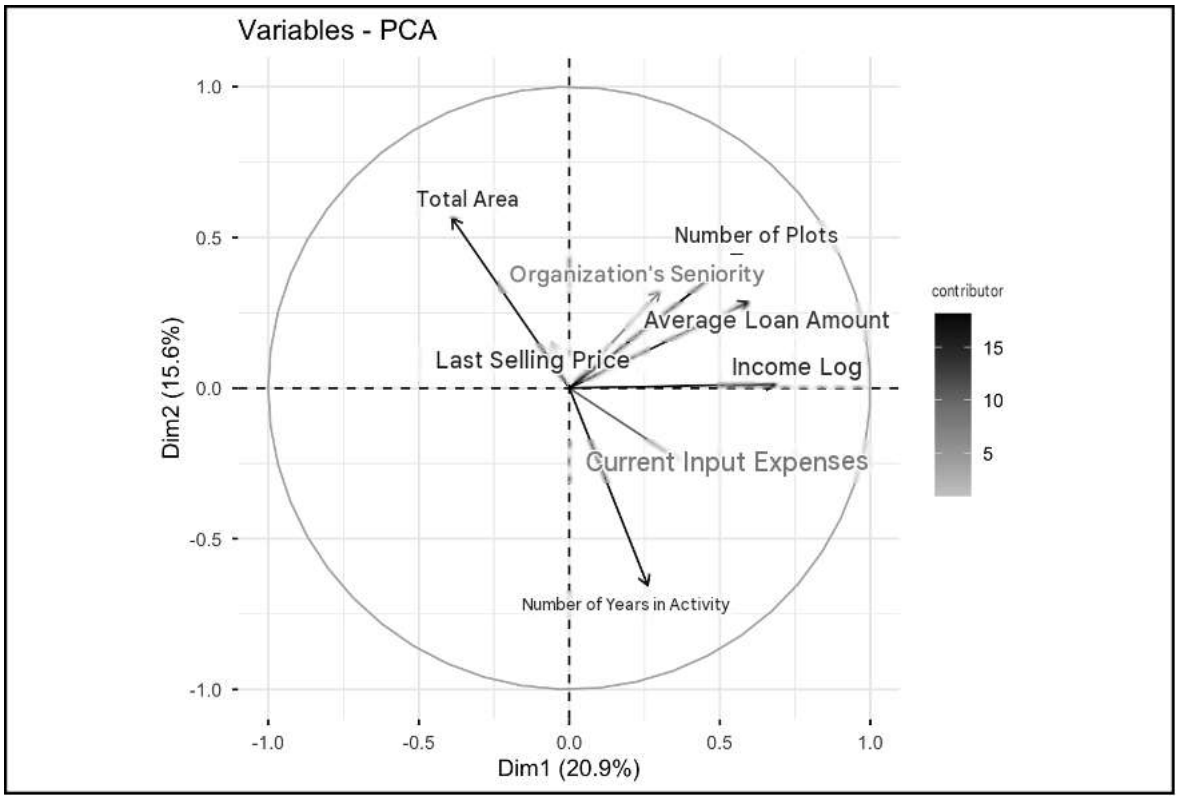


Figure2: Correlation Circle

The correlation matrix allows us to analyze the relationships between variables. The first axis is primarily correlated with cultivated area, the number of plots, input expenditures, and annual income. It reflects a gradient of productive capitalization, contrasting farms with fewer resources against those with greater resources and investment capacity. The second axis is more closely associated with organizational seniority and access to financial resources, reflecting an organizational dimension of the farms. The third axis highlights differences related to marketing strategies, with the most recent selling price appearing to be relatively independent of the other structural variables. Overall, the PCA shows that farm performance results from the interaction between productive resources, organizational integration, financial capacity, and marketing strategies.

Farm Projections and Profile Structuring:-

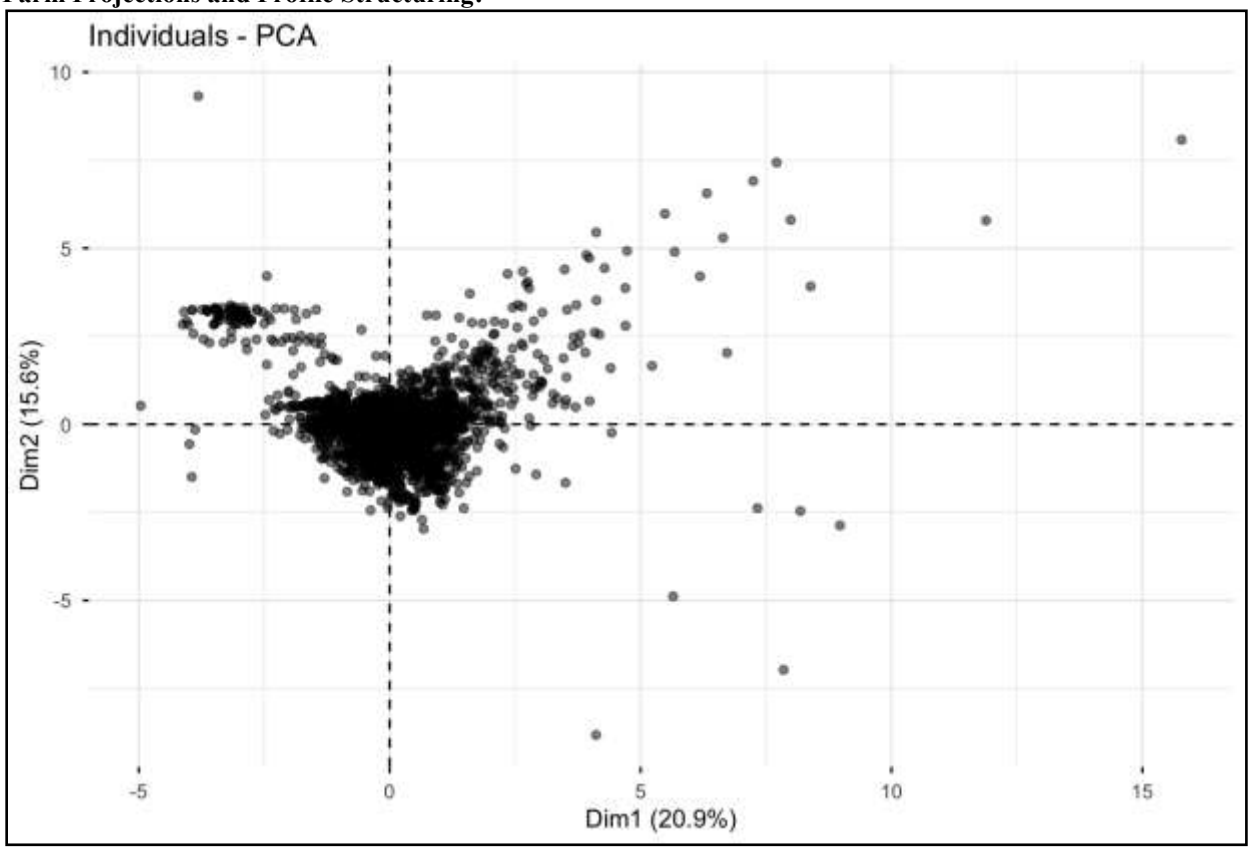


Figure3: Projection of Farms

The projection of farms onto the first two axes reveals significant dispersion in the factorial space, confirming the heterogeneity observed in the descriptive analyses. Several clusters emerge, suggesting the existence of distinct profiles based on land resources, financial capacity, and organizational integration.The biplot confirms the defining role of production and financial variables in the organization of the factor space. Farms differ primarily based on their level of capitalization, their investment capacity, and their economic performance. This diversity justifies the use of Hierarchical Principal Component Analysis (HCPC) to identify homogeneous groups of farms.

Agricultural Monitoring and Digitalization:-

Farms in the Mboudoum Union receive monitoring support from extension agents, aided by digital tools such as the mAgri platform (Figure 17). These tools facilitate data collection, crop monitoring, and the dissemination of technical advice, contributing to better farm management.

Typology of Rice Farms Using Hierarchical Principal Component Analysis (HCPC):-

The Hierarchical Principal Component Classification (HCPC) identified seven classes of farms with distinct characteristics in terms of productive resources, access to financing, and economic performance.

Classification Structure

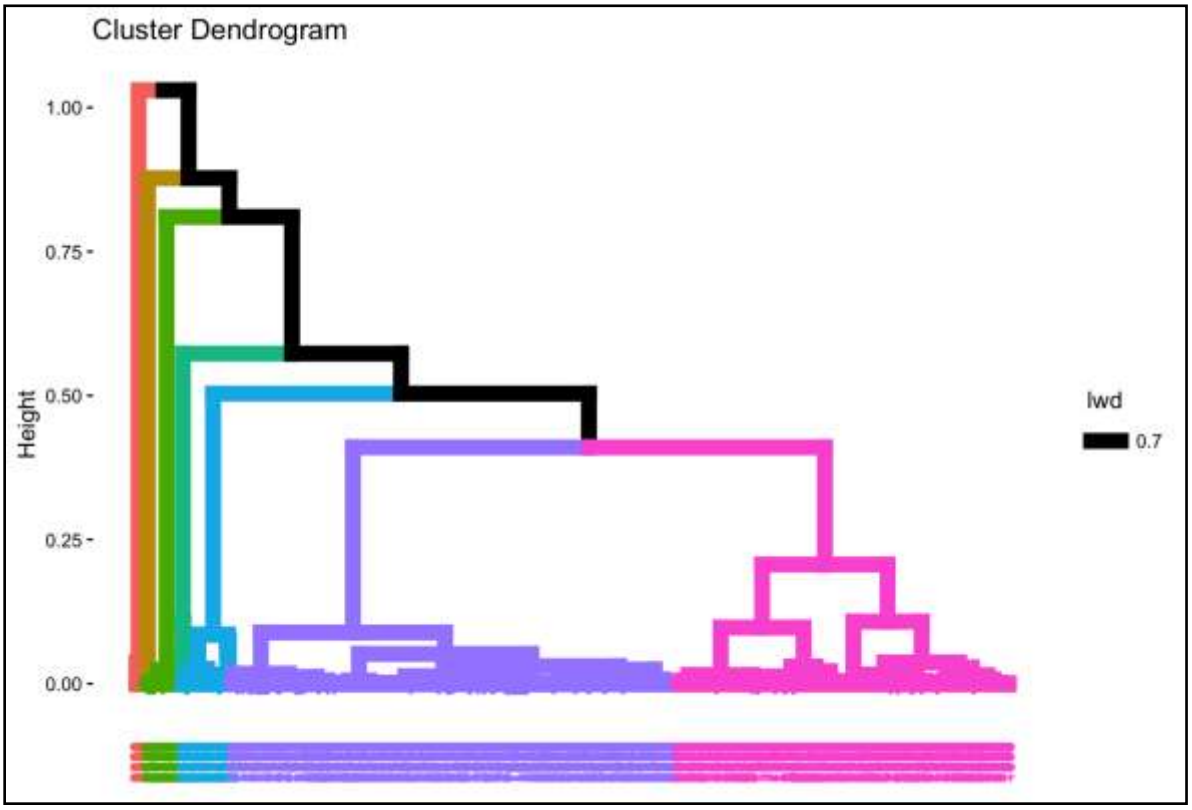


Figure4: Dendrogram

The dendrogram highlights seven groups of farms, confirming the heterogeneity observed during the PCA.
The class projection shows a clear separation of the groups in the factorial space, primarily based on capitalization level, access to credit, and economic performance.

Description of Farm Classes:-

Table 8: Average Characteristics of the Classes

Class	Number of Farms	Experience (years)	Years in operation (years)	Area (ha)	Number of plots	Average loan (FCFA)	Input expenses (FCFA)	Average income (FCFA)
1	1	10.0	18.0	54.00	1.00	0	0	450,000
2	114	7.5	17.0	67.10	1.10	16,170	21,346	139,881
3	1,360	14.6	22.8	1.06	1.22	87,510	63,396	160,602
4	930	27.7	30.7	0.90	1.33	176,545	220,710	327,708
5	531	15.7	24.7	2.21	4.20	517,935	152,032	720,146
6	39	14.7	2,026	2.67	3.72	631,558	154,228	660,487
7	7	23.6	30.9	7.70	2.43	5,392,897	2,488,541	743,800

The HCPC distinguishes seven farm profiles:-

Class 1 (n = 1): an atypical farm characterized by a very large area (54 ha), which is not representative of the study population. Class 2 (n = 114): small farms with limited capital, low levels of credit, low levels of investment in inputs, and low income. They represent the most vulnerable group. Class 3 (n = 1,360): small, traditional family farms, constituting the majority of the sample (45.6%), with moderate levels of resources and income. Class 4 (n = 930): experienced farms with an intermediate level of intensification, characterized by better access to credit and higher incomes than those in Class 3. Class 5 (n = 531): high-performing entrepreneurial farms, benefiting from better capitalization, higher investments in in put, and the highest incomes among the representative classes. Class 6 (n = 39): farms with an atypical profile, notably marked by an anomalous value for organizational seniority, which requires verification of the database. Class 7 (n = 7): large, highly capitalized farms, characterized by very high

levels of credit, investment, and land area, but representing a small proportion of the sample. Overall, this typology highlights the great diversity of rice farms, ranging from small, family-run farms with limited capital to heavily invested entrepreneurial farms.

Comparative Analysis of Economic Performance:-

The distribution of income confirms differences between classes: Classes 5 and 7 have the highest incomes, while Classes 2 and 3 have the lowest. The areas under cultivation also differ among the classes. The most successful farms generally have larger areas under cultivation, coupled with greater investment capacity. These results show that performance varies depending on the farms' endowment of productive resources and their investment capacity.

Statistical Validation of the Typology:-

The ANOVA on annual income reveals a highly significant effect of class membership ($F = 77.72$; $p < 0.001$). Tukey's post hoc test confirms significant differences, particularly between classes 2 and 3 (low-capitalized) and classes 5 and 7 (highly capitalized and with higher incomes). The HCPC highlights a wide diversity of rice farms, ranging from small, poorly capitalized farms to highly capitalized ones, which leads to an analysis of the factors influencing economic performance using multivariate regression.

Determinants of Rice Farm Performance:-

A multiple linear regression analysis identified the factors associated with the economic performance of farms (measured by the logarithm of annual income), including farming experience, organizational integration, land resources, access to financing, input expenditures, and conditions for accessing agricultural services and markets.

Table 9: Results of the multiple linear regression analysis of the determinants of the economic performance of rice farms

Explanatory variables	Coefficient β	95% confidence interval	p-value
Number of years in operation	0.01	[0.00; 0.01]	< 0.001
Tenure in the organization	0.00	[0.00; 0.00]	0.003
Number of plots	0.09	[0.07; 0.11]	< 0.001
Total area	-0.02	[-0.02; -0.01]	< 0.001
Average loan amount	0.00	[0.00; 0.00]	< 0.001
Current input expenditures	0.00	[0.00; 0.00]	< 0.001
Search for Buyers			
Easy	-0.11	[-0.19; -0.03]	0.005
Impossible	1.10	[-0.61; 2.70]	0.200
Very difficult	0.26	[0.12; 0.40]	< 0.001
Very easy	-0.27	[-0.38; -0.17]	< 0.001
Access to agricultural services			
None	-0.66	[-0.81; -0.51]	< 0.001
Other services	-0.59	[-0.69; -0.48]	< 0.001

Influence of Organizational Factors:-

Farming experience ($\beta = 0.01$; $p < 0.001$) and length of membership in farmers' organizations ($p = 0.003$) have a positive and significant effect on income, highlighting the importance of experience and organizational integration.

Influence of productive resources:-

The number of plots is positively associated with income ($\beta = 0.09$; $p < 0.001$), while total land area has a significant negative effect ($\beta = -0.02$; $p < 0.001$), suggesting that performance depends more on the efficiency of land use than on land availability alone.

Influence of Access to Financing and Inputs:-
Both the amount of loans and expenditures on inputs are positively and significantly associated with income ($p < 0.001$), confirming the role of financing and productive investment in intensification and economic performance.

Influence of Agricultural Services and Trade Relations:-
Access to agricultural services is significantly linked to income: the absence of services ($\beta = -0.66$; $p < 0.001$) and other forms of services ($\beta = -0.59$; $p < 0.001$) have negative coefficients relative to the reference. The difficulty of finding buyers is also significant for the categories "easy," "very difficult," and "very easy," but not for "impossible" ($p = 0.200$), confirming the importance of marketing conditions. Producers reporting very significant difficulties in finding buyers have incomes that differ significantly from those in the reference category ($p < 0.001$). Conversely, certain categories associated with an easier search for markets are also significant, reflecting the importance of marketing mechanisms in value creation. These results underscore that economic performance depends not only on production but also on farmers' ability to access markets effectively.

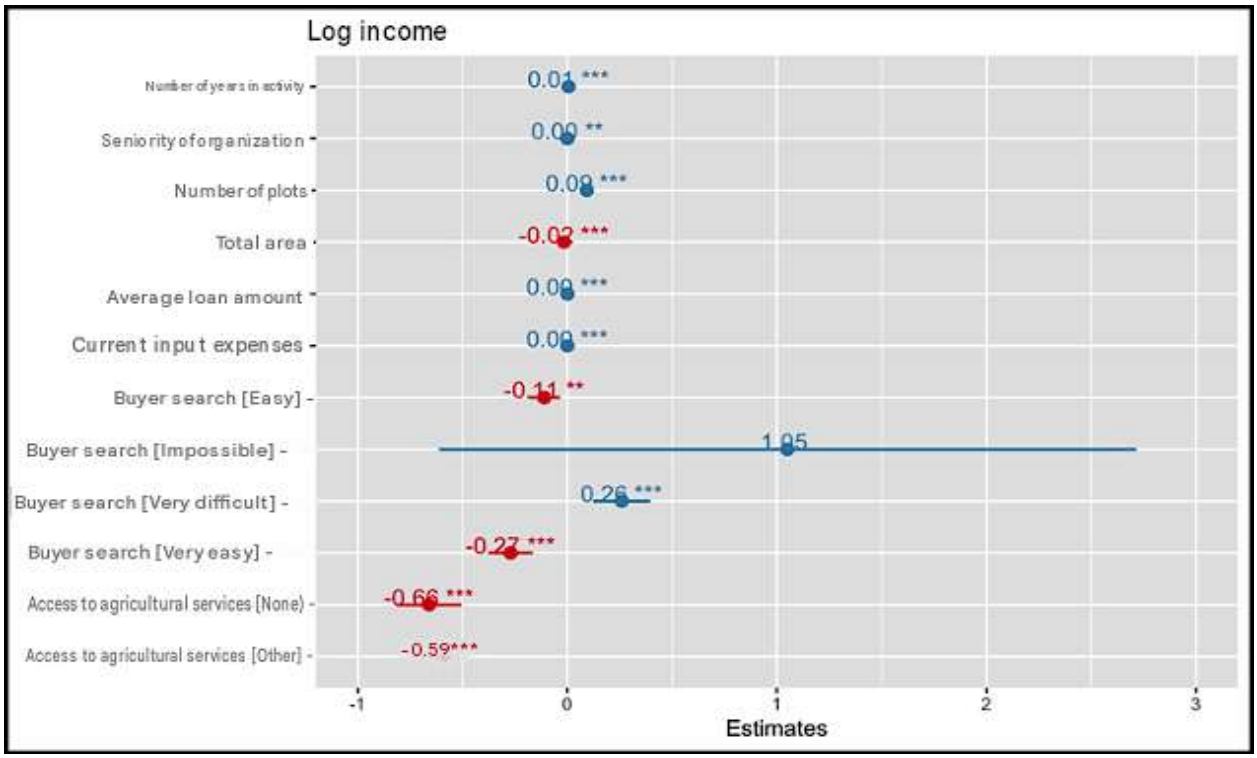


Figure5: Relative Importance of the Estimated Coefficients

The main factors associated with performance are the number of plots, input expenditures, access to financing, and agricultural services; organizational factors also have significant effects. The marginal effects confirm that any improvement in access to productive resources, financing, and technical support leads to an increase in the economic performance of farms.

Summary of Performance Determinants:-
The regression reveals that organizational, production, financial, and commercial factors collectively influence economic performance. Experience and organizational tenure are positively associated with income, as are access to credit and investment in inputs. Agricultural services and marketing conditions also play an important role. Sustainable income growth therefore requires a combination of organizational strengthening, access to financing, technical support, and market integration.

Discussion:-

A High Degree of Organizational Integration Among Producers, but Heterogeneous Levels of Engagement:-
The Mboudoum Union features a mature and structured farmers' organization that plays a key role in managing infrastructure and coordinating production, consistent with the findings of Fall (2018). However, disparities in the

length of time producers have been members lead to inequalities in access to information and opportunities, which limits collective effectiveness.

Access to factors of production remains a key factor in the differentiation of farms:-
Farms vary greatly in terms of size, credit, and inputs, reflecting the coexistence of small family-run operations and more capital-intensive units (Seck et al., 2010; MAER, 2021). Despite this, the majority of producers adhere to the recommended input rates, indicating that intensification practices have been widely adopted (FAO, 2013). The best-resourced farms mobilize more resources, making access to production factors a major determinant of differentiation.

Economic performance characterized by significant heterogeneity among producers:-
Income and selling prices show a wide range, with a majority of small-scale farms and a few high-performing operations. According to the value chain approach (Porter, 1985; Kaplinsky and Morris, 2000), this disparity reflects unequal access to resources and markets, influenced by both the characteristics of the farms and their organizational environment.

Multivariate analyses reveal several key dimensions of rice-farming operations:-
The PCA reveals complementary dimensions that intersect organizational, productive, and economic factors. The principal axes contrast poorly equipped farms with better-equipped units, confirming that performance results from a combination of several interdependent factors.

The existence of multiple farm profiles confirms the diversity of the local productive fabric:-
The HCPC identifies several profiles ranging from low-capitalized units to intensive operations with performance levels confirmed by ANOVA. This diversity, common to African irrigated systems (Bationo et al., 2020), calls for support mechanisms tailored to each profile in terms of financing, technical advice, and collective organization.

Organizational and production factors significantly influence economic performance:-
The regression confirms that agricultural experience and organizational seniority are positively correlated with income, as are the number of plots, access to credit, and spending on inputs. Ultimately, the performance of rice farms depends on the interaction between collective organization, access to resources, financing, technical support, and market integration.

Conclusion:-

This study analyzed the relationships between collective organization, access to factors of production, and the performance of rice farms in the Mboudoum Union (Senegal River Valley), based on data covering 2,982 producers. The results reveal an organizational structure centered on village groups, but characterized by significant heterogeneity among producers in terms of experience, tenure, and access to factors of production (land area, credit, inputs, and agricultural services). The ACP and HCPC confirm these disparities by identifying several profiles, ranging from small, undercapitalized farms to more intensive and better-resourced units, while the multiple regression analysis shows that agricultural experience, organizational tenure, the number of plots, access to credit, and spending on inputs positively influence income. Performance thus results from a combination of collective organization, productive resources, and market integration, making the Mboudoum Union a strategic player in the economic resilience of producers. These results support the need to expand access to credit, improve technical support, and digitize services (e.g., mAgri). Future research incorporating spatial, climatic, and agronomic data would deepen our understanding of value chains in West African irrigated systems. Finally, collective organization within the Mboudoum Union helps offset the individual vulnerability of smallholder farmers in the face of financial and logistical barriers. Maximum economic performance is achieved when membership in the organization ensures a timely supply of inputs aligned with readily available agricultural credit and strict adherence to the harvest schedule.

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