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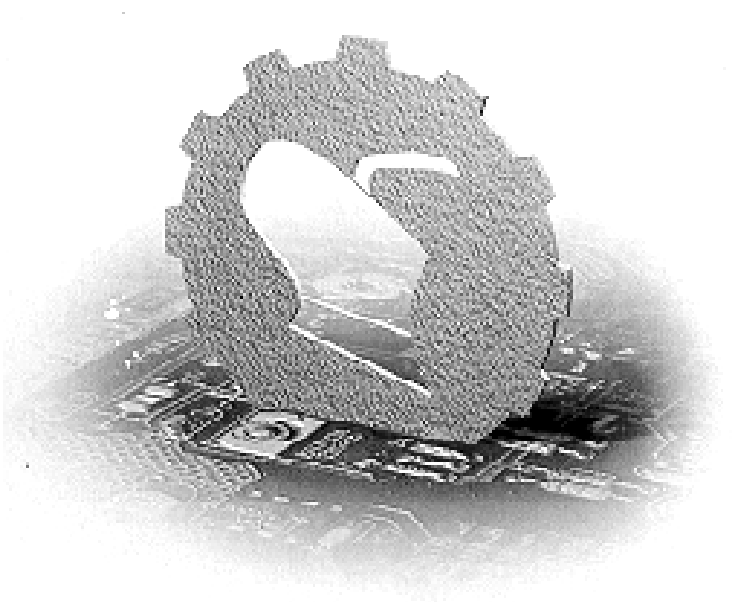

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THE IMPORTANCE OF SAFE FINANCIAL REPORTING WITH THE AIM OF REALISTIC MANAGEMENT OF AGRICULTURAL MACHINERY, EXAMPLE OF THE REPUBLIC OF SERBIA

Ognjen Bakmaz[1], Miloš Dragosavac[2], Aleksandra Brakus[3], Goran Krstajić[4], Nebojša Borojević[5], Željko Grubješić[6], Dragana B. Popović[7], Slobodan Popović[8]*

[1]*The College for Business and Management Studies, East Sarajevo-Sokolac, Republic of Bosnia and Herzegovina*
[2,3]*High School of Modern Business, Belgrade, Republic of Serbia*
[4]*Colleges of Organizational Studies EDUKA, Republic of Belgrade, R.Serbia*
[5,6]*Pensions and Disability Insurance Fund, Prijedor, Republic of Bosnia and Herzegovina*
[7]*Student at Faculty of Economics in Subotica, Republic of Serbia*
[8]*Public utility Company Gradsko Zelenilo, Novi Sad, Republic of Serbia*

Abstract: Reliable financial reporting depends on numerous factors that can be applied in the real-world management processes of many legal entities. In this paper, the authors emphasise the importance of secure reporting for decision-makers in relation to the actual use of agricultural machinery, both for individual farms and for medium-sized companies operating mainly in agriculture. The paper analyses the following factors: the value of agricultural machinery, fuel consumption and the maintenance of agricultural machinery in the two forms of agricultural production organisation mentioned. The main conclusion is that medium-sized agricultural enterprises use more expensive agricultural machinery and have lower fuel consumption and maintenance costs for agricultural machinery. The importance of reliable reporting was substantiated by applying regression analysis after conducting 131 surveys.

*Corresponding Author. E-mail: slobodan.popovic49@gmail.com
ORCID: 0000-0002-6321-8141

The Authors demonstrated that the value of agricultural machinery to individual farms can be predicted by actual fuel consumption and maintenance costs.

***Key words**: financial reporting, agricultural machinery, business security*

INTRODUCTION

Safe and realistic business decision-making by decision-makers largely depends on established controls in business [1-5].

The establishment of realistic business decision-making in agricultural enterprises, but also in general, largely depends on the correct evaluation of all parts in them [6-9].

Real reporting to business owners is the essence of making valid management decisions at all levels of observation [10-12].

The basis of correct, safe and realistic business decision-making are financial reports on all parts of legal entities, which is of great importance especially for agriculture and companies that operate mainly in it, and the essence is decision-making while reducing business risk [13-15].

MATERIALS AND METHODS

The research was conducted in the period from November 1 to November 30, 2023 on the territory of the Republic of Serbia. 110 medium-sized agricultural enterprises and 121 agricultural holdings were surveyed, i.e. a total of 131 participants were included in the survey. Everyone was guaranteed complete anonymity and a statement was made that after the survey, the data obtained will be used exclusively for scientific purposes and the writing of this paper.

The value of the mechanization was obtained on the basis of the statement of the owner of the farm on the real value of the mechanization, that is, on the basis of the business books in which it is kept from the last final account of the company.

In addition, for the factors of fuel consumption and maintenance of agricultural machinery, the evaluation of respondents was used in the interval from 1 to 5, so that with 1 it was possible for the respondents to declare that there is a weak influence of the factor on business, that is, use, and with 5 as a strong influence.

The goal of the research was to examine whether there is a difference between individual farms and medium-sized agricultural enterprises in relation to: the value of agricultural machinery in business books, the owner's assessment of fuel consumption and maintenance of machinery in relation to the observed individual agricultural farms and medium-sized agricultural enterprises.

The t test of independent samples was used to examine the differences between individual farms and medium-sized agricultural enterprises. In the research, multiple linear regressions where applied for agricultural farms to examine the mentioned three factors in relation to the possibility of predicting the value of mechanization.

The data obtained from the survey were statistically processed using the software IBM SPSS (Statistical Package of Social Science) version 25 and the threshold value where 0.05.

RESEARCH RESULTS AND DISCUSSIONS

Safe financial reporting of individual producers as well as medium-sized agricultural enterprises in this study is shown based on the analysis of three factors, namely:
the value of agricultural mechanization, fuel consumption and its maintenance, which can be seen in Table 1.

Reinforcement of the presentation from Table 1 is done below by predicting the value of mechanization at individual farms and the results themselves are given in Tab.2.

Table 1. Presentation of factors in relation to the form of use of agricultural machinery from the point of view of significance

Analyzed factors	Name of machinery	Form of use of machinery		t	p
		Individual farms	Medium-sized agricultural enterprises		
		Middle value			
The value of mechanization	Tractor	3906.50 ± 2548.44	4924.32 ± 3058.77	-10.553	<0.0005*
	Small machinery	369 ± 227.47	539 ± 238.66	-18.318	<0.0005*
Fuel consumption	Tractor	6.61 ± 0.69	5.20 ± 1.64	9.358	<0.0005*
	Small machinery	4.49 ± 0.00	3.12 ± 0.00	16.099	<0.0005*
Maintenance of machinery	Tractor	6.22 ± 1.13	3.40 ± 1.08	23.014	<0.0005*
	Small machinery	4.59 ± 0.43	1.99 ± 0.00	38.478	<0.0005*

*Statistical level of significance at the level of 0.05

Table 2. Prediction of the value of mechanization at individual farms

	Beta	t	p
A constant	-	-4.779	<0.0005*
Fuel consumption	0.300	2.942	0.028*
Maintenance of machinery	0.180	1.781	0.074

*Statistical level of significance at the level of 0.05

Based on the results shown in Table 1, it can be seen that for all analyzed factors, that is, for all the use of machinery, there is a statistically significant difference, as well as that medium-sized agricultural enterprises have more expensive agricultural machinery in use compared to individual farms, as well as that they have lower consumption fuel and lower maintenance costs of agricultural machinery.

The regression analysis yielded a coefficient of determination of 0.375, on the basis of which it can be concluded that the obtained model describes 37.5% of the total variance.

The value of mechanization can be predicted based on fuel consumption and maintenance of mechanization since the model is statistically significant (F=161.228, p<0.0005), which can be seen in the presentation of the obtained research results in Table 2.

CONCLUSION

The results obtained in the study suggest that by analyzing the value of agricultural mechanization, fuel consumption and maintenance costs, it can be concluded that there is a statistically significant difference in the actual use of individual farms as well as medium-sized agricultural enterprises.

Second, medium-sized agricultural enterprises own more expensive agricultural machinery compared to individual farms.

Third, medium-sized agricultural enterprises achieve lower fuel consumption as well as having lower maintenance costs for all agricultural machinery.

In the end, it can be concluded that the value of agricultural machinery can be predicted on the basis of two factors, i.e. on the basis of fuel consumption and maintenance of agricultural machinery.

CONFLICT OF INTEREST

None is declared.

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ZNAČAJ SIGURNOG FINANSIJSKOG IZVEŠTAVANJA SA CILJEM REALNOG UPRAVLJANJA POLJOPRIVREDNOM MEHANIZACIJOM, -PRIMER REPUBLIKE SRBIJE

Ognjen Bakmaz[1], Miloš Dragosavac[2], Aleksandra Brakus[3], Goran Krstajić[4], Nebojša Borojević[5], Željko Grublješić[6], Dragana B. Popović[7], Slobodan Popović[8]

[1]Visoka škola za uslužni biznis Istočno Sarajevo-Sokolac, R. Bosna i Hercegovina
[2,3] Visoka Škola modernog biznisa, Beograd, Republika Srbija
[4]Visoka škola organizacionih studija EDUKA, Beograd, Republika Srbija
[5,6] Fond za penzijsko i invalidsko osiguranje, Prijedor, Republika Bosna i Hercegovina
[7] Student Ekonomskog Fakulteta u Subotici, Novi Sad, Republika Srbija
[8]Javno komunalno preduzeće Gradsko Zelenilo Novi Sad, Republika Srbija

Abstract: Sigurno finansijsko izveštavanje zavisi od mnogobrojnih faktora koji se mogu primeniti u procesima realnog upravljanja brojnih pravnih lica. U ovom radu autori ističu važnost sigurnog izveštavanja nosioca odlučivanja u vezi realnog korišćenja poljoprivredne mehanizacije i to kako kod individulanih gazdinstava tako i kod srednjih preduzeća koja se pretežno bave poljoprivredom.

U radu su analizirani faktori: vrednost poljoprivredne mehanizacije, potrošnja goriva i održavanje poljoprivredne mehanizacije, u pomenuta dva oblika organizovanja poljoprivredne proizvodnje.

Osnovni zaključak je da srednja poljoprivredna preduzeća koriste skuplju poljoprivrednu mehanizaciju, kao i da imaju niže vrednosti potrošnje goriva i niže troškove održavanja poljoprivredne mehanizacije.

Značaj sigurnog izveštavanja osnažena su nakon urađene 131 ankete i to putem primene regresione analize.

Autori su dokazali da se kod individualnih gazdinstava može predvideti vrednost poljoprivredne mehanizacije putem realne potrošnje goriva i troškova održavanja iste.

Ključne reči: *finansijsko izveštavanje, poljoprivredna mehanizacija, bezbedno upravljanje*

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ASSESSMENT OF SMALLHOLDER OIL PALM FARMERS' CAPABILITY TO SUPPLY OIL PALM FRUITS FOR PRODUCTION OF SPECIAL PALM OIL IN NIGERIA

Owolarafe Oseni Kehinde[*1], Falana Olumide Babatope[1], Okorie Victor Ogbonaya[2], Binuyo Gbonjubola Oluwafunmilayo[3], Ogunsina Babatunde Sunday[1], Obayopo Surajudeen Olanrewaju[4], Morakinyo Tunde Afolabi[5], Owolabi Ibraheem Akanni[1], Badmus Ganiyu Ademola[6], Olaoye Isaac Olatunde[7]

[1]*Department of Agricultural and Environmental Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria*
[2]*Department of Agricultural Extension and Rural Development, Obafemi Awolowo University, Ile-Ife, Nigeria*
[3]*African Institute for Science, Policy and Innovation, Obafemi Awolowo University, Ile-Ife, Nigeria*
[4]*Department of Mechanical Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria*
[5]*Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife, Nigeria*
[6]*Nigerian Institute for Oil Palm Research, Benin City, Nigeria*
[7]*Department of Agricultural and Civil Engineering, First Technical University, Ibadan, Nigeria*

Abstract: This study employs a cross-sectional design to examine factors essential for enabling smallholder farmers to provide the necessary quality and quantity of fresh oil palm fruits for producing special palm oil in Nigeria. We utilized proper sample sizes and a multi-stage sampling technique for respondent selection (stage 1 - zoning, stage 2 - identifying available farmers in each state, and stage 3 - applying Slovin's formula for respondent selection).

[*]Corresponding Author. Email address: owolarafe@yahoo.com
ORCID: 0000-0002-6748-8704

Surveys were distributed to 528 farmers across six palm oil-producing states. The findings indicate that farmers take an average of three days to transport fresh fruit bunches to processing facilities, adversely affecting the volume available for special palm oil production. Factors such as access to information, membership in organizations, and education level were identified as critical to improving farmers' capabilities in the supply chain. Consequently, the study recommends that key stakeholders enhance extension services provided to farmers.

Key words: *Extension education, Smallholder farmers, fruit production, quantity and quality, special palm oil.*

INTRODUCTION

The oil palm is a critical agricultural crop for vegetable oil production [1], boasting a significant yield of approximately 5 tons of palm oil per hectare [2]. It thrives in 20 states across Nigeria, predominantly within the rainforest and derived savannah zones, marking it as the leading oil-bearing crop in terms of direct consumption and processing into oil and cake. The processing of ripe fresh fruit bunches from the oil palm tree yields three commercial products: crude red palm oil, palm kernel oil, and palm kernel cake (or meal). Palm oil serves as the primary cooking oil in Nigerian cuisine, essential for preparing soups and various food items [3].

After bleaching and refining, palm oil finds broader applications in the production of margarine, confectionery, ice creams, soap, and substitutes for filled milk or cocoa butter. Palm kernel oil is utilized in creating artificial cream fillings, soap, cosmetics, personal care products, emulsifiers for food processing and pharmaceuticals, and in the manufacture of toiletries, tobacco products, alkyd resins, paints, varnishes, cellophane, explosives, and polyurethane. Palm kernel cake, on the other hand, is valued as livestock feed, highlighting the oil palm's versatile role in both the agricultural and industrial sectors [1,3,4,5].

Except for a few large and medium-scale plants, oil palm fruit bunches harvested by farmers are usually processed into technical palm oil (TPO), which is of low quality (with free fatty acid and moisture content of more than 3 and 1%, respectively). This category of palm oil finds limited uses in food and agro-allied industries. Special palm oil (SPO) is a palm oil of high quality with free fatty acid and moisture content of less than 5% and 1%, respectively. This grade of palm oil is the best for food processing industries and is usually in high demand by the large-scale food and applied processing industries [4,5].

Most industries forced to purchase TPO (due to insufficient special palm oil) undergo extra cost of refining the oil to usable form that can fit into their applications. Special palm oil production is low due to the fact the available few oil palm estate owners are only the key actors leading to the production of crude palm oil with less or equal to 5% Free Fatty Acid [4].

From being one of the leading exporters of crude palm oil in the 1960s, Nigeria is now a net importer. PwC reported that the importation of crude palm oil to supplement local production between 2014 and 2018 is in the range of US$1.28 billion [6].

The importation of the product increased to US$186.9 billion between 2017 to 2022 [7]. Furthermore, with the growing population of the country (about 200 million), the vegetable oils and fats required to support the populace are in the region of 2.34 million metric tons annually. It is astonishing to discover that the country also imports considerable quantity of Indonesia palm oil and that of neighbouring West African countries such as Benin, Togo, and Ivory Coast [8].

In a bid to close the supply gap and encourage local investment, the Federal Government put in place some policy measures, including refined palm oil as one of the items that importers are restricted from accessing foreign exchange at the interbank market, increasing the duty charge on crude palm oil, the establishment of special borrowers programme to make framers have access to a loan at low-interest and listing of palm oil as a commodity of priority support for the Central Bank of Nigeria, among others. It is opined that with these efforts, the production of fresh palm fruit bunches to support the production of special palm oil will be enhanced. It, therefore, becomes imperative to ascertain the current capacity of the farmers in terms of technical know-how and material resources in this regard. Accordingly, farmer and farm-related characteristics are interrogated to assess the capability of the farmers to contribute to filling the SPO supply gap in Nigeria.

Prior to the emergence of Special Palm Oil (SPO), Nigeria's palm oil production was limited to Technical Palm Oil (TPO), catering exclusively to domestic consumption. With the onset of industrialization, the demand for SPO surged, prompting a shift in production practices. This transition required farmers to adapt to new methodologies for producing and delivering fresh fruit bunches suitable for SPO, marking a significant departure from traditional TPO production techniques. These novel conditions, introduced to smallholder farmers since the 1960s—the period signifying the start of industrialization in Nigeria—entail substantial changes in agricultural practices. The ongoing effort to communicate these updated practices underscores the critical need for enhancing farmer capabilities and leveraging technological advancements. This study aims to thoroughly investigate the impact of these advancements and the capacity of farmers to boost the productivity and sustainability of SPO production in Nigeria. It seeks to identify effective strategies to address the sector's challenges, thereby facilitating a smoother transition towards more advanced and efficient production methodologies in the context of a rapidly industrializing agricultural landscape.

MATERIAL AND METHOD

This study was conducted in six selected states in Nigeria (Akwa Ibom, Edo, Imo, Kogi, Ondo, and Osun). The states were purposefully selected among the palm oil states in Nigeria based on the high density of the palm. The standard formula for calculating the minimum sample size when the universe contains 10,000 objects or more was used to select the respondents [9]. The formula is presented in Equation 1.

$$n = \frac{z^2 pq}{d^2} \qquad \text{……..……(1)}$$

Based on available data on the population of oil palm fruit processors in each state, a total of 528 farmers were selected as respondents.

The instrument used for data collection is a well-structured, validated questionnaire supported by a field observation checklist. The questionnaire elicits information on the demographic characteristics, ownership of the mill, number of male and female dependents, mode of land acquisition for plantation, oil palm fruits processing, sales of products, and awareness about SPO among others.

The checklist was to obtain information on sequential and procedural steps of various relevant operations. Data were collated through Epidata and analyzed with the Statistical Package for the Social Sciences. Descriptive statistics such as frequency count and percentage were used to describe the data while cross-tabulation and Chi-Square analysis were used to make deductions.

RESULTS AND DISCUSSION

Farmer-related characteristics

Table 1 presents a detailed grasp of the socio-demographic profiles and operational circumstances of oil palm farmers in selected Nigerian states, offering insights into the challenges and opportunities within the sector. It was observed that 22% of the respondents were between the ages of 30 – 39 years, while 29% indicated that their ages were between 40 – 49 years, 23.7% were between the ages of 51 – 59 years and 19.4% were 60 years, and above. The age distribution of respondents underscores a mature farmer demographic, with a substantial portion aged 40 years and above, suggesting that a significant number of farmers may face physical constraints in engaging in labor-intensive activities such as cutting palm groves and transporting fruit bunches. This observation raises concerns about the sustainability of labor inputs and the potential need for mechanization or younger labor forces to maintain production levels, [10].

Marital status and gender distribution data reveal a predominance of married male respondents, highlighting the gendered nature of oil palm farming in the region. Majority (88.3%) of the respondents were married, 38(7%) never married, while 22(4.1%) and 3(0.6%) were widowed and separated, respectively. Many (74.6%) of the respondents were male while 25.4% were female. This gender imbalance reflects broader societal norms and potentially points to gender inequalities in access to resources, decision-making, and opportunities within the agricultural sector. Moreover, gender roles differ at various stages in the cultivation of oil palms. While the processing of palm fruits is often considered a women's industry, men's increased participation in off-farm work is attributed to the relative labour efficiency of oil palm compared to other crops, [11].

Educational attainment among the farmers shows a spectrum from no formal education to tertiary certificates. Only 8.4% of the respondents had no formal education, 30% had First School Leaving Certificate, 39% had West African Education Certificate and 10.1% had tertiary certificates. While the majority have received some form of formal education, the variation in educational levels may affect their capacity to adopt new technologies, comply with SPO production standards, and engage with complex market or regulatory environments.

The household composition, characterized by an equal distribution of male and female children, alongside a high dependency on household labor, reflects traditional family structures. There was a fairly equal distribution of male and female children within respondents' households, as the majority (78.1%) of the respondents had a house size within the range of 1 to 4 males and 72.5% had the same range for female children. This reliance on family labor for farm operations is a common feature in West Africa [12], emphasizing the need for strategies to enhance labor efficiency and manage the timely transportation of fresh fruit bunches to processing centers critical for SPO production which requires processing within 24 hours of harvesting. The equal distribution of male and female children within households is consistent with anthropologists' claim that the human population is equally distributed between males and females, [13]. It enables farms with limited mechanization and cash to hire labour to ensure the timely evacuation of fresh fruit bunches from their respective farms to the nearby processing centres. Evidence has suggested that one of the great obstacles to the production of SPO in Nigeria is the delay between harvesting and processing centres, [5]. Production of SPO requires among others the processing of fresh bunch within 24 hours of harvesting.

Table 1. Distribution of the socio-demographic characteristics of respondents

Parameters	Frequency	Percentage
Age group (in 10 years)		
<30yrs	32	5.9
30-39yrs	119	22
40-49yrs	157	29
50-59yrs	128	23.7
60yrs+	105	19.4
Total	541	100
Marital status		
Never married	38	7
Married	477	88.3
Widowed	22	4.1
Separated	3	0.6
Contin. Table 1.		
Total	540	100
Sex		
Female	140	25.4
Male	411	74.6
Total	551	100
Highest qualification obtained		
None	44	8.4
FSLC	158	30.2
WAEC/NECO	204	39
ND	28	5.4
HND	36	6.9
BSc.	43	8.2
MSc.	9	1.7
PhD	1	0.2
Total	523	100

Contin. Table 1.			
Household size			
Number of Females	1 – 4	377	72.5
5+		142	27.3
Total		520	100
Number of Male	1 – 4	407	78.1
5+		114	21.9
Total		521	100
The Average income per annum			
From Primary			
100000-500000		56	12.7
500001-1000000		52	11.8
1000000+		332	75.5
Total		440	100
From Occupation			
50000-500000		58	21.7
500001-1000000		72	27
1000000+		137	51.3
Total		267	100
Membership of any Organization	No	245	46.4
Yes		283	53.6
Total		528	100
Farm Ownership			
Government-owned		26	4.7
Single privately owned		222	40.2
Cooperatively-owned		13	2.4
Our family-owned it		32	5.8
My Inheritance		64	11.6
I planted/purchased it		81	14.7
I got it through a lease		97	17.6
Gift		9	1.6
Others		8	1.4
Total		552	100

The economic insights, indicating oil palm farming as the primary occupation for more than half of the respondents with an average annual income of ₦1,000,000, suggest that oil palm farming represents a significant livelihood source. However, the income level also points to the economic vulnerabilities and the importance of improving productivity and market access to enhance incomes. A higher percentage (53.6%) of the respondents were members of an organization, just as 47.6% and 38.9% were ordinary and executive members, respectively. Membership in organizations is notably high, suggesting a potential avenue for collective action, knowledge sharing, and support. This organizational involvement could be leveraged to facilitate access to credit, inputs, and training, addressing some of the production and marketing challenges faced by farmers.

About 40.2% of the respondents were operating on a single-privately owned oil palm farm. This is the highest category among the ownership types.

Hence, it could be concluded that the plantations are mainly owned by individuals in the community.

Spatial arrangement and selection of appropriate land capabilities are needed to control the productivity of oil palm plantations, [14].
Few (11.6%) of the respondents inherited oil palm farm, 17.6% got it through a lease just as 14.7% and 5.8% operated the farm as a purchased and family-owned venture, respectively. Land ownership patterns, with a significant proportion of respondents operating on single-privately owned farms, highlight the importance of land management practices in optimizing productivity. The findings suggest that strategic land selection and spatial arrangement are critical for enhancing the productivity of oil palm plantations.

Oil palm farm-related characteristics

The data from Table 2 provides insightful details about the characteristics of oil palm farms, including land type, variety of oil palm trees, and harvesting frequency, which are essential factors influencing the productivity and quality of oil palm production.

A significant proportion of respondents (33.2%) have their oil palm farms located in forest areas, while 28.8% are situated in lands previously used for arable crops. This distribution suggests a reliance on diverse ecological zones for oil palm cultivation, each with its unique advantages and challenges. The existence of 22.3% of farms as pre-established plantations and 11.8% alongside other tree crops indicates a blend of monoculture and intercropping practices among the farmers. The small percentage (3.8%) of farms located on abandoned lands could imply either a limited availability of such lands or a preference for more fertile and established farming areas.

The nearly equal distribution of *Dura* (thick shell, 49.8%) and *Tenera* (thin shell, 48%) varieties among the farms indicates a diverse genetic base. While these varieties are advantageous in certain aspects, they have relatively lower oil content compared to the *Pisifera* variety (shell-less) [15]. This diversity in varieties could impact the overall oil yield and quality. The majority of respondents (67.8%) reported a monthly harvesting cycle, which could be influenced by factors such as labor availability, farm size, and the maturity period of the fruits. The less frequent harvesting cycles (fortnightly: 22.2%, bimonthly: 5.3%, quarterly: 4.7%) might affect the freshness of the fruit, which is crucial for the quality of palm oil, especially for Special Palm Oil (SPO) production that requires processing within 24 hours of harvesting.

Table 2. Land Description and Farm Properties

The land upon which your oil palms grow was previously	Frequency	Percentage
Forest	174	33.2
Abandoned land	20	3.8
Oil Palm plantations	117	22.3
Other tree crops	62	11.8
Arabic crop farm	151	28.8
Total	524	100
Age of oil palms farm under control		
1-10yrs	156	29.8
11-20yrs	200	38.2
21-30yrs	81	15.5
31yrs+	86	16.4
Total	523	100

Contin. Table 2. Types of fruits are found on oil palm under your control		
Thick shell	274	49.8
Hybrid	264	48
No shell	12	2.2
Total	550	100
How often do you harvest your palm fruit		
Fortnightly	122	22.2
Monthly	372	67.8
Bimonthly	29	5.3
Quarterly	26	4.7
Total	549	100

Implications for oil palm production

1. The choice of land type and farm location reflects the farmers' knowledge and strategic decisions regarding optimal conditions for oil palm cultivation. This aspect is critical for ensuring the sustainability and environmental impact of oil palm farming.
2. The prevalence of *Dura* and *Tenera* varieties suggests a potential need for agricultural extension services to guide farmers in selecting high-yielding and disease-resistant varieties to maximize oil production.
3. The harvesting frequency data indicates a need for improved logistics and processing capabilities to ensure that the harvested fruits are processed timely, thereby enhancing the quality of the palm oil produced.

A notable 65.22% of respondents reported spending less than one hundred thousand Nigerian Naira on planting materials from research stations, indicating a preference or reliance on research-based sources for quality planting materials. This reflects an understanding among a majority of farmers of the importance of using scientifically developed and certified seeds or seedlings for enhancing farm productivity. Conversely, lower percentages of respondents spent the same amount on planting materials from nearby farms (43.75%), neighbor farms (26.83%), and nearby forests (28.85%). This variance in spending patterns across different sources suggests differing perceptions of value, accessibility, or quality of planting materials obtained from non-research sources.

The reliance on research stations by a significant portion of respondents underscores the recognized value of improved planting materials in achieving higher yields and disease resistance. In the past five decades, research and development (R&D) activities, coupled with technological advancements, have significantly contributed to increased agricultural yields in Malaysia, [16]. Research stations are likely to provide genetically improved varieties that can enhance oil palm productivity. The engagement with nearby farms, neighbor farms, and forests as sources for planting materials, albeit to a lesser extent, might be influenced by factors such as cost, convenience, and traditional practices. However, the lower spending on materials from these sources could also imply concerns about the quality or productivity potential of the materials obtained.

Table 3. Source of planting material and how much spend on the farm under control.

Sources of Planting Material	How much Spend on Farm under Control				
		<100000	100001-500000	500000+	Total
Research Station	NO	24(34.78)	18(28.13)	4(19.05)	46(29.87)
	YES	45(65.22)	46(71.88)	17(80.95)	108(70.13)
Total		69	64	21	154
Nearby Farm	NO	25(33.78)	28(43.75)	7(46.67)	60(39.22)
	YES	49(43.75)	36(56.25)	8(53.33)	93(60.78)
Total		74	64	15	153
Neighbour	NO	30(73.17)	31(77.50)	9(81.82)	70(76.09)
	YES	11(26.83)	9(22.50)	2(18.18)	22(23.91)
Total		41	40	11	92
Nearby Forest	NO	37(71.15)	31(53.45)	9(100.00)	77(64.71)
	YES	15(28.85)	27(46.55)	0(0.00)	42(35.29)
Total		52	58	9	119

Implications for policy and practice

1. The findings suggest a need for policies and programs that ensure the availability and accessibility of high-quality planting materials from research stations to a wider range of farmers. Enhancing farmers' access to improved varieties could significantly contribute to increasing the productivity and sustainability of the oil palm sector, [17].
2. Additionally, there is an opportunity for agricultural extension services to provide education and awareness about the benefits of using quality planting materials. Such initiatives could help bridge the gap between research and practice, encouraging more farmers to invest in improved varieties.
3. The result also highlights the importance of establishing robust quality control mechanisms for planting materials sourced from informal channels (e.g., nearby farms and forests) to ensure they meet certain productivity and health standards. This could involve certification schemes or guidelines for the collection and distribution of planting materials.

Table 4 provides an overview of the condition of farming implements across different ownership models of oil palm plantations, revealing insights into the operational efficiency and maintenance practices within the sector.

A significant majority of respondents (63.64% for government-owned and 62.04% for single-privately owned) reported that implements were in good condition. This high percentage suggests effective maintenance and possibly better access to resources for repairs and replacements in these ownership categories. The good condition of government-owned implements may reflect well-structured maintenance programs, while the similar condition of single-privately owned implements indicates individual commitment to sustaining operational efficiency.

Table 4. Ownership of Plantation and Efficiency of the Equipment

Ownership of Plantation	The efficiency of the Equipment			
	Poor	Fair	Good	Total
Government-owned	1(9.09)	3(27.27)	7(63.64)	11
Singe Privately Owned	5(4.63)	36(33.33)	67(62.04)	108
Cooperatively-owned	0(0.00)	4(100.00)	0(0.00)	4
Our Family-Owned it	1(5.26)	7(36.84)	11(57.89)	19
Inheritance	9(40.91)	6(27.27)	7(31.82)	22
Planted/Purchase	3(7.14)	16(38.10)	23(54.76)	42
Through Lease	0(0.00)	38(42.70)	51(57.30)	89
Gift	0(0.00)	0(0.00)	2(100.00)	2
Others	1(20.00)	3(60.00)	1(20.00)	5
Total	20(6.62)	113(37.42)	169(55.96)	302

Notably, none (0.0%) of the respondents reported good condition for cooperatively owned implements, with all indicating a fair condition. This stark difference could imply challenges in collective management and maintenance of equipment, possibly due to resource constraints or coordination difficulties within cooperative structures. A majority (57.89%) considered family-owned implements to be in good condition, suggesting that these implements receive adequate care, possibly due to the direct involvement and vested interest of family members in the plantation's success. In contrast, only a minority (31.82%) reported that inherited implements were in good condition, which may point to challenges in maintaining older equipment passed down through generations or possibly a lack of investment in upgrading such implements.

Over half (54.76%) of the respondents indicated that purchased implements were in good working condition. This finding could reflect the tendency to invest in quality equipment when purchasing new or the prioritization of maintenance for assets directly acquired through personal investment. Implements acquired through lease were reported to be in good condition by a significant majority (57.30%), likely due to lease agreements stipulating maintenance responsibilities or the lessees' motivation to maintain the equipment well to ensure operational efficiency. Interestingly, all implements received as gifts were reported to be in good condition, though this category had a very small sample size (100%), making it difficult to draw broad conclusions.

Implications for agricultural productivity

1. The condition of farming implements is crucial for operational efficiency and productivity in oil palm cultivation. The data suggests that ownership type impacts the condition of implements, with government and single privately owned equipment generally in better condition than those owned cooperatively or inherited.
2. The challenges highlighted in maintaining cooperatively owned and inherited implements point to the need for targeted interventions, such as cooperative management training programs or financial support for equipment upgrades, to ensure these groups can maintain or improve their operational efficiency.
3. Enhancing access to quality implements and establishing robust maintenance practices across all ownership types are essential steps toward boosting productivity and sustainability in the oil palm sector.

Addressing these needs through policy support, extension services, and financial mechanisms could significantly impact the sector's overall performance and contribution to the economy.

Table 5 provides crucial insights into the logistics of transporting fresh oil palm fruit bunches to processing centers, focusing on the distance from the farm to the processing center and the duration it takes for evacuation. This logistical aspect is critical for maintaining the quality of palm oil, as the freshness of the fruit bunches significantly influences oil yield and quality.

Table 5. Processing Center Distance and Days it takes to Evacuate the Fruit

Processing Center Distance from Farm	Days it takes to Evacuate Fruit		
	< 5days	6 days+	Total
(1-10) kilometer	297(75.77)	95(24.23)	392
(11-20) kilometer	22(78.57)	6(21.43)	28
(21-30) kilometer	8(80.00)	2(20.00)	10
31+ kilometer	5(71.43)	2(28.57)	7
Total	332(75.97)	105(24.03)	437

The data indicates that a significant majority (75.77%) of the respondents' farms are located within 1 to 10 kilometers of an oil palm fruit processing center, and these farmers manage to transport their produce in less than 5 days.
This proximity and timely transportation are advantageous for maintaining the quality of the fruit bunches, as shorter distances and evacuation times reduce the risk of fruit spoilage and degradation, which can affect the quality of the oil produced.

Despite the majority managing to evacuate their produce in less than 5 days, there is still a notable portion (24.23%) within the same 1 to 10 kilometers range who take 6 days or more for evacuation. This delay, even over relatively short distances, suggests potential challenges in transportation logistics, labor availability, or farm management practices that could hinder timely delivery to processing centers.

For distances beyond 10 kilometers, the proportion of farmers who take longer to evacuate the fruit slightly decreases, which might seem counterintuitive. This could indicate that farmers situated further from processing centers may plan more efficiently or use different logistics strategies to ensure timely delivery, understanding the increased risks of spoilage due to longer distances.

Implications for productivity and quality

1. The necessity for fresh fruit bunches to be processed within 24 hours of harvesting to produce high-quality oil underscores the importance of logistical efficiency. The result suggests that while proximity to processing centers is generally beneficial, improvements in transportation and farm management practices are needed across all distances to minimize evacuation times.
2. The education status of farmers, mentioned as a factor enabling timely operations, points to the role of knowledge and skills in managing logistical challenges. Educated farmers may have better access to information on best practices and more capacity to organize their resources effectively.

Strategies for improvement

Enhancing the logistical chain from farm to processing center is crucial for the sector. This could involve investments in better road infrastructure, increased access to transportation means, and the development of smaller, local processing units to reduce travel distances for farmers situated further away.
Training and education programs focusing on logistical management and the importance of quick evacuation can help farmers of all education levels improve their practices. Additionally, cooperative models or community-based approaches could be employed to pool resources for transportation, making the process more efficient and cost-effective.

CONCLUSIONS

To effectively elevate Special Palm Oil (SPO) production in Nigeria and surmount the sector's prevailing challenges, a holistic strategy is imperative. This strategy must navigate through the complex landscape of oil palm farming, addressing demographic and educational influences, operational dynamics, logistical hurdles, and the pivotal role of agricultural extension services.

- An aging farmer population necessitates initiatives to attract younger individuals to agriculture, ensuring future sector sustainability. Educational levels among farmers play a crucial role in their ability to adopt innovative practices and technologies, underscoring the need for educational programs aimed at enhancing agronomic knowledge.
- The dependence on research stations for superior planting materials highlights the importance of fostering stronger links between researchers and the farming community. Such collaboration is essential for the dissemination of improved seed varieties that promise enhanced yields and crop quality, directly impacting SPO production efficiency.
- Proximity to processing centers and the efficacy of fruit evacuation processes are critical for maintaining oil palm fruit quality. While many farmers in close proximity to processing centers manage timely evacuation, there's a pressing need for infrastructural enhancements and logistical improvements to support farmers across all distances.
- Agricultural extension services are crucial in narrowing the gap between research innovations and their practical application on farms. They play a vital role in providing farmers with the necessary knowledge and skills to boost farm productivity, improve SPO quality, and embrace sustainable practices.

Addressing the oil palm sector's challenges and boosting SPO production necessitates a coordinated approach. Initiatives focused on revitalizing the farmer demographic, expanding educational outreach, enhancing access to quality resources, refining operational and management practices, and improving logistical efficiency are essential. Additionally, reinforcing agricultural extension services will equip farmers with the requisite knowledge for best practice implementation, leading to heightened productivity, sustainability, and sector profitability.

This multifaceted strategy will not only fulfill domestic SPO demand but also reestablish Nigeria's status in the global palm oil marketplace.

DISCLOSURE STATEMENT

In the development and execution of this study, we report no financial conflicts of interest or personal connections that might seem to affect our research outcomes.

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PROCENA SPOSOBNOSTI MALIH PRERAĐIVAČA U SNABDEVANJU PROIZVODIMA OD ULJA KOD PROIZVODNJE SPECIJALNOG PALMINOG ULJA U NIGERIJI

Owolarafe Oseni Kehinde[1], Falana Olumide Babatope[1], Okorie Victor Ogbonaya[2], Binuyo Gbonjubola Oluwafunmilayo[3], Ogunsina Babatunde Sunday[1], Obayopo Surajudeen Olanrewaju[4], Morakinyo Tunde Afolabi[5], Owolabi Ibraheem Akanni[1], Badmus Ganiyu Ademola[6], Olaoye Isaac Olatunde[7]

[1]Department of Agricultural and Environmental Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria
[2]Department of Agricultural Extension and Rural Development, Obafemi Awolowo University, Ile-Ife, Nigeria
[3]African Institute for Science, Policy and Innovation, Obafemi Awolowo University, Ile-Ife, Nigeria
[4]Department of Mechanical Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria
[5]Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife, Nigeria
[6]Nigerian Institute for Oil Palm Research, Benin City, Nigeria
[7]Department of Agricultural and Civil Engineering, First Technical University, Ibadan, Nigeria

Apstrakt: Ova studija koristi dizajn poprečnog preseka observacione studije kod ispitivanja faktora koji su bitni malim proizvođačima (farmerima) u obezbeđenju neophodnog kvaliteta i količine svežeg ploda (voća) uljane palme u proizvodnji specijalnog palminog ulja u Nigeriji.
Korišćene su odgovarajuće veličine uzorka i višestepena tehnika uzorkovanja za selekciju ispitanika (faza 1 - zoniranje, faza 2 - identifikacija dostupnih farmera u svakoj državi, i faza 3 - primena Slovin formule za selekciju ispitanika).

Ankete su podeljene na 528 farmera u šest država koje proizvode palmino ulje. Nalazi pokazuju da je farmerima proizvođačima potrebno u proseku tri dana da prenesu sveže grozdove plodova (voća) do postrojenja za preradu, što negativno utiče na raspoloživu količinu proizvodenog specijalnog palminog ulja.
Faktori kao što su pristup informacijama, članstvo u organizacijama i nivo obrazovanja identifikovani su kao ključni za poboljšanje sposobnosti farmera u lancu snabdevanja.
Shodno navedenom, studija preporučuje da ključni akteri unaprede savetodavne usluge koje se pružaju farmerima.

Ključne reči: *Stručno obrazovanje, mali farmeri, proizvodnja voća, količina i kvalitet, specijalno palmino ulje.*

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SYNERGIES IN FARMER'S PROCUREMENT, PRODUCTION AND DISTRIBUTION TASKS THROUGH COMMON MARKET ACTIONS

László MAGÓ*

Department of Engineering Management, Institute of Technology, Hungarian University of Agriculture and Life Sciences, 2100 Gödöllő, Páter K. str. 1., R. Hungary

Abstract: Aim of this paper is to introduce a model, which provides effective solutions and support for establishment of the agricultural input and output market systems. Input used in agriculture are mostly technical systems, chemical materials and biological products. The output are the crops, livestock products and energy.
Consequently, profit of agriculture is extremely low and production enlargement is not possible. Possibility to change this situation can be the online-marketplace, which can be created at the input or/and output side. These fields could improve procurement and distribution conditions of agriculture and imply chances to enlarge production through better profit.
The system should foster the producers, should foster more successful production, and must not restrain them. Hence it should provide market advantages at all the elements of the production (regardless the size of property and production system). Therefore, a real solution could be made for practical development of agriculture by increase of suppliers' competition situations.

Key words: *Farm management, online-marketplace, procurement, distribution, production management.*

*Corresponding Author. E-mail: mago.laszlo@uni-mate.hu
ORCID: 0000-0001-6082-8051

INTRODUCTION

In Hungary the former system, which worked intensively has been the "production systems" based on big factories, [1], [2]. These systems have been established along production paths, [3], [4]. The system administrators have provided the input, they have worked up the production experience, and hence a "self-learning" system has been made. They have taken expectations of the market that time into consideration. For the time being the production structure and the market have been altered and we have not found the production system that could meet the challenges, [5], [6].

Changing of the present European Common Agricultural Policy (CAP) can be expected, [7], [8]. Decreasing the deforming impact of the supporting system the role of innovation is more and more important, [9]. Our model supports it effectively in many areas (e.g. optimization of invests and operation, reducing of production costs, increase of the research efficiency). Our unique agricultural possibilities are capitalized using the planned up-to-date information system, making competitive advantage for farmers and food industry. In addition, the system will be advantageous for inputs production, mostly for agricultural machine industry, [10], [11].

In a small-scale farm environment significant savings can be achieved by the common utilisation of the machines and by the employing professional machine works both in the investments and the machine operation, [12], [13]. Those beneficial machine service and collaboration forms are used worldwide, especially in the agriculture of the developed countries, [14], [15]. In past years status quo analyses and the evaluation of experience showed that there is need for the farmers cooperation in the East European countries including Hungary for the rational utilisation of resources and to improve the efficiency of assets and to minimize costs, [16]. However, the organizations, structures, schemes, models and frames of standard forms has not been formed as yet, so that the utilisation of the advantageous solutions is on quite a low level, [17], [18].

The successful formulation of machine utilisation and business supporting forms decisively depend on the conditions and the appropriate knowledge about the properties of the different forms, [19]. It is highly important that all the factors and characteristics should be discovered for the benefits and disadvantages of forms from the organisational, operational, economical, and all the other points of view in order to determine and declare the criteria of introduction for each economy circles of farmers, [20], [21], [22].

MATERIAL AND METHOD

As estimated, in Hungary the turnover of the input could approach a several billion EUR annually. It is supposed that the input side pressure is indicated in 15-20 % of extra profit from traders towards producers, which means that producers' profit possibilities are reduced by this rate in the rate of utility. On the other hand, annual sponsored limits of agriculture have been realized to a great extent by purchasers of produced materials through the pressured purchase price.

The relationship between producers and input providers is quite determined in the field, [23]. It means that input users are connected tightly by the agency of manufacturers and traders and their relationship is determined by traders' profit maximisation. In this relationship a producer has hardly any possibility to compare complete supply portfolios and validate suppliers' most favourable proposals (minimal procurement price, the best quality, etc.)

Aims of this model are:
- establishment of competition situation among input providers,
- enlargement of supply side,
- discontinue inflexible trade structures.

in order the most favourable procurement conditions could be made.

The system enables the producers' common tender announcement. This could be resulted in a more favourable position in the tender announcement through quantity increase of claims arisen in one transaction by competiting the participants in the supply position.

The information system, which substitutes effects of large-scale plant and the self-learning structure provide that the solutions described in our model provide an intensive development path for the agriculture.

The alteration in the online-marketplace and interests could be seen on Figure 1.

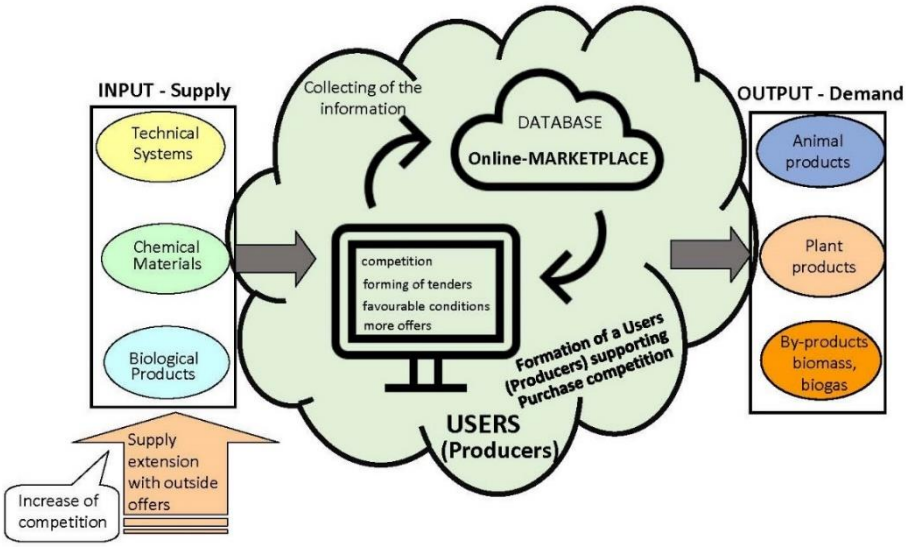

Fig. 1. The online-marketplace and interests (Magó and Fenyvesi, 2009, own editing)

RESULTS AND DISCUSION

Elaboration of the procurement and sales competition supporting producers

Central element of development is the database, which is the basis of the online-market place. For users (producers) the market field collects proposals as well as helps to write procurement tenders and sales tenders, hence it fosters competition of suppliers and purchasers. Producers can achieve more favourable positions by this system in terms of procurement price level, quality and other product qualities regarding their input materials (technical systems, chemical materials, biological products).

Despite the fact that participants in the supply market will compete with each other, they will have also advantages since supply market of the input products provided by them will be more transparent also for them and can be planned in an easier way and specification of participants in the market will be more simply. Therefore, efficiency of their trade will increase.

Number of participants in the supply can gradually increase since the system expects new members. As a consequence, competition can increase, number of products in supply can increase and their quality features improve.

Advantages realized by participants of the online-marketplace

By using the “online-marketplace”, it will be the producers on the first place who will have advantages since their agriculture can be planned in an easier way and can be transparent. Besides the faster information flow, they can achieve decrease in their cost. Quality assurance and standardization guarantee utility and marketing of quality products.

By inducing this system, cooperation among producers will be fostered. Creation of common utility forms of machines and machine types can increase efficiency regarding machine procurement and utility of machines.

Cooperational solutions foster use of results achieved due to modern technological solutions. Apart from production devices, access to money assets can be improved. The method how to obtain market information can be developed, as well. Also, common logistical solutions could be improved.

Table 1. Advantages realized by participants of the online-marketplace

Benefits		
from the viewpoint of distributors	Plannable input claim, demand supply balance	
	More efficient trade	
from the viewpoint of farming	Plannability	
	Transparency	
	Cost reduction	
	From the view of input output quality assurance, standardisation	
	Fast information flow	
stimulation of cooperation	Forming of common machine usage forms, machine circles	
	Development of modern technological solutions, introduction	
	More efficient appearance into loan offices' direction	
	Global market information	
	Common logistical solutions	
from the viewpoint of concerned authorities, government, market players, experts, R&D&I	Forming of a regional informational system	Accurate data from the use of the inputs (qualitative, quantitative features, temporal)
		Statistics to the subsidy-, aid systems, market forecasts, (crop estimation based on inputs and a sowing construction
	Registration of expenditures, realizations	
	Optimisation of EU and national subsidies	

Besides producers and distributors, the system provides advantages also for the government, authorities, experts and other participants of the R+D+I market.

A field informatics system can be accomplished by which we could get an exact picture and data about utility and time-quality-quantity features of inputs. Collection of data can be provided for the supportive market forecast systems (estimation of production on the basis of structure of inputs and products). It can contribute to optimization of the national and the EU subsidies.

Structure of costs and marketing can be monitored at traders and producers implied in the system.

On the Table 1., we can follow the benefits of the usage of online-marketplace.

Structure of participants in the market field

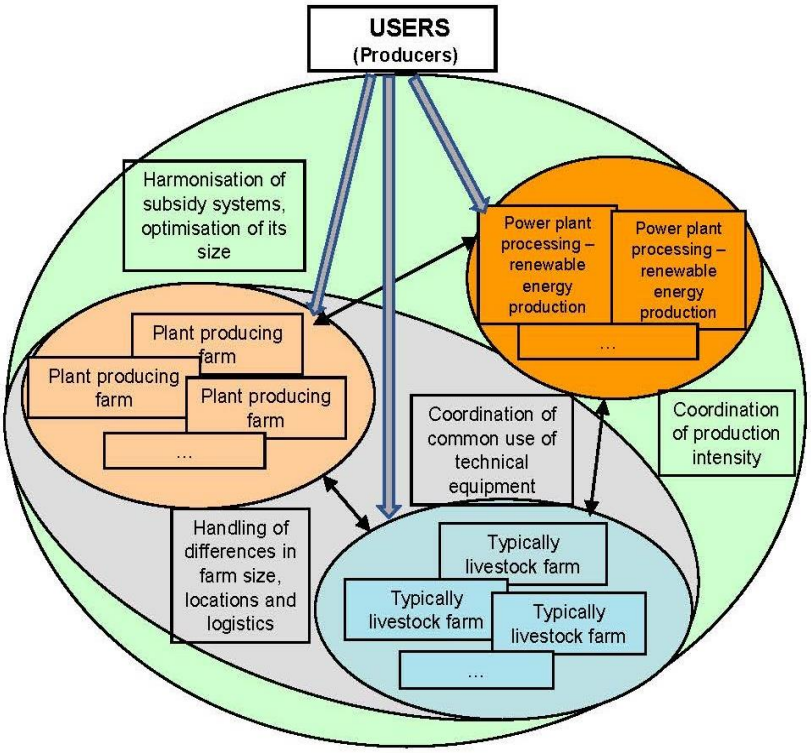

Fig. 2. Structure of participants in the online-marketplace (Magó and Fenyvesi, 2009, own editing)

Considering structure of users (producers), they can belong to different branches. Plant production and livestock farms can be emphasized (these can be also mixed plant production and livestock farms). The energy plant process factories using products of plant production agriculture produces energy out of agricultural renewable materials. By using the system, these factories can enter by their claims regarding input materials for procurement while they are interconnected no matter where they are located or how big or small they are. Cooperation can extend to harmony concerning common utility of technical devices as well as accomplishment of a more effective access to money assets. Coordination of intensity regarding production can be accomplished on a higher, more comprehensive level by participation of more producers. Moreover, harmony of supportive systems and their optimization in accordance with their different stimulating measures could be more accurate and deeper professionally. (Figure 2.)

The system covering participants of the online marketplace

The information system that is going to be established stimulate users (producers) to cooperate with each other. It provides conditions of effective information flow by covering all of the users. It provides a common base for application of innovation systems. Coordination of R+D+I tasks can be accomplished mutually by covering a bigger production structure.

CONCLUSIONS AND RECOMMENDATIONS

Agricultural production is largely carried out by small and medium-sized enterprises and farmers. These enterprises and farmers can accomplish concentration necessary for obtainment of market advantages very hard. Therefore, such a system is necessary, which can coordinate and keep in touch with producers and is self-assertive in an effective way.

By the model of a marketplace, which can be considered a trade and production system in agriculture and its aims to take the following stipulations into consideration, so the characteristics of users in the market field should be [24]:

- We consider producers autonomous and equal farmers/organizations, which could have the best situations to make decisions. We do not restrict their decisions about production.
- Market relations are essential, and activities as well as production must meet the requirements set by the market.
- The system must comply with the market and all the requirements that arise during its operation, such as environmental regulations and subsidies. It is these requirements that determine the conditions of operation, not the functioning of the scheme.

The system should foster the producers, should foster more successful production and must not restrain them. Hence it should provide market advantages at all of the elements of the production (regardless the size of property and production system). As a consequence, a real solution could be made for practical development of agriculture by increase of suppliers' competition situations.

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SINERGIJA POLJOPRIVREDNIKA U POSLOVIMA NABAVKE, PROIZVODNJE I DISTRIBUCIJE KROZ ZAJEDNIČKE TRŽIŠNE AKCIJE

László MAGÓ

Department of Engineering Management, Institute of Technology, Hungarian University of Agriculture and Life Sciences, 2100 Gödöllő, Páter K. str. 1., R.Hungary

Abstrakt: Cilj ovog rada je da predstavi model koji obezbeđuje efikasna rešenja i podršku za uspostavljanje sistema tržišta inputa i proizvoda u poljoprivredi. Input koji se koristi u poljoprivredi su uglavnom tehnički sistemi, hemijski materijali i biološki proizvodi. Rezultat su usevi, stočni proizvodi i energija.
Shodno tome, profit poljoprivrede je izuzetno nizak i povećanje proizvodnje nije moguće. Mogućnost da se ova situacija promeni može biti online tržište, koje se može kreirati na ulaznoj i/ili izlaznoj strani.
Ove oblasti bi mogle da poboljšaju uslove nabavke i distribucije u poljoprivredi i da impliciraju šanse za povećanje proizvodnje kroz bolji profit.
Sistem treba da neguje proizvođače, da neguje uspešniju proizvodnju, a ne sme da ih ograničava.
Zato treba da se obezbede tržišne prednosti u svim elementima proizvodnje (bez obzira na veličinu imovine i proizvodnog sistema).
Stoga bi se moglo napraviti pravo rešenje za praktičan razvoj poljoprivrede povećanjem konkurentskih situacija dobavljača.

Ključne reči: *Upravljanje farmom, onlajn pijaca, nabavka, distribucija, upravljanje proizvodnjom*

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ADAPTATION STRATEGIES FOR, NIGERIAN COASTAL COMMUNITIES FACING RISING SEA LEVELS AND ENCOURAGEMENT OF AGRICULTURAL ACTIVITIES: A COMPREHENSIVE REVIEW

Uduakobong Ndiana-Abasi AKPAN[1*], Ubong E. ASSIAN[2], Kubiat AKPAN[3]

[1]*Department of International Environmental Studies,*
Norwegian University of Life Science (NMBU), Norway
[2]*Department of Agricultural and Food Engineering, Faculty of Engineering,*
University of Uyo, Uyo, P.M. B. 1017, Akwa Ibom State, Nigeria
[3]*Department of Mechanical and Aerospace Engineering,*
Faculty of Engineering, University of Uyo, Uyo, P.M. B. 1017,
Akwa Ibom State, Nigeria

Abstract: In an effort to gather adaptation strategies for reducing or combating rising sea levels (RSLs) faced by Nigerian coastal communities, and encouragement of agricultural activities, a comprehensive review of literature was conducted on similar subject matter based on the previous studies carried out by other researchers across the world. However, impact of and factors promoting rising sea levels were discussed. Their approaches of adaptation were explored on the basis of restricted solutions implemented for efficient management of the RSLs. The study further presents a wide-range of different and well-defined native adaptation strategies and utilized by the affected coastal communities to combat the impact of the RSLs. These strategies included wetland protection and restoration, coastal engineering solutions, among others. This study also underscores the importance of community involvement and collaboration with government in implementing coastal zoning protocols and government policy recommendations to alleviate the negative effect of RSLs.

*Corresponding Author. E-mail: assian4real@yahoo.com
ORCID: 0000-0002-5470-0374

By providing hands-on solutions, this study contributes to the ongoing global dissertation on climate adaptation and resilience in vulnerable coastal areas, especially in Nigeria.

***Keywords**: Rising sea levels, coastal communities, adaptation strategies, agricultural activities.*

INTRODUCTION

The coastal communities in Nigeria comprises of states that are closest to the Atlantic Ocean. These include Akwa Ibom, Bayelsa, Cross-River, Delta, Edo, Lagos, Ogun, Ondo and Rivers States (Figure 1), [1].

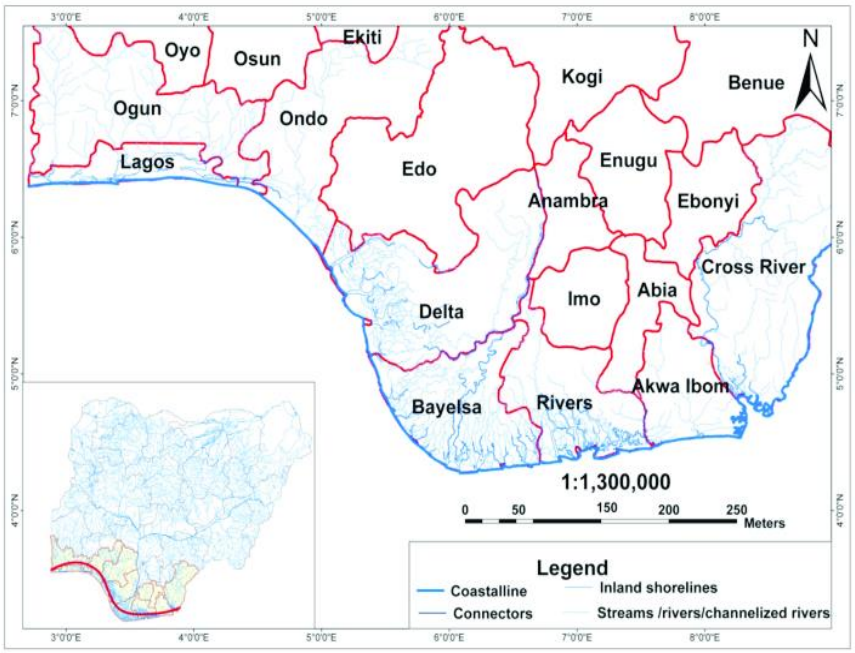

Fig. 1. Coastal regions of Nigeria, [2].

A number of coastal communities has in recent times suffered series of environmental pollution and flooding which indirectly hinder agricultural activities. Among the aforementioned states are oil-producing states. These include Akwa Ibom, Bayelsa, Cross-River, Delta, Edo and Rivers States. Commercial activities are also prevalent in these coastal states – besides the oil producing states. Lagos, for instance, is generally considered as the economic capital of the country. As a result, large number of people migrate to the area for available job opportunities. The inland-coastal migration in Nigeria is not an isolated scenario; such migration is experienced globally, [1]. The rise in populace in these coastal areas and pollution generated from industrial activities, worsen the condition of global climate.

The extensive study on flooding and rising sea levels (RSLs) has principally focused on societal adaptation to combat RSLs, whereas there has been relatively less emphasis on studying the coastal erosion menaces. Coastal erosion is a natural process involving alterations in coastal landforms as a result of sediments deposition or loss, leading to either advancing or retreating coastlines, [3]. In densely populated regions, such as retreating coasts, this natural phenomenon transmutes into a hazard, worsened by both human activities and climate change. Studies have showed that human activities, like construction and coastal development, have been less explored as origins of coastal erosion but should be a substantial concern, [4, 5].

Also, human activities have meaningfully affected coastal regions, creating environmental problems that require attention not only physical and environmental factors but also human-induced influences, [5]. Coastal zones are gradually utilized for various purposes such as agriculture, tourism, harbours, and settlements, leading to widespread engineering and interruption of natural coastal processes, [6]. The convergence of a growing population at risk and the expected impact of climate change on coastal dynamics will intensify the effects of coastal hazards on social-ecological systems. These systems associate both ecological and social elements in controlling resource flow, [7].

The resultant impact of RSLs under a sustained period result in the loss of sediment (land). This process is known as coastal erosion. The coastal erosion triggered by rise in sea level evaluated between 1984 and 2016 increased the shore line of Rivers State coast, with 30% of the coast accreted and 70% undergoing erosion, [8]. Climate alteration deteriorates the rate of coastal erosion. Consequently, people are displaced from their homes and forced to move further inland. Regrettably, sometimes, flooding occurs even at night, leading to destruction of valuable items, including farmlands and even human lives, [9].

The unlucky reality at the global level, at present, is that the efforts aimed at decreasing the progression of climate alteration seems insufficient. The rate of climate change impact far outpaces global attempts to adapt to them. Moreover, the degree and magnitude of climate alteration are larger than earlier prediction. By middle of the century, about one billion people would be exposed to greater risks of flooding caused by RSLs, [9]. Hence, in this study, effort is made to assess the adaptation strategies that could be implemented to reduce the effects of RSLs and encouragement of agricultural activities on the coastal communities in Nigeria. Specifically, we shall look at: (i) assessment of the impacts of RSLs on coastal communities in Nigeria; (ii) review of adaptation strategies implemented in various parts of the world to manage the RSLs and (iii) the appraisal of local strategies implemented to manage the situation.

IMPACT OF AND FACTORS PROMOTING RISING SEA LEVELS (RSLs), AND ADAPTATION STRATEGIES / MEASURES

Impact of Rising Sea Levels (RSLs) in Nigerian Coastal Communities

The augmented atmospheric water content due to sharp evaporation, as a result of global warming, has led to a prominent increase in heavy rainfall across Nigeria, especially in the year 2012., [10].

These increased rainfalls triggered considerable flooding, making urban drainage channels to overflow, breach in riverbanks, submergence of floodplains and tidal flats. The costs of such flooding are terrible, involving the loss of terrestrial wildlife, widespread damage to crops in farmlands, and the destruction of both human lives and property, particularly regions situated within tidal flat and flood-plains regions. Unfortunately, coastal inhabitants are plunged into hardships and economic distress. Remarkably, the Niger Delta coastal zone, considered to have complex network of rivers and drainage systems, serves as a deposition region for inland floodwaters across Nigeria, [10]. Moreover, the coastal zones face with the destructive aftermath of extreme rainfall and wind storms, inflict havoc on power transmission lines, sub-station equipment, and agricultural lands, [11, 12].

The effect of rainfall on the coastal zone results in landward floods from the mainland to the continental shelf, whereas the impact of RSLs outspreads from the shoreline towards the hinterland.

The movement of seawater into coastal aquifers creates a stern threat to the groundwater resources in the Nigerian Coastal Zone. This intrusion meaningfully changes the water table, hydrogeochemical features, and the interface between freshwater and saltwater, resulting in considerable dislodgment of the hydraulic slope landward, [13]. Simultaneously, the rising rate of coastal erosion attributed to increased wind velocities and the intensified influence of wave energy on shorelines has resulted in rapid shoreline retreat in areas such as Lagos, Awoye/Molume, Ogberedo, Forcados, Escravos, Ibeno, Brass and others, [14]. Nevertheless, coastal region such as Niger Delta had displayed temporary shoreline progression due to sediment inflow from hinterland floods, [15].

The collective influence of RSLs, flooding and erosion seriously looms to diminish Nigeria's already scanty beaches, possibly displacing key recreational facilities for tourism, [16]. Universally, RSLs, mainly come from global warming and subsequent result in polar ice melting. RSL is likely to increase from 15 cm to 95 cm. Locally, climate-induced sea-level rise in Nigeria is related to regular storm increase, which results in vast erosion along the coastline, [17].

Based on geographical setting, coastal erosion, amplified precipitation and flooding, the Niger Delta region is susceptible to sea-level rise, [18]. This disastrous event led to the submersion of substantial land area into the Atlantic Ocean, posing significant fears to both the populace and the regional economy, [19, 20]. The coastal regions are liable to undergo environmental changes due to shifts in ocean and atmospheric activities. These changes influence fish migration patterns in response to salinity and thermocline variations, thereby meaningfully affect fishes both in the ocean and inland waters, [21]. Also, the changes could lead to reduction in fishing yields, which may likely influence the availability and cost of fish resources, an essential dietary food in Nigeria, [22, 23].

Coastal environmental degradation, resulting from industrial pollution through oil and gas exploration and the hostile effects of climate variation, sternly endangers fresh water supplies, exposing several coastal inhabitants to precarious water sources. This situation causes numerous health hazards, including heat-related diseases in both human and animal populations, and ozone layer depletion in the coastal zone, [24].

Factors Facilitating the Rising Sea Levels in Nigeria

Coastal communities have lower elevation compared to other neighbouring regions. As a result, the water-tables are higher than those in-land areas, hence, decreases soil seepage capacity in coastal areas. Simultaneously, precipitation is higher and there are greater likelihoods of heavy rainfall to be experienced, coupled with poor waste disposal management aggravates the situation, [1]. Deforestation, caused by human activities, appears to be a key player increasing coastal erosion. Moreover, anthropogenic activities such as engineering projects, land reclamation, establishment of seaports and jetties, sand and gravel mining, dredging, and altering river channels aggravate coastal erosion, [25, 26, 27]. Persistent urbanization tendency could drive coastal erosion to uncontrollable levels, [27].

Quest for building materials and roofing leads to backshore vegetation removal, leaving coastlines vulnerable to weathering agents such as strong winds, waves and RSLs. As one of the most densely populated areas, coastal areas require effective monitoring and management strategies to control erosion. Inefficient coastal management practices, excessive water extraction, river diversion, sand mining, building and construction activities could pose major threats to coastal erosion, [28]. As mentioned beforehand, coastal regions in the world attract immigration, particularly when such regions are favourable shipping courses. It is extensively reported by numerous scholars that economic activities, i.e., industrialization has contributed enormously to the predominant global warming experienced today. Regrettably, the coastal communities are toughest hit by the RSLs. However, Table 1 shows information on the economic activities that occur in the coastal areas in Nigeria.

Table 1. General Economic Information on the Nigerian Coastal Area

S/N	State	Population (persons)	Land Area (km^2)	Population Density (persons /km^2)	Economic Activities
1.	Akwa Ibom	5,780,581	7,081	816.35	Oil and gas, agro-allied, industries, wood work and furniture, soap and detergent manufacture, metal works, hide and skin, lumbering and sawmilling, arts and crafts.
2.	Bayelsa	2,394,725	10,773	222.29	Oil and gas, coastal tourism, agriculture, aquaculture, palm oil milling, local gin making, carving and weaving, and trading.
3.	Cross Rivers	4,175,020	22,590	184.82	Petrochemical, wood processing, agriculture, aquaculture, quarrying and cement manufacturing, rubber and latex, metals processing
4.	Delta	6,107,543	17,698	345.10	Oil and gas, processing, wood,petrochemical, foam, metals, manufacturing, and alloys

Cont. Table 1.					
5.	Edo	5,161,137	17,802	289.92	Agriculture and fishing, petrochemical, wood processing, foam manufacturing, metals and alloys
6.	Lagos	15,772,884	3,345	4715.36	Textile, food processing, foam and water, asbestos, pharmaceuticals, metals and alloys, shipping
7.	Ogun	6,445,275	16,762	384.52	Textile, breweries, lumbering and sawmill, foam, plastics and rubber manufacture and quarrying
8.	Ondo	5,469,707	15,500	352.88	Agriculture, lumbering and sawmill, oil and gas, quarrying, sand mining.
9.	Rivers	7,234,973	11,077	653.15	Petrochemical, oil and gas, foam manufacturing, metals and alloys, and pharmaceuticals

Note: The population is 2019 forecast based on the 2006 Nigeria Census figures
Source: [29,30,31]

Adaptation Strategies and Measures

The realistic technique to tackle the present trend of RSLs and its associated consequences is adaptation. This truth is worthy of note, reason been that the emissions drop cannot be dealt with near and the mid-term impact of RSLs. This means that even though all the carbon emissions were removed now, the RSLs would still rise, due to global warming effect, [9]. Luckily, those people that lived on the coastlines, for numerous decades, have learnt to adapt to coastal fluctuations. The experience summed up over time has been passed down to the present generations. Still, the rate of coastal variations nowadays is rather considered momentous and the implementation of more real solutions are important. However, the strategies for implementing adaptive solutions have characteristic limitations which must be addressed. Such limitations range from methodological or technical to economic constraints. Social constraints may also exist and acceptable by the affected inhabitants. For example, the use of sea walls technology could lead to the safety of some inhabitants behind it and some who reside in the adjacent coastlines may be vulnerable, [32]. Based on this premise, it is essential to implement adaptive solutions that are locally-sensed. If successful, the solutions may be scaled up to sustainable level. Besides, the adjacent communities could also learn and implement the same. Successful adaptation entails the implementation of the following, [33]: (i) the use of dykes, rip-raps, seawalls and groynes.

These facilities, if adequately calibrated, could aid in the estimation of safety levels; (ii) construction of new natural bumper areas or renewal of degraded ecosystems; and (iii) planned relocation of inhabitants and properties from affected areas.

In Nigeria, numerous approaches have been adopted by affected coastal communities to control the situation. Such approaches include: (i) utilization of bags filled with sand and placed along the shore; (ii) building of canals and channels; (iii) construction of river embankments; and (iv) raising the existing ground above its level or shore protection embankments, [34].

Communities within the coastal regions require mutual support, in cases of disasters such as flood. Assistance to flood victims could be in form of grant, loan or temporary accommodation until the flood water recedes. Materials used in the design and construction of walkways in such communities have evolved over time. These materials can withstand frequent devastating flood experienced in such communities, [2].

CASE STUDIES, POLICY COMMENDATIONS AND EXECUTION, AND APPRAISING THE EFFICIENCY OF ADAPTATION STRATEGIES

Case Studies

Non-governmental organizations (NGOs), for instance, in Papua New Guinea's, New Ireland Province introduced training programs for locals, where advanced methods for building and maintaining lasting boat jetties and seawalls (Figure 2) were adopted. Here, rock from deceased coral and near-by community's materials were used. Equipped in the training was the sharing of their knowledge with the neighbouring areas, which aided them to hand-pick and implement the strategy. Ecosystem-based adaptation approaches, used natural bionetworks as shown in Figure 3, [32].

Fig. 2. Seawalls, [32].

Fig 3. Restored Mangroves in Papua New Guinea, [32].

The aforementioned strategies offer various benefits such as erosion control, flood reduction and storm protection. The involvement of local bionetworks control naturally aligns with local needs and contexts. For example, successful mangrove restoration was initiated in Indonesia, Fiji and southern Florida [32].

In Manus Province, Papua New Guinea, island regions sought to reproduce a rich coral reef restoration project from a neighbouring island to protect shorelines and boost fish habitats. Nevertheless, local adaptation strategies may suffer some limitations. Failures abound, in terms of poor local support or ownership, poor maintenance needs and inadequate community consultation [35]. Also, in Vanuatu, a locally engrossed ecosystem restoration scheme was carried out. It involved tree nurseries which were faltered due to the neglect of maintenance and replenishment of coastal vegetation amid increased tidal heaves. Besides, seawall building schemes aimed at fighting erosion and land loss in Federated States of Micronesia and Fiji failed due to their inefficient and inadequate local approval or ownership. The future adaptation strategies could be redefine based on the setbacks learnt from similar failed projects [36].

Policy Commendations and Execution

Based on the predominant condition, integrating policies such as complete coastal zone control strategies that embrace both environmental and human aspects, in-line with specific climate variation adaptation policies must be put in place. Partnerships between non-governmental organizations (NGOs), government bodies, research institutes, and local communities are vital. Partnerships is to ensure inclusive decision-making processes and effective implementation of adaptation strategies. Furthermore, community involvement is important. Allowing local communities to involve in planning, decision-making, and capacity-construction enterprises is paramount. This inclusion permits contribution of traditional practices and local knowledge, and adaptation strategies to be more efficient and sustainable. Funding and resource provision play a substantial role. There is a need to provide funds for coastal adaptation schemes, ensure fair distribution and effective usage. Encouragement of public-private partnerships (PPPs) could enhance additional financial resources for adaptation plans.

These partnerships should secure private sector investments while the host communities derive target benefits and ensure environmental sustainability.
Moreover, supports for research and development in some robust infrastructures and sustainable livelihoods are indispensable.

Appraising the Efficiency of Adaptation Strategies

There is need to regularly evaluate and appraise the adaptation strategies implemented in the coastal communities. Such evaluation can create room for progress and in turn ensure the inhabitants' safety in such places. It will also promote sustained economic activities in the coastal areas such agriculture, trade, etc.

CONCLUSION

In a nutshell, the coastal regions of Nigeria (Akwa Ibom, Bayelsa, Cross-River, Delta, Edo, Lagos, Ogun, Ondo and Rivers) have been faced with innumerable challenges aggravated by flooding, environmental pollution, impact of industrial activities, predominantly in oil-producing states. The concentration of commercial activities, as well as considerable inland-coastal migration, deepens the strain on these areas, which result in high vulnerability to impact of climate variation. In order to tackle these challenges, healthy policy frameworks, all-inclusive coastal zone management strategies and explicit climate variation adaptation policies must be put in place. Collective efforts of governmental bodies, NGOs, research institutes and local communities are vital to enhance efficient planning, decision-making, and implementation of adaptation strategies. Engagement of local communities in planning and capacity-building plans, traditional knowledge sharing is very important to ensure more sustainable adaptation measures. Furthermore, provision of adequate funding and resource allocation and encouragement of public-private partnerships, can boost financial support for adaptation initiatives. Supports for research and development in some robust infrastructures and sustainable livelihoods are indispensable which further strengthen the adaptive capacity of coastal communities. Again, to ensure the success of these strategies, continuous assessment and review must be upheld. Frequent assessments of implemented adaptation strategies would enable improvements, ensure the safety of coastal populaces and foster sustained economic activities in these regions.

CONFLICT OF INTEREST

None is declared.

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STRATEGIJE PRILAGOĐAVANJA OBALSKIH ZAJEDNICA NIGERIJE KOJE SE SUOČAVAJU SA PORASTOM NIVOA MORA, I PODSTICANJE POLJOPRIVREDNIH AKTIVNOSTI: SVEOBUHVATNI PREGLED

Uduakobong Ndiana-Abasi AKPAN[1*], Ubong E. ASSIAN[2], Kubiat AKPAN[3]

[1]Department of International Environmental Studies, Norwegian University of Life Science (NMBU), Norway
[2]Department of Agricultural and Food Engineering, Faculty of Engineering, University of Uyo, Uyo, P.M. B. 1017, Akwa Ibom State, Nigeria
[3]Department of Mechanical and Aerospace Engineering, Faculty of Engineering, University of Uyo, Uyo, P.M. B. 1017, Akwa Ibom State, Nigeria

Apstrakt: U nastojanju da se prikupe strategije prilagođavanja za smanjenje ili suzbijanje porasta nivoa mora ((PNM – porast nivoa mora, eng. RSLs - rising sea levels) sa kojima se suočavaju zajednice stanovinika na obalama mora u Nigeriji, sa podsticanjem poljoprivrednih aktivnosti. Zato je sproveden sveobuhvatan pregled literature o sličnoj temi na osnovu prethodnih studija koje su sproveli drugi istraživači u Svetu, gde se raspravlja o uticaju i faktorima koji podstiču porast nivoa mora. Njihovi pristupi prilagođavanju istraženi su na osnovu različitih rešenja implementiranih za efikasno upravljanje (PNM – porast nivoa mora).

Studija dalje predstavlja širok spektar različitih i dobro definisanih strategija prilagođavanja stanovnika koje koriste pogođene obalske zajednice u borbi protiv uticaja (PNM – porast nivoa mora). Između ostalog, ove strategije su uključivale zaštitu i obnovu močvara, i inžinjerska rešenja obale mora. Ova studija takođe naglašava važnost uključivanja zajednice i saradnje sa vladom u implementaciji protokola o uređenju priobalja i preporuka vladine politike za ublažavanje negativnih efekata (PNM – porast nivoa mora).

Pružajući praktična rešenja, ova studija doprinosi aktuelnoj globalnoj problematici o klimatskoj adaptaciji i otpornosti u osetljivim obalnim oblastima, posebno u Nigeriji.

Ključne reči: *Porast nivoa mora, obalske zajednice, strategije prilagođavanja, poljoprivredne delatnosti*

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TRADITIONAL SERBIAN COUNTRY COTTAGE EQUIPPED WITH THE PASSIVE TROMBE WALL

Aleksandar M. Nešović[1]*, Dragan Z. Cvetković[1]

[1] *University of Kragujevac, Institute of Information Technologies, Jovana Cvijića bb, 34000 Kragujevac, Republic of Serbia*

Abstract: This paper investigates the passive use of solar energy in a traditional Serbian country cottage (<100 m^2) in the vicinity of the city of Kragujevac – the implementation of the passive Trombe wall. Through a seven-month (from October 1 to April 30) comparison with a classic cottage (without the passive Trombe wall), the benefits of mentioned solar systems are determined. Both country cottages (created in the Google SketchUp program), and in the EnergyPlus program, are equipped with central heating systems with coal boilers (heat energy generators). The results showed that the consumption of useful (thermal) energy can be reduced from 4823.97 kWh to 3923.22 kWh, final energy from 7836.21 kWh to 6372.99 kWh, and primary energy from 10187.07 kWh to 8284.89 kWh. Environmental and economic indicators are also on the side of a country house with the passive Trombe wall: CO_2 emission is reduced by 0.61 t, and financial investments for heating during the analyzed period are reduced from 312.49 € to 254.14 €.

Keywords*: Country cottage, energy-eco efficiency, passive Trombe wall, simulation, traditional Serbian architecture.*

INTRODUCTION

The latest studies show that over a thousand village (rural) settlements in Serbia are on the verge of survival, even though they have a large energy and ecological potential, in addition to agricultural, tourist, and economic ones.

*Corresponding Author. E-mail address: aca.nesovic@gmail.com
ORCID: 0000-0002-1690-2389

The existence of a homestead, the main characteristic of a traditional rural household, greatly reduces the density of construction, thus providing a whole spectrum of possibilities for using renewable energy sources, such as solar energy.

Unlike cities, where solar energy, due to the high density of buildings, is mainly focused on the active solar systems (solar thermal collectors [1], photovoltaic panels [2], and photovoltaic-thermal collectors [3]), villages are much more suitable for implementing passive solar systems, as the Trombe walls [4], etc.

The Trombe wall is an interesting green architectural concept that, in combination with other HVAC and solar (active) systems, can in some cases reduce the annual consumption of final energy in buildings by over 30% [5].

In the literature, there is a large number of papers (analytical, software, experimental, and combined) with emphasis on different elements of the Trombe walls: geometric characteristics (relation between glazing and non-glazing [6], the thickness of the massive wall [7], the thickness of the air layer [8], the thickness of the glazing [9], etc.), use of the different colors coatings [10], use of the insulating materials [11], use of the glazed materials [12], implementation of the natural and forced ventilation [13], sizing of the fan units [14], etc.

Serbian scientific literature also records a large number, mostly numerical (in the use of various software packages: EnergyPlus and jEplus [15, 16], RMSun and InSunTr [17], MATLAB [18, 19], only EnergyPlus [20-22], TRNSYS [23]) papers in which various aspects of the Trombe wall are expressed. Bojic and colleagues from Lyon [24] used EnergyPlus software to apply the Trombe wall to two Mozart house model types: the original Mozart house model and the modified Mozart house model.

In the mentioned papers, the building models were: educational building located in Niš [15], rectangular single-store building located in Belgrade [16], residential building located in Niš [17], one-zone residential building located in Niš [20], modern residential building located in Belgrade [21], and modern residential building located in Kragujevac [22].

In this paper aspects of the Trombe wall are numerically investigated on the model of the traditional Serbian country cottage in the vicinity of the city of Kragujevac. Kragujevac is located in a belt of moderate continental climate with distinct seasons, so the focus is on a seven-month period that includes the heating season (from October 15 to April 15) and two transition periods (October 1 to October 14 – the first transition period, April 16 to April 30 – the second transitional period). The research mostly focuses on the energy performance of the Trombe wall, then on the ecological and economic ones. Through this work, the authors want to promote rural settlements in another way, reminding them of their ancient national importance.

MATERIALS AND METHODS

RESEARCH SUBJECT

The 3D model of a traditional Serbian country cottage (TSCC) in the vicinity of the city of Kragujevac is shown in Fig. 1a. A family of four has 6 rooms at their disposal, i.e. thermal zones (TZ). Children use room TZ4, while parents stay in multifunctional room TZ3 (Fig. 1b).

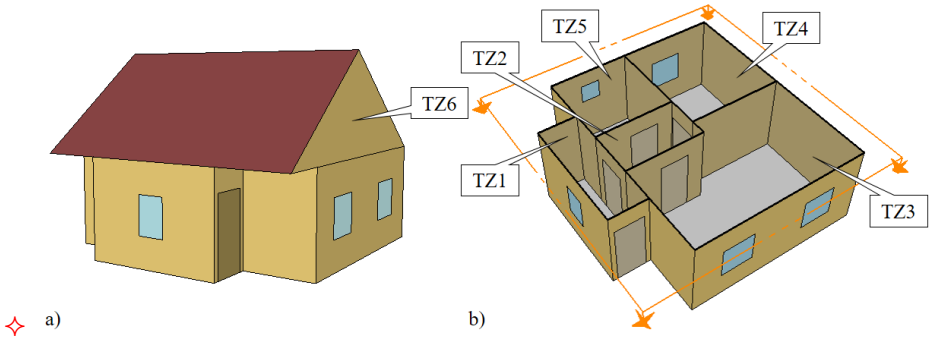

Figure 1. 3D model of the TSCC (a) and room layout (b): TZ1 – Hall 1, TZ2 – Hall 2, TZ3 – Multifunctional room (Living room, Kitchen, Dining room, Bedroom), TZ4 – Children's room, TZ5 – Bathroom, TZ6 – Attic.

The TSCC has been designed following the regulation on energy efficiency of buildings [25]. The maximum permitted heat transfer coefficients U_{max} [W/(m^{2}K)] of the external construction elements for the new buildings are presented in Tab. 1.

Table 1. The maximum permitted U_{max} values of the external construction elements for the new buildings, [25].

Construction building element	Mark	U_{max} value [W/(m^{2}K)]
Ground floor	GF	0.3
External wall	EW	0.3
Intermediate construction above the open passage	IC	0.2
Slope roof	SR	0.15
External window	EW	1.5
External door	ED	1.6

The net area of the TSCC is 89.72 m^2 (TZ1 is 4.32 m^2, TZ2 is 3.75 m^2, TZ3 is 18 m^2, TZ4 is 10.5 m^2, TZ5 is 6.25 m^2, and TZ6 is 46.9 m^2). The central heating system (with coal boiler as heat energy generator) is used to heat TZ3, TZ4, and TZ5 (34.75 m^2, i.e. 38.73% of the TSCC).

THE PASSIVE TROMBE WALL

The Trombe wall cleverly combines two fields: architecture and mechanical engineering. In the first place, the Trombe wall represents an external building element (external wall, EW) that separates the interior space of the building from the external environment. Due to its specific design (Fig. 2a, Tab. 2), which implies the installation of glazing (1) in front of the massive southern facade wall (2), which is coated with a selective coating (3) on the side of the glazing, the Trombe wall has another, indirect, role – reducing the final energy consumption for heating, through the following stages: absorption of solar energy, conversion of solar energy into thermal energy, accumulation (storage) of thermal energy, delivery of thermal energy to the thermal zone by the basic principles of heat energy transfer (conduction through the wall, convection and radiation from the wall).

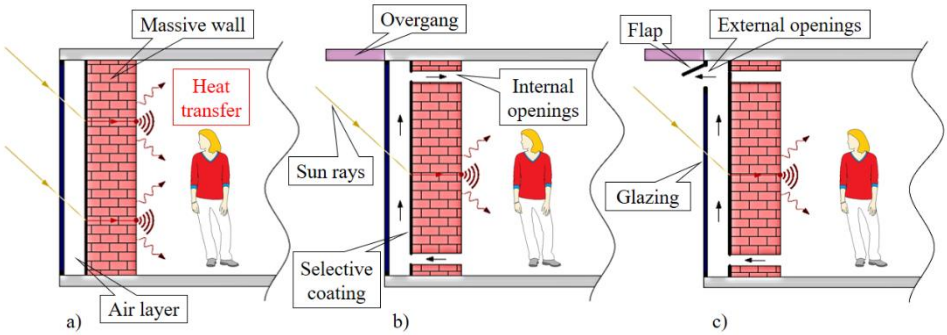

Figure 2. Types of the Trombe walls: the passive (a), the active with internal openings (b), and the active with internal and external openings (c).

The mentioned variant (Fig. 2a) represents the basic variant of the Trombe wall. As, over time, these constructions were improved with various additional elements (overhangs, curtains, openings, fans, etc.), it is clear that over time the classification of the Trombe walls was established in the literature, namely into the following two categories: the passive Trombe walls (Fig. 2a) and the active Trombe walls (Fig. 2b, Fig. 2c).

The following figures show the southern facade of the TSCC before (Fig. 3a) and after (Fig. 3b) the installation of the passive Trombe wall.

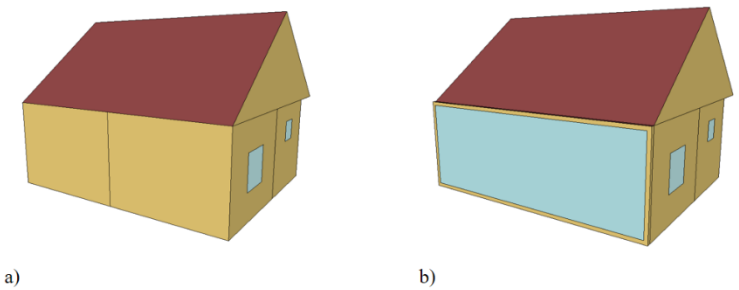

Figure 3. The southern facade of the TSCC before (a), and after (b) the installation of the passive Trombe wall.

Table 2. The geometric-thermal performance of the passive Trombe wall [26].

Description	Unit	Layer			
		Glazing	Air layer	Selective coating	Massive wall
Thickness	[m]	0.003	0.1	0.0016	0.4
Thermal conductivity	[W/(mK)]	0.9	-	393	1.73
Density	[kg/m^3]	-	-	8907	2242
Specific heat	[J/(kgK)]	-	-	370	837
Solar transmittance	[-]	0.899	-	-	-
Solar reflectance	[-]	0.079	-	-	-
Absorptance	[-]	-	-	0.94	0.65
Emissivity	[-]	-		0.06	0.9

ENERGY AND ENVIRONMENTAL INDICATORS

Total useful heat energy consumption E_{USE} [kWh] in the TSCC is the sum of the thermal zones (for TZ3 E_{TZ3} [kWh], TZ4 E_{TZ4} [kWh], and TZ5 E_{TZ5} [kWh]) useful heat energy consumption Eq. (1):

$$E_{USE} = \sum_{TZ=3}^{5} E_{TZ} = E_{TZ\,3} + E_{TZ\,4} + E_{TZ\,5} \quad \text{.....(1)}$$

Total final energy consumption E_{FIN} [kWh] in the TSCC in that case is Eq. (2)

$$E_{FIN} = \frac{E_{USE}}{\eta_{PN} \cdot \eta_{RS} \cdot \eta_{CB}} \quad \text{.....(2)}$$

where [25]: η_{PN} [-] is the pipe network efficiency (η_{PN}=0.95), η_{RS} [-] is the regulation system (η_{RS}=0.9), and η_{CB} [-] is the coal boiler efficiency (η_{CB}=0.72).

Total primary energy consumption E_{PRY} [kWh] in the TSCC depends on the primary energy transformation coefficient for coal R_{PRY}=1.3 [25] Eq. (3):

$$E_{PRY} = R_{PRY} \cdot E_{FIN} \quad \text{.....(3)}$$

In the end, CO_2 emission can be determined as Eq. (4):

$$M_{CO2} = m_{CO2} \cdot E_{PRY} \quad \text{.....(4)}$$

where m_{CO2} [kg/kWh] is the specific CO_2 emission (m_{CO2}=0.32 kg/kWh [25]).

RESULTS AND DISCUSSION

The next figure (Fig. 4) shows the monthly total useful heat energy consumption in the TSCC before and after the passive Trombe wall. In the same figure, for the same analyzed cases in TSCC, the monthly total energy savings e_{USE} [%] is also shown.

The monthly total useful heat energy consumption, in the TSCC before the passive Trombe wall, were (Fig. 4): 265.35 kWh (October), 612.04 kWh (November), 1026.36 kWh (December), 1283.73 kWh (January), 819.48 kWh (February), 546.60 kWh (March), and 270.40 kWh (April).

Conversely, the monthly total useful heat energy consumption, in the TSCC after the passive Trombe wall, were (Fig. 4): 136.53 kWh (October), 434.17 kWh (November), 938.40 kWh (December), 1206.97 kWh (January), 668.94 kWh (February), 350.28 kWh (March), and 187.92 kWh (April).

Based on all of the above, the monthly total energy savings were (Fig. 4): 48.55% (October), 29.06% (November), 8.57% (December), 5.98% (January), 18.37% (February), 35.92% (March), and 30.50% (April).

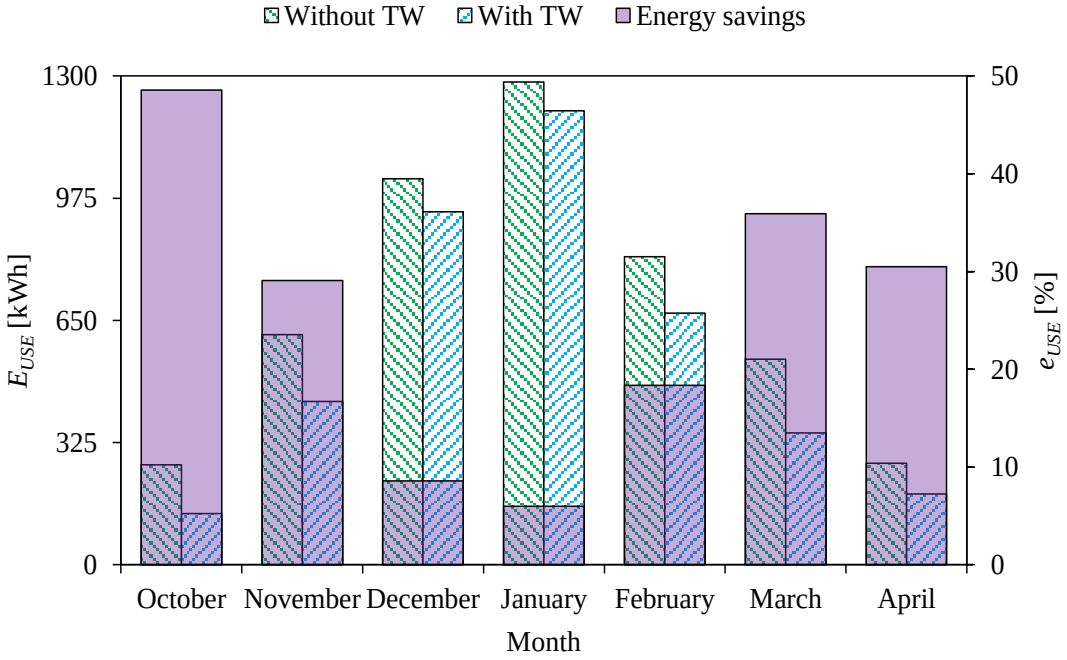

Figure 4. Monthly total useful heat energy consumption and energy savings in the TSCC before and after the passive Trombe wall.

The highest percentage savings were achieved at the beginning and end of the analyzed period (October, March, and April) when the weather was on the side of the passive Trombe wall. The external ambient temperature is higher. The same goes for the solar radiation (direct, diffuse, and reflected). In that case, the passive solar design reaches its full expression, because the accumulated heat energy is higher (on the one hand), and the heat losses through the glazing are lower (on the other hand). In the winter months, although the Sun elevation angle is more favorable due to the passive Trombe wall (solar incidence angle [27]), the intensity of the solar radiation is much weaker and the external ambient temperatures are often below zero. Due to the mentioned effects, the energy savings are less than 10% (8.57% in December and 5.98% in January).

If it is accepted that the thermal power of coal is 18.5 MJ/kg (5.14 kWh/kg) [28], and the price of coal is 205.13 €/t, the annual financial costs can be reduced by almost 20% (18.67%).

CONCLUSION

Energy consumption in the residential sector, both globally and nationally, is very high. An increasing number of people live in cities, and fewer live in the countryside. In the EU, around 72% of the human population lives in urban areas. This share is assumed to reach around 80% in 2050.

The way out can be seen in increasing the energy efficiency in cities, but we should certainly work on their deurbanization. The authors believe that promoting countries (and raising energy efficiency in them) is a long-term solution that needs to be worked on.

Following that, in this paper, the energy, ecological, and economic aspects of the country houses in Serbia (small net areas built in accordance with traditional principles) were investigated. The consumption of useful, final, and primary energy was analyzed on the case study model of the traditional Serbian country cottage equipped with a modern passive solar system – the passive Trombe wall.

The results of the numerical research (Google SketchUp software package is used for building design, EnergyPlus software package is used for simulation thermo-technical systems) showed that in an economic sense, costs for heating in the traditional Serbian country cottage equipped with the passive Trombe wall can be reduced up to 20%.

Serbia is a country rich in natural resources and landscapes, and this should be used in the best way: responsible politics, infrastructure projects, clear goals, engagement of scientific and professional people (multidisciplinary approach), even greater participation of state bodies and all citizens.

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TRADICIONALNA SRPSKA SEOSKA KUĆA OPREMLJENA PASIVNIM TROMBE ZIDOM

Aleksandar M. Nešović[1] , Dragan Z. Cvetković[1]

[1] Univerzitet u Kragujevcu, Institut za informacione tehnologije, Jovana Cvijića bb, 34000 Kragujevac, Republika Srbija

Rezime: U ovom radu istražuje se pasivno korišćenje solarne energije u tradicionalnoj srpskoj seoskoj kući (<100 m^2) u okolini Kragujevca – implementiranjem pasivnog Trombe zida.
Kroz sedmomesečno (od 1. oktobra do 30. aprila) poređenje sa klasičnom kućom (bez pasivnog Trombe zida) određuju se prednosti korišćenja ovakvih solarnih sistema.
Obe seoske kuće (kreirane u programu Google SketchUp), u programu EnergyPlus, opremljene su sistemima centralnog grejanja sa kotlovima na ugalj (generatori toplotne energije).
Rezultati su pokazali da se potrošnja korisne (toplotne) energije može smanjiti sa 4823.97 kWh na 3923.22 kWh, finalne energije sa 7836.21 kWh na 6372.99 kWh, a primarne energije sa 10187.07 kWh na 8284.89 kWh.
Ekološki i ekonomski pokazatelji takođe su na strani seoske kuće sa pasivnim Trombe zidom: emisija ugljen-dioksida redukovana je za 0.61 t, a troškovi grejanja za analizirani period umanjeni su sa 312.49 € na vrednost 254.14 €.

Ključne reči: *Energo-eko efikasnost, pasivni Trombe zid, seoska kuća, simulacija, tradicionalna srpska arhitektura.*

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IMPACT OF REFUGEE SETTLEMENTS ON LAND DEGRADATION IN UGANDA

Uduakobong Ndiana-Abasi AKPAN[1]*, Justine MAWADRI [1], Denniz ASINGWIRE [1], Ayesha BUTT [1], Nimitkumar ENGINEER [1], Ima-Obong Joseph AKPAN [2]

[1]Department of International Environmental Studies, Norwegian University of Life Science (NMBU), Norway
[2]Department of Mechanical Engineering, Michael Okpara University of Agriculture, Umudike, Nigeria

Abstract: In an effort to examine various drivers of land degradation in refugee settlement in Uganda, the study titled 'Impact of Refugee Settlement on Land Degradation in Uganda' was conducted where Pressure-State-Response Framework was used to analyze the current state of land, the main drivers of land degradation, and responses to the identified drivers in Bidi Bidi refugee settlement in Uganda. Findings of the study revealed that the increase in the refugee population has led to a loss of grasslands, croplands and woodlands in the refugee settlement. The most degraded land types were grassland, woodland, and cropland. This was primarily attributed to unending human pressure of cutting trees for firewood or sales, bush-burning, mono cropping, over cultivation and building of infrastructure such as roads and urban centers which exerted pressure on the land leading to land degradation. Responses to these pressures have been implemented by different actors including the government of Uganda, community groups, humanitarian agencies and households. This study recommends implementation of sustainable land management practices, enforcement of government policies and increased awareness on the impacts of human activities on land.

Keywords*: Refugee population, settlement, land, main drivers, degradation, Uganda.*

*Corresponding Author. E-mail: assian4real@yahoo.com
ORCID: 0000-0002-5470-0374

INTRODUCTION

Uganda has demonstrated a commendable history by hosting a significant number of refugees from the neighbouring nations affected by persisted violence and conflicts.
For instance, political instability in Democratic Republic of Congo, South Sudan, Burundi, and Ethiopia is contributing to a drastic increase in the refugee population in Uganda [1, 2, 3].

As of October 2023, a total of 1,583,009 refugees and asylum seekers live in Uganda [4]. About 48% of the refugees in Uganda are living in poverty, with West Nile region experiencing the highest rate, [5].
Due to this high refugee population and increased demand for natural resources to meet their needs, the area faces severe land degradation, [6]. These economic challenges faced by refugees, compounded by severe food insecurity intensify the environmental impact on the already fragile ecosystems. The dependence on wood fuel for energy contributes to deforestation and land degradation, [5]. The 40% cut in food aid by the World Food Programme has further contributed to the existing challenges. As the refugees struggle to meet their needs, they unsustainably use land resources. There are rising concerns regarding the possible effects of refugee communities on Uganda's natural resources since many of them are situated near some of the country's most environmentally sensitive places, [7]. The pressure on natural resources not only impacts the well-being of refugees but also has environmental consequences such as land degradation. As the number of refugees continues to rise, it is important to understand context of their impact on land degradation in Uganda. Land degradation is defined as a negative shift in land condition, because of direct or indirect human-induced activities such as deforestation, overgrazing and bush burning. The settlement of refugees poses significant effect on Uganda's land resources given the small size of land allocated to each household measuring 30 × 30 square meters, [8]. When displaced people move into wooded regions and build up communities there, it often results in a wide variety of environmental problems, most notably the destruction of the forest, [9]. It also results in deforestation and the conversion of wooded land for agricultural use or habitation. Such actions destroy natural resources resulting in loss of vegetation cover, [10]. Thus, it is crucial to address land degradation in the context of refugee settlements. Not only is this necessary for the preservation of Uganda's natural resources, but also for reducing degradation of land, [11]. To achieve a balance between protecting the critical forests and their inhabitants, while simultaneously providing housing for refugees, Uganda requires the implementation of environmentally responsible land management practices and conservation activities. However, there have been many interventions in the form of direct aid, skills training, forest regeneration, solar systems and improved cook stoves to reduce land degradation. Despite these efforts, the degradation of land in Bidi Bidi refugee settlement continues. Therefore, there is need to examine various drivers of land degradation in this refugee settlement in Uganda so that viable solutions can be suggested to conserve, protect, and restore land resources in the area. Therefore, the findings of this study would contribute to addressing the knowledge gap on the impact of refugee settlement on land degradation particularly as it pertains to grassland, woodland, and cropland.

It may also help local authorities and National government agencies such as National Environmental Management Authority (NEMA) and Ministry of Environment and Energy to improve on management of land by regulating refugee activities in a way that they sustainably use nature resources within the refugee area. Again, it would also help the government and stakeholders to plan and budget for land use management.

In addition, it may inspire organizations and development partners to ensure that means to conserve, restore and maintain land are improved, maintained, and strengthened, [12]. Nevertheless, the following research questions were formulated as guides to achieving the main objective:

a) What is the current state of land in the refugee settlements in Uganda?
b) What are the main drivers of the land degradation in the refugee settlements in Uganda?
c) What are the responses to the identified drivers of the land degradation in refugee settlements in Uganda?

Conceptual Framework

The Organization for Economic Cooperation and Development (OECD) created the Pressure-State-Response conceptual framework for impact analysis to improve the provision of essential information for evaluating and analyzing environmental management [13]. The Pressure-State-Response framework is widely used as a means of reporting to describe the activities of humans that put pressure on the environment, altering the quality and quantity also known as, the state of natural resources, [14]. It examines the intersections in the three domains of pressure, state, and responses. It comprises of indicators for actions that cause environmental pressures, the status of the environment that may be affected by these activities, and societal responses, [15]. Factors like population increase and urbanization cause an increase in human resource extraction from the natural environment and discharge of waste into the ecosystem. At the same time, changes in the natural environment have an impact on human activity so as a result, humans take appropriate precautions to respond to its changes, [16].

METHODOLOGY

Study Area

Bidi Bidi settlement is located in Northern Uganda, Yumbe District as shown in Figure 1. The settlement covers 764 km^2, 32 % of the total land area, [8].

Fig. 1. The location of Bidi Bidi refugee settlement in Uganda, [17].

Approaches Used in Literature Search

The approaches used in literature search were based on a review of the literature on the impact of refugees on land degradation. There was insufficient time and resources to acquire primary data; hence, none was collected. Multiple search engines, including Google Scholar, Scopus, and Oria, were utilized to search for literatures. Multiple search options were employed to gain access to a broader range of information and discover information not available on other search engines. A keyword search was conducted within the search engine using phrases such as ("Refugee settlement or camp or crisis and land degradation) AND Impact," "Refugee and Asylum seeker Population AND Uganda." Articles, reports, books, and case studies related to the issue were downloaded, reviewed, and incorporated in the study based on the search results. Literature that was not published in English or that was published between 1990 and 2013 was removed. Only two essential literature materials out of twenty-six were consulted. This implies that approximately 92.3% of the references predominately were between 2017 and 2024. This was done to provide current information about the study. Articles that did not include "refugee settlement, vegetation, forest, and land use" were also eliminated. Although electronic databases are critical for ensuring reliable data, they were not a solution for all problems. The researchers also got information from reports and websites of development organizations such as the United Nations High Commissioner for Refugees [UNHCR] and Food and Agricultural Organization [FAO]. The review was guided by two potential links between refugee settlements and land degradation which include: plant cover and land use.

RESULT AND DISCUSSION

The study used the Pressure-State-Response framework which provided foundational conceptualization of the impact of refugee settlement on land degradation and entry point for analysis.

It recognizes human activities such as wood cutting for cooking fuel and sales, creation of settlements, land clearing for agriculture and loss to fires through bush burning which exert pressure on key aspects of land resources. A typical example is shown in Figure 2. The government, humanitarian agencies and communities have responded to the land state changes with various interventions, for example tree planting.

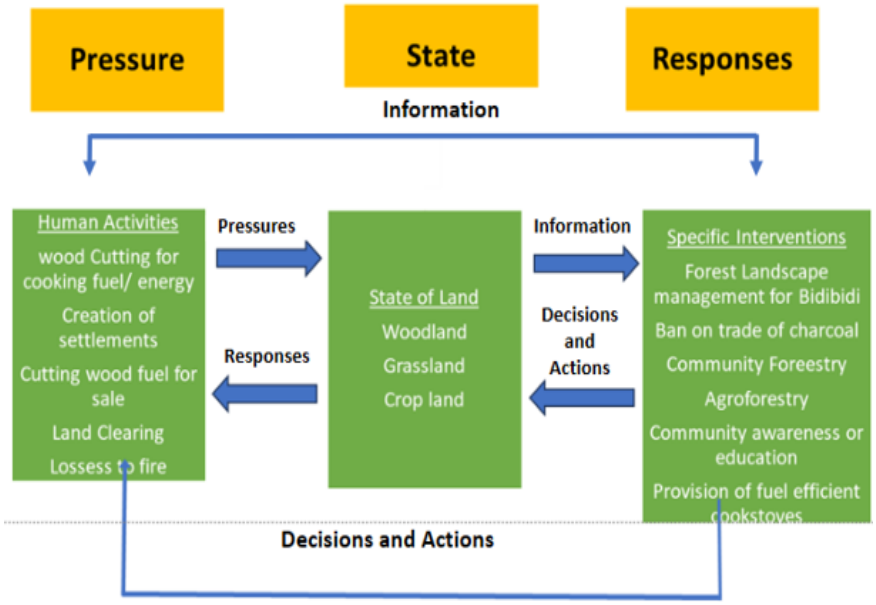

Fig. 2. Pressure-State-Response Framework of Bidi Bidi refugee settlement in Uganda

The State of the Land

The Land Area

Bidi Bidi refugee settlement was divided into five zones. Each zone contains residential and agricultural regions, as well as a small market, a health center, and schools, [18, 8].

Description of the State of Land Change

(a) State of Wood Land

Wood land was found to be highly degraded with reduced forest/tree covers, lost habitat for some animal species and limited regenerative capacity of some plant species [6]. Before the creation of the settlement, the area had dense vegetation cover. After the creation of the settlement, wood land decreased from 97.5% to 42.1% between 2015-2019, [12].

(b) **State of Grassland**

Grassland in Bidi Bidi refugee settlement was degraded. Some of the area became bare and with reduced vegetation cover, [19]. Before the creation of the refugee settlement, the area had high grassland cover of up to 81.2% and thereafter reduced to 39.0% between 2015 to 2019., [12].

(c) State of Cropland

The cropland became degraded. Crop yield reduced, soil became more eroded and there was increase in infestation of pests and diseases. This was attributed to over cultivation because of the small size of land measuring 30 × 30 m^2 which is not enough, [8]. Cropland coverage increased from 4.6% in 2015 to 16.9% in 2019., [12]

However, a typical breakdown of land use classes inside the main settlement perimeter and within authorized residential zones in the Bidi Bidi refugee settlement is given in Table 1.

Table 1. Percentage breakdown of land use classes inside the main settlement perimeter and within authorized residential zones in the Bidi Bidi refugee settlement

Land Use	Land Area (%) in 2015 (Before Establishment)	Land Area (%) in 2019 (4 Years After Establishment)
	Large Settlement Boundary	
Urban Area	3.4	6.7
Cropland	4.6	16.9
Grassland	67.4	69.2
Shrub/Forest	24.7	7.2
Shrub/Forest Grassland	92.0	76.4
	Within the Settlement	
Urban Area	1.8	32.6
Cropland	0.7	25.4
Grassland	81.2	39.0
Shrub/Forest	97.5	42.1

Source: Nakalembe *et al.,* [12].

The Pressures on Land

(a) Wood Cutting for Cooking Fuel/Energy and Sales

The demand for cooking fuel in Bidi Bidi in the form of firewood and charcoal was high and this was attributed to the local cooking methods used by refugees, for example three-stone open fire and improved mud-stoves [20]. For this demand to be met, refugees cut wood and shrubs leaving the land bare. More than 90% of the people in Uganda rely on wood and charcoal to meet their domestic fuel consumption needs [6]. This has resulted in rampant destruction of forests to procure wood and charcoal as essential livelihood commodities. Northern Uganda refugee population data for April 2019 showed a total firewood consumption of 149,262 metric tons per year in Bidi Bidi settlement [20]. Selling wood fuel is one of the income-earning activities carried out in Bidi Bidi [19].

(b) Land Clearing for Agriculture

Upon arrival in Bidi Bidi settlement, each refugee household is allocated a small piece of land (30 × 30 m^2) by the Ugandan government to live and grow food, [21, 8].

Therefore, the refugees cleared woodland and grassland in search of bigger land for agriculture. Subsistence farming is majorly carried out [22]. Refugee homes in the Bidi Bidi cultivate a variety of crops, including sorghum, cassava, and peanuts, often known locally as groundnuts. The most common livestock constitutes 30% chicken, 28% ducks and 27% goats, [23].

(c) Wood and Land for Construction

The initial establishment of Bidi Bidi settlement in 2016 involved woodland and grassland clearing and the growing urbanization in the area showed increase in demand for land and materials like wood for building facilities, for example, shops and houses, [18]. The refugee households construct semi-permanent structures and improve their homes with latrines and kitchen shelters. Building materials used include wood, mud, grass, tarpaulins, bricks, and iron sheets (to a small extent). Exactly 30.2% increase in built-up areas in residential zones and 3.3% increase in the settlement boundary was noted in Bidi Bidi during the study period of 2015 to 2019, [12].

(d) Bush Burning

A positive relationship between the burned area and cropland area in Bidi Bidi has been shown because man-made fires are commonly used to clear new areas for land preparation and agriculture. Burning of crop residues after harvest has made fires more prominent within cropland areas than in natural vegetation. The majority of burned area was detected during and soon after the rainy season ended, that is; December to March, [12].

(e) Mono Cropping and Over Cultivation

Given the small piece of land allocated to refugees, single crops are planted during planting season to increase the quantity of yields especially for storable food crops like maize to ensure household food security, [21]. Constant cultivation of crop land leads to nutrient loss which encourage high use of fertilizers that causes soil and water pollution.

Responses

There have been many interventions that try to minimize the use of wood fuel by innovative methods and to conserve the forests by active engagement of the refugees.

(a) Responses Towards Wood Cutting for Cooking Fuel/ Energy and Construction

(i) **Promotion of Planting of Trees and Establishment of Wood Lots**: In order to increase restoration of degraded woodland in Bidi Bidi refugee settlement, the government of Uganda and humanitarian agencies like UNHCR, World Vision have promoted planting of trees and establishment of wood lots, [24].

(ii) **Encouragement of Planting of Fast-growing Tree Species:** Fast-growing tree species such as red gum and eucalyptus are encouraged to be planted in order to fill the gap and for the availability of wood in the settlement, [6]. Refugees are also equipped with knowledge and skills through training in tree growing and forest management.

(iii) **Provision of Energy Efficient Cook Stoves**: In order to achieve a reduction in biomass consumption for domestic cooking, interventions of providing energy efficient cook stoves to the refugees are performed. Refugees in Bidi Bidi are equipped with skills through trainings by organizations like Norwegian Refugee Council (NRC) [25]. Trainings include the construction of mud cook stoves which are energy efficient and produce less smoke thereby reducing effect on human health.

(b) Responses to Land Clearing for Agriculture/ Bush Burning

The following interventions were implemented to reduced pressure on land resulting from agriculture related clearing:

(i) Sustainable farming practices like agroforestry, community forestry have been adopted in the settlement [25];
(ii) Agroforestry restores forest land through natural regeneration and assisted natural regeneration of indigenous tree species. Community forestry models involve local people dominating the decision making in forest management [6];
(iii) Advocacy by local government and community leaders to stop bush burning and slash agriculture [25];
(iv) Regulatory interventions towards land conservation.; and
(v) The Government of Uganda has laid statutes that dictate the allocation, use and management of land and resources by refugees [26].

CONCLUSION AND RECOMMENDATIONS

The high number of refugees in the Bidi Bidi refugee settlement has put more pressure on how the land is used, which has led to land degradation. The 30 × 30 meters square of land allotted to each refugee household is not enough to support their livelihoods and this has resulted into overuse of the land. The degradation of land in the settlement is due to unsustainable land management practices among the refugee households. Cutting of trees for fuel, bush-burning, mono cropping, over cultivation, expansion of land for agriculture and the construction of infrastructure such as roads and urban centers were the main drivers of land degradation in the settlement. The most degraded land types were grassland, woodland, and cropland which was evidenced by loss of forest cover, increased area of bare ground, increased soil erosion, and a limited capacity for natural vegetation to regrow, low crop yield as key indicators of land degradation. Responses to address land degradation in Bidi Bidi refugee settlement included regulations, implementing sustainable land management techniques, and raising public knowledge of the effects of human activity on the environment. To further reduce land degradation, the following recommendations were proposed:

a) There is a need to promote sustainable land management measures in the current forest management plan;
b) The study observed that implementation of existing land conservation policies in the refugee settlement is still lacking. Therefore, re-aligning existing policies to the existing land resource challenges and increasing awareness on conservation strategies among refugees are recommended;

c) There is need for more sustainable agricultural practices to conserve the land while meeting human food needs; and
d) Education on land management systems should be improved for refugees to understand how their activities affect land resources.

CONFLICT OF INTEREST

None is declared.

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UTICAJ IZBEGLIČKIH NASELJA NA DEGRADACIJU ZEMLJIŠTA U UGANDI

Uduakobong Ndiana-Abasi AKPAN [1], Justine MAWADRI [1], Denniz ASINGWIRE [1], Ayesha BUTT [1], Nimitkumar ENGINEER [1], Ima-Obong Joseph AKPAN [2]

[1]Department of International Environmental Studies, Norwegian University of Life Science (NMBU), Norway
[2]Department of Mechanical Engineering, Michael Okpara University of Agriculture, Umudike, Nigeria

Apstrakt: U nastojanju da se ispitaju različiti uzroci-pokretači degradacije zemljišta u izbegličkim naseljima u Ugandi, sprovedena je studija: Uticaj naseljavanja izbeglica na degradaciju zemljišta u Ugandi, u kojoj je korišćen okvir pritisak-stanje-odgovor za analizu trenutnog stanja zemljišta, glavni pokretači degradacije zemljišta, i odgovori na identifikovane uzročnike-pokretače u izbegličkom naselju Bidi Bidi u Ugandi.

Rezultati istraživanja ove studije su otkrili da je povećanje izbegličke populacije dovelo do gubitka travnjaka, obradivih površina i šuma u izbegličkom naselju. Najviše degradirani tipovi zemljišta bili su travnjaci, šume i usevi.

Ovo se prvenstveno pripisuje neprekidnoj delatnosti ljudi, kao što je: seča drveća za ogrev ili prodaje, spaljivanja žbunja, monokulture, prekomerne obrade i izgradnje infrastrukture kao što su putevi i urbani centri koji su vršili pritisak na zemljište što dovodi do pojave značajne pojave degradacije zemljišta.

Odgovore na ove pritiske sproveli su različiti akteri, uključujući vladu Ugande, grupe u zajednici, humanitarne agencije i domaćinstva.

Ova studija preporučuje implementaciju prakse održivog upravljanja zemljištem, sprovođenje vladinih politika i povećanje svesti o uticajima ljudskih aktivnosti na osobine zemljišta.

Ključne reči*: Izbegličko stanovništvo, naselje, zemljište, glavni pokretači, degradacija, Uganda*

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