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Competency Improvement Needs of Farmers in Soil Erosion Management Technique for Sustainable Farming in Benue State

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Abstract: The study sought to identify the competency improvement needs of farmers in soil erosion management technique for sustainable farming in Benue State. The study had three specific objectives, three research questions were answered. The study adopted survey research design. The population of the study was 10,423 persons comprising 10400 farmers and 23 agricultural extension agents. Taro Yamemi formular was used to draft 385 (362 farmers and 23 agricultural extension agents). The instrument for data collection was a structured questionnaire titled Competency Improvement Needs of Farmers in Soil Erion Management Technique Questionnaire (CINFSEMTQ) containing 30 items. The instrument was divided into need and performance categories and were structured in a 4-points response options. Data were collected by the researcher and 5 research assistants. 378 copies of the instrument representing 98 percent were retrieved for analyses using discrepancy model. It was found from the study that farmers need competency improvement in 10 items each of biological, chemical and organic techniques of soil erosion management. Among the recommendations made were that: government should organize training for the farmers on the right use of the chemical techniques of soil erosion management in a way that it would not cause significant side effect to the soil.

Keywords: *Competency Improvement, Soil Erosion Management, Farmers and Sustainable Farming.*

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I. INTRODUCTION

All agricultural activities which are the bases for food supply depends on the soil. Due to the huge dependent on soil, it is usually prone to degradation, misuse and erosion. Erosion is the tear and wear of the soil surface as a result of water, wind, loss of soil nutrients and agro-industrial activities among others. Hörner and Wollni (2021) defined soil erosion as the tear and wear of soil surface by water, wind or other factors. Soil erosion according to the Eze, (2013) refers to washing away of soil surface which contains the essential mineral for plant growth. Soil erosion is a huge threat to farmers as it makes the soil devoid of important mineral elements which are needed for plant growth and development.

Soil erosion is influenced by certain factors which includes: the amount, distribution and intensity of rainfall, the topography of the land, the face of prevailing wind, soil physical condition or characteristics like structure and texture, extent of vegetative cover, the type of crop grown, and the system of husbandry adopted (Tugrul, Jesús & Artemi, 2019). Crop growing farmers are expected to possess skills in soil erosion prevention and control in order to conserve the soil and increase their agricultural productivity. For a largely organized community to remain agrarian over decades, the greatest impact of erosion which lies in the volumetric loss of soil, decrease in the soil nutrient capacity, moisture retention capacity, organic matter content and depth of the soil with resultant effect on soil being seriously impoverished will need to be curtailed as these negatively influence crop production (Onu & Muhhamed, 2014). It also leads to obstruction of farm activities as the physical layout of the farm is obstructed during the tear and wear. Consequently, farmers began to face challenges such as poor yield, lack of fertile land for crop production, degradation and others.

Due to these and numerous other disadvantages of soil erosion to the farmers and the entire crop production activities. There is need for proper mechanism or technique to be adopted to manage it especially in situation where they cannot be totally avoided. Because some of the causes of soil erosion are natural, it becomes difficult to totally avert. Farmers can hardly control the rate of rainfall and wind which leads to soil erosion. This is why farmers need to demonstrate

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competency in the technique for managing these soil erosion menace as they occur.

Competency is the ability to demonstrate the steps involved in carrying out a task. Oodo, Eje, Okorie, Wever and Izuka (2024) defined competency as the ability to carry out tasks efficiently. Competency in this study refers to the ability of farmers to efficiently manage soil erosion using sustainable techniques that will guarantee efficient crop production. Competency improvement on the other hand is the act of enhancing one's ability in carrying out a task. Eje (2018) explained competency improvement as the strategic process of enhancing an individual's or team's skills, knowledge, and behaviours to better meet job requirements, improve performance, and drive career or organizational growth, often involving identifying gaps and providing targeted learning and practice to reach higher levels of proficiency, even expertise. It moves beyond just having a skill to knowing how and when to apply it effectively, progressing from unconscious mistakes to automatic mastery (Olaitan, Asogwa & Abu, 2011). Competency improvement in this study is the process of enhancing farmers knowledge, affection and skill in managing soil erosion for sustainable farming.

Soil erosion management techniques are the measures for controlling the effect of erosion on the soil by farmers. Eze (2013) emphasized that soil erosion management technique entails activities aimed at reducing the effect of soil erosion on crop production. According to Gambo, Fullen and Baldwin (2025) soil erosion management can also be called control and they involve techniques used to reduce existing erosion or rehabilitate damaged land such as terracing, check dams, bio-nets, contour farming. Though to ensure profitable crop production, soil erosion management can also be combined with preventive measures for a comprehensive approach. While prevention is proactive or stopping the process, management is often reactive which implies mitigating the effects and rehabilitating. Soil erosion management techniques include organic manuring which helps in binding the soil particles together, ridging across slope, making embarkment and others. In the context of this study, soil erosion management technique can be categorized into biological techniques, chemical technique and organic techniques.

Biological techniques are techniques involving the use of biological processes such as use of activities of living things to control or manage the effect of soil erosion. According to Ogar (2023) Biological soil erosion management uses plants and natural processes to stabilize soil through some techniques such as cover cropping, contour farming, mulching and others. These reduces water runoff, increase soil infiltration. Eze et al., (2022) identified that these also holds soil particles with roots, offers sustainable, cost-effective, and eco-friendly erosion control. Biological technique according to Gambo et al. (2025) involves cover cropping, integrating trees, shrubs, and crops/livestock in a single system to provide windbreaks and deep root systems that bind soil, plowing and planting across a slope, following its natural curve, to create ridges that slow water flow, strip cropping and others.

These biological processes help to protect soil surface, plant canopy and residue intercept raindrops and shield soil from wind. The plant roots form a network that physically holds soil particles together while the vegetation slows water, increasing infiltration and reducing sediment transport (Ogar, 2023). Organic matter improves soil structure, water retention, and nutrient cycling which reduces the effect of soil erosion. However, farmers seem to lack sufficient competency in the adoption of these biological techniques. Onu and Mohamed (2014) found that farmers need competency improvement in biological techniques such as Growing crops such as legume clover) or grasses during fallow periods or between main crops to keep the soil covered; Cultivation of crops across the slope, rather than up and down, to slow down surface runoff; Planting trees to create forests or restoring degraded forests.

Chemical technique of soil erosion management is the use of chemical to manage the effect of soil erosion on the soil and plants. Adams et al (2020) asserted that chemical techniques for soil erosion management involve adding various chemical substances to the soil to bind particles, improve soil structure, and increase resistance to wind and water. This technique is usually used in areas where vegetation cannot be established quickly or is not sufficient for stabilization (Azare, 2021). The author stated that farmers usually find it difficult adopting the chemical technique until they are specially guided by trained agricultural extension agents. The chemical techniques for soil erosion management as outlined by Ben-Hur, Malik, Letey and Mingelgrin (2021) include cementitious materials, Biochemical, binders such as Polymers and Chemical Stabilizers. These techniques are effective for ground improvement as they alter the strength and hydraulic conductivity of the soil (Rodrigo-Comino et al., 2019). The use of cement line as an additive has proved to increase soil strength and durability through cementitious hydration and cation exchange. Lime is especially effective in fine-grained soils by reducing plasticity and swelling (Miller, Willis & Levy, 2019). Also, materials such as fly ash, calcium carbide residue (CCR), and silica fumes are used as cost-effective alternatives or in blends with cement/lime to enhance stabilization. Binders such as polymers and chemical stabilizers form a protective crust-like layer on the soil surface or bind particles together within the soil matrix. A study by Ape (2021) found that farmers in Benue State needs to improve on their skills in erosion control especially in the adoption of the chemical techniques which though may have some effects on the land but provides quicker correction to eroded land.

However, the choice of chemical technique depends on factors such as soil type, farm project duration and environmental considerations. These treatments can be applied via spray-on treatments for surface stabilization or mixed directly into the soil for deeper ground improvement (Tugrul, Jesús & Artemi, 2019). The author further stated that for solutions (like polymers or chlorides), a slurry of the chemical and water may be sprayed over the surface, similar

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to hydroseeding but for lime or cement, it is mixed into the soil using specialized equipment to ensure even distribution.

The organic technique is another way of managing soil erosion. This involves building healthy soil with organic matter and using natural covers. It includes techniques like no-till farming which allows crop to be grown directly on the soil without tilling, planting cover crops which adds nutrient to the soil, applying mulches which decompose to add manure to the soil, integrating agroforestry all to anchor soil with roots, slow water runoff, and reduce wind impact, creating resilience thereby improving overall fertility of the land. Xiong, Sun and Chen (2018) noted that the key organic technique of soil erosion management includes building soil organic matter. Decomposed plant/animal matter acts as glue, binding soil particles together. Covering soil with straw, wood chips, or other organic materials shields it from raindrop impact and retains moisture. These techniques bind soil, prevent displacement, reduces raindrop impact and wind force. It also improves aeration and water absorption, making soil less prone to washing/blowing away (Tisdall & Oades, 2018). All these techniques combined creates a robust, living system that protects soil and improves fertility so that farmers enjoy sustainable farming. Ogar (2023) found that farmers need to enhance their skills in controlling soil erosion using the organic technique as it provides the most sustainably effective result devoid of side effects on the soil. Thus, organic technique of soil erosion control is a component of sustainable farming practice.

Sustainable farming is a farming practice that encourages farmers to produce food in a way that the natural resources are conserved while also keeping the production cycle continuously moving. Sustainable farming entails the application of sustainable farming practices in carrying out all farming operations. For crop production to be sustainable, erosion must be controlled or managed to avert degradation and other effects of soil erosion. Onu and Muhhamed (2014) pointed out that sustainable farming can only be achieved when the land is conserved.

However, sustainable farming in Benue State face land degradation challenge as a result of erosion in many farming areas, limiting the rate of production. Ape (2021) observed that farmers in rural and semi-urban areas where crop production dominate lack sufficient skill in managing soil erosion. It is on this bases that there is need for a study to ascertain the competency improvement need of farmers in soil erosion management in Benue State.

➢ *Statement of the Problem*

Every crop farmer requires technical skills in preventing, controlling or managing the effect of soil erosion for sustainable crop production. When farmers possess competency in erosion control, they can adopt the practices to conserve the land faced with erosion. But farmers seem to lack the ability to demonstrate the tasks required in erosion management for sustainable crop production. Farmers in Benue State need significant competency improvement in soil erosion management, particularly in cultural practices like mulching and cover cropping, and mechanical practices such as terracing, channelling, and contour farming. A major gap exists in awareness and application of these techniques, with many farmers still relying on outdated methods like slash-and-burn and having little or no knowledge of effective management measures such as biological, chemical and organic techniques. There has been no study aimed at bridging this gap thus, the need for this study. Improving these skills by the farmers when identified will require targeted training programs to address the specific areas of needs.

➢ *Purpose of the Study*

The main purpose of this study is to identify the competency improvement need of farmers in soil erosion management technique for sustainable farming in Benue State. Specifically, the study sought to identify the competency improvement needs of farmers in:

- Biological techniques of soil erosion management
- Chemical technique of soil erosion management
- Organic techniques of soil erosion management

➢ *Research Questions*

The following research questions were answered for the study

- What are the competency improvement need of farmers in biological techniques of soil erosion management?
- What are the competency improvement need of farmers in Chemical technique of soil erosion management?
- What are the competency improvement need of farmers in Organic techniques of soil erosion management?

II. METHODOLOGY

The study adopted survey research design. Survey research design aims at collecting data from a representative sample of a population using instruments like questionnaire and result obtained would be generalized on the entire population. The design is suitable for this study as data collected from a representative sample of farmers will be generalized on the entire crop farmers in the State. The study was carried out in Benue State in North central zone of Nigeria. Benue state is made up of 23 local government areas with her headquarters in Makurdi. Benue State is one of the North-Central states in Nigeria with a population of about 4,253,641 in 2006 census. The State is known as the food basket of the nation as the major commercial activity of the indigent is centred on crop production. The state was chosen for the study because there are many farming areas affected by erosion and the farmers yean for management techniques to cope with issue and ensue sustainable crop production. The population of the study is 10,423 persons comprising 10,400 registered crop farmers and 23 agricultural extension agents in the State. The total sample for the study was 385 drafted using Taro Yameni formular for sample size. 382 registered farmers were sampled using stratified random sampling technique while all the 23 extension agents were used. The instrument for data collection was a structured questionnaire titled Competency Improvement Needs of Farmers in Soil Erosion Management Technique Questionnaire (CINFSEMTQ) containing 30 items generated from literature

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reviewed for the study. The instrument was divided into need and performance categories. The two categories were structured in a 4-points response option of very high VH, High H, Low L and very low VL; with a corresponding weight of 4, 3, 2 and 1 respectively. The instrument contained sections A and B. Section A contained information on the relevant personal characteristics of the respondents while section B was on the main research questions. The instrument was validated by three lecturers, two were experts in soil science while one was from agricultural education, all from Joseph Sarwuan Tarka University Makurdi. The instrument was thereafter administered to 10 farmers and 10 extension agents from Nasarawa State which shares similar characteristics with the respondents. The responses of the respondents were analysed using Cronbach alpha coefficient and a reliability coefficient of 0.81 and 0.87 were obtained for the need and performance categories respectively. Data were collected by the researcher and 5 research assistants who were briefed on how to administer and retrieve the instrument from the respondents. 378 copies of the instrument representing 98.9 percent were retrieved for analyses. The performance mean was represented with Xp while the expected or needed mean was represented with Xn. The performance gap (PG) was obtained by subtracting the Xp from Xn. (PG= Xn-Xp).

This could yield zero, negative or positive result. A zero result means that the extent to which the item is performed is same as the extent to which they are expected or needed which shows that no improvement is needed. A negative result means that the extent to which the item is performed is higher than they are expected or needed, meaning that no improvement is needed while a positive result shows that the extent to which the item is performed is below the extent to which they are expected or needed, implying that improvement is needed in such item.

III. RESULTS

- *Research Questions 1: What are the Competency Improvement Needs of Farmers in Biological Technique of Soil Erosion Management in Benue State*

Table 1: Need Gap Analyses of the Respondents on the Biological Techniques of Soil Erosion Management

S/N	ITEM STATEMENT	$\bar{X}_n$	$\bar{X}_p$	PG $(\bar{X}n - \bar{X}p)$	Remark
1	Use of grasses to cover the soil, especially in areas prone to high erosion	3.19	2.80	0.39	IN
2	Plant rows of trees or shrubs at right angles to the prevailing wind to reduce wind speed, reducing soil erosion by wind.	3.28	2.64	0.64	IN
3	Spread plastics or paper sheet over cultivated patch or round tree seedling	3.14	2.79	0.35	IN
4	Grow crops such as legume clover) or grasses during fallow periods or between main crops to keep the soil covered.	3.18	2.48	0.7	IN
5	Plant trees to create forests or restoring degraded forests.	3.26	2.98	0.28	IN
6	Plant strips of permanent vegetation such as grasses, trees, shrubs along riverbanks or between agricultural fields and water bodies to trap sediment.	3.30	2.84	0.46	IN
7	Cultivation of crops across the slope, rather than up and down, to slow down surface runoff	3.35	2.88	0.47	IN
8	Grow two or more crops together on the same field to provide better ground cover and soil protection	3.25	2.81	0.44	IN
9	Regularly alternate the types of crops grown on the same land to maintain soil structure, reducing the likelihood of erosion compared to monoculture	3.18	2.52	0.66	IN
10	Using living cuttings to create small, low-retaining walls that hold soil in place, especially on steep slopes	3.33	2.62	0.71	IN

Keys: Xn- mean of need category, Xp-mean of performance category, NG- need gap, IN- improvement needed, INN- improvement not needed

The result of the study Presented in Table 1 shows that all the items had their performance gap (PG) ranging from 0.28 to 0.71 and are all positive. This means that the level at which the items are performed by the farmers is lower than the level they are needed, therefore competency improvement is needed in all the items in biological technique of soil erosion management for sustainable farming in Benue State.

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➢ *Research Questions 2: What ae the Competency Improvement Needs of Farmers in Chemical Technique of Soil Erosion Management in Benue State*

Table 2: Need Gap Analyses of the Respondents on the Chemical Techniques of Soil Erosion Management

S/N	ITEM STATEMENT	$\bar{X}_n$	$\bar{X}_p$	PG $(\bar{X}n - \bar{X}p)$	Remark
1	Use biopolymers derived from plants or bacteria to bind soil particles and reduce erosion	3.33	2.96	0.37	IN
2	Use high-performance polymers like polyacrylamide to effectively promote the formation of soil aggregates, which are more difficult for water to wash away	3.43	2.84	0.59	IN
3	Use traditional chemicals like cement, lime, fly ash to improve the engineering properties of weak soil by increasing its density and shear strength.	3.42	3.05	0.37	IN
4	Mix chemicals such as alum or specialty polymers on soil surface to add to sediment-laden water to cause suspended particles to "clump" or flocculate	3.29	2.77	0.52	IN
5	Application of gypsum to sodic soils to improve water infiltration to reduce erosion	3.33	3.05	0.28	IN
6	Use hygroscopic Salts such as calcium chloride ($CACL_2$) to suppress dust therefore increasing soil bearing capacity	3.45	3.02	0.43	IN
7	Use bacteria to precipitate calcium carbonate (calcite) within the soil pores which bind soil particles together to reduce the erodibility of the soil	3.38	2.95	0.43	IN
8	Use enzymes such as TerraZyme which react with soil organic matter to form cementitious materials, reducing soil permeability to increase its strength.	3.40	3.17	0.23	IN
9	Adopt hydroseeding slurry method where seed, fertilizer, mulch, and chemical tackifiers are mixed then sprayed over slopes to provide instant surface protection from erosion.	3.42	2.88	0.54	IN
10	Use ionic Soil Stabilizers (ISS) to make clay soil less susceptible to water absorption, dispersion, leading to particle aggregation.	3.37	3.13	0.24	IN

Keys: Xn- mean of need category, Xp-mean of performance category, NG- need gap, IN- improvement needed, INN- improvement not needed

The result of the study Presented in Table 2 shows that all the items had their performance gap (PG) ranging from 0.23 to 0.59 and are all positive. This means that the level at which the items are performed by the farmers is lower than the level they are needed, therefore competency improvement is needed in all the items in chemical technique of soil erosion management for sustainable farming in Benue State.

➢ *Research Questions 3: What are the Competency Improvement Needs of Farmers in Organic Technique of Soil Erosion Management in Benue State*

Table 3: Need Gap Analyses of the Respondents on the Organic Techniques of Soil Erosion Management

S/N	ITEM STATEMENT	$\bar{X}_n$	$\bar{X}_p$	PG $(\bar{X}n - \bar{X}p)$	Remark
1	Grow legumes such as clover groundnut or grasses during fallow periods or between main crops to keep the soil covered, protecting it from wind / rain	3.36	3.07	0.29	IN
2	Cover the soil surface with crop residues, straw, leaves, or wood chips to protect against raindrop impact, slow down surface runoff	3.32	3.03	0.29	IN
3	Leave at least 30% of crop residue from the previous harvest on the soil surface before planting to protect it	3.38	3.04	0.34	IN
4	Plow together green plant material to improve soil structure which increase its water-holding capacity.	3.45	2.91	0.54	IN
5	Use organic fertilizer compost to improve soil aggregation, which increases infiltration to reduce runoff.	3.42	3.15	0.27	IN
6	Plant dense-rooted grasses such as Napier grass, Guatemala grass along contour lines to create natural terraces which filters runoff	3.38	3.04	0.34	IN

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7	Add decomposed organic material to bind soil particles together, improving their resistance to erosion	3.33	2.96	0.37	IN
8	Use grass strips as contour barriers to allow nature to form terraces over time	3.39	3.07	0.32	IN
9	Use drip irrigation system to prevent excessive runoff leading to soil erosion.	3.35	3.11	0.24	IN
10	Move livestock between pastures to prevent overgrazing, which destroys vegetation and exposes the soil.	3.33	2.96	0.37	IN

Keys: Xn- mean of need category, Xp-mean of performance category, NG- need gap, IN- improvement needed, INN- improvement not needed

The result of the study Presented in Table 3 shows that all the items had their performance gap (PG) ranging from 0.27 to 0.37 and are all positive. This means that the level at which the items are performed is lower than the level they are needed, therefore competency improvement is needed in all the items in organic technique of soil erosion management.

IV. DISCUSSION OF THE FINDINGS

The result of the study revealed that farmers need competency improvement in biological techniques of soil erosion management for sustainable farming in Benue State. The result is in keeping with Ogar (2023) who found that farmers and agricultural teachers are required to acquire skills in soil erosion management using biological technique for effective crop production. The result is also in keeping with Onu and Mohamed (2014) who found that farmers need competency improvement in biological techniques of soil erosion management such as growing legume or grasses during fallow periods or between main crops to keep the soil covered; cultivation of crops across the slope rather than up and down, to slow down surface runoff; planting trees to create forests or restoring degraded forests. The findings align with the researcher's initial assertion that every crop farmer need to demonstrate sufficient skill in adoption of biological erosion management techniques to be able to produce crop sustainably even in farming localities with poor topography.

The result of the study revealed that farmers need competency improvement in the chemical techniques of soil erosion management. The finding is in keeping with Ben-Hur, Malik, Letey and Mingelgrin (2021) who found that farmers need improvement in the adoption of chemical techniques of soil erosion management including use of cementitious materials, biochemical, binders such as Polymers and Chemical Stabilizers. In keeping with the findings of the study also, Ape (2021) found that farmers in Benue State needs to improve on their skills in erosion control especially in the adoption of the chemical techniques which though may have some effects on the land but provides quicker correction to eroded land. Moreso, the findings of the study agree with Azare (2021) who noted that farmers would require the guidance of trained extension agents on the use of chemical technique to manage soil erosion, implying that they need competency improvement in the technique.

The result of the study also revealed that farmers need competency improvement in the organic techniques of soil erosion management. This finding is in accordance with Ogar (2023) found that farmers need to enhance their skill in controlling soil erosion using the organic technique as it provides the most sustainably effective result devoid of side effects on the soil. In line with the finding of this study also, Onu and Muhhamed (2014) found that farmers need competency improvement in organic techniques of soil erosion control such as adding decomposed organic material to bind soil particles together, improving their resistance to erosion, plowing together green plant material to improve soil structure which increase its water-holding capacity. In keeping with findings of the study also, Ape (2021) observed that farmers in rural and semi-urban areas where crop production dominate lack sufficient skill in managing soil erosion.

V. CONCLUSION

Based on the result of the data collected and findings made from study, it was concluded that farmers in Benue State need competency improvement in 30 items in soil erosion management techniques for sustainable farming. They are: biological technique (10items), chemical techniques (10items) and organic techniques (10items).

RECOMMENDATION

Based on the findings of the study, the following recommendations were made

- Farmers should seek more training from agricultural extension agents on the biological techniques of soil erosion management
- Government should organize training for the farmers on the right use of the chemical techniques of soil erosion management in a way that it would not cause significant side effect to the soil and to the sustainability of farming practice.
- Farming communities should seek training on the organic farming techniques which prevents or controls soil erosion sustainably.
- Farmers should adopt eco friendly agronomic practices that would naturally reduce the exposure of the soil to erosion.

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