Dissemination and Adoption of Sustainable Soil Management Technologies Among Farmers; Advances in Climate Smart Agricultural Practices in Nigeria.

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Abstract:
The study examined Sustainable Soil Management (SSM) in the context of Climate Change. It provided insight into specific SSM technologies disseminated by Extension agents and adopted among farmers through Research-Extension-Farmer-Input Linkage System (REFILS) activities. This was with a view to determining the appropriateness of these SSM technologies for the advancement of Climate Smart Agriculture in the region.

A total of 380 respondents comprised of 44 extension agents and 336 farmers were purposively sampled across the four Agricultural Development Programme (ADP) zones in Oyo state for this study. Findings identified a total of 24 SSM technologies categorized as Soil Erosion Control, Soil Nutrient Management, Minimum Soil Disturbance, Water Management Techniques, Vegetation Management and Agroforestry System to have been disseminated and adopted among the farmers. The farmers perceived some of the technologies to be appropriate based on their application suitability, ecological importance, economic importance and socio-cultural acceptability. It is concluded that the farmers' perceived appropriateness of the technologies disseminated influenced their efforts towards involvement in activities that would promote the widespread adoption. These technologies should therefore be prioritized by SSM implementers to achieve the targeted advances in Climate Smart Agriculture (CSA). Adoption of the identified and appropriate SSM technologies should be promoted among the farmers as a necessity for the transition to CSA.

Key words: Climate-Smart Agriculture, Sustainable Soil Management, Appropriateness, REFILS, Dissemination, Adoption

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1. Introduction

Soil serves as a significant medium for agriculture because of the environmental, economic and social roles it plays. It is a major source nourishment to humans As posited by Keesstra *et al* [1], soils now form the inter-connecting point of multiple United Nations Sustainable Development Goals (SDGs), accounting for a large volume of the global food provision and also provides many essential ecosystem services. However, the fact that food production is now on high demand has resulted in too much pressure on the use of soil, thus leading to decline in its quality in developing countries, particularly Nigeria. As noted by FAO and ITPS [2], climate change, land degradation and losses in biodiversity has resulted in soil becoming one of the world's most vulnerable resources. Soil and land degradation now has adverse impacts on ecosystem services consequently affecting the food security, maintenance of water quality and availability, protection of human health and the establishment of the basis for a range of socio-economic activities [3]. It therefore becomes imperative to address the issue of soil and land degradation for a sustainable development.

According to FAO [2015], Soil management is considered sustainable if: the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing either the soil functions that enable those services or biodiversity. Implementation of Sustainable Soil Management practices can result in more contributions of the soil in building resilient agricultural ecosystems that is capable of coping with the impacts of climate change with mitigating effects. As opined by Ziadat *et al* [4], for the uptake of Climate-Smart Sustainable Soil Management Practices to be upscaled, adequate technical knowledge, coupled with effective stakeholders' synergy with a supportive enabling environment must be ensured. For SSM technology delivery system targeted at the end users (farmers) to be successful, there should be in place, an effective linkage system among the actors involved in the generation, dissemination and utilization of the knowledge and information. As noted by Agbamu [5], effective communication links between the actors is very germane for meaningful developmental success in agricultural production and rural development to be recorded as these links will enable new management practices and technologies to be well suited to local ecological conditions. Since farmers often use multiple sources of information to shape and enrich their knowledge base in managing their farms [6], there is therefore a need for effective synergy and collaboration between research and extension. They need to utilize the available channels of information to acquire relevant knowledge and information which are to be passed across to the farmers to enhance the upscale of SSM technologies among them. It can therefore be established that for a successful implementation of SSM technologies and measures, there must be a well enabling environment which will consequently result in increased adoption of these technologies among the target beneficiaries.

Research-Extension-Farmer-Input Linkage System (REFILS), as noted by Nnadozie *et al*. [7] can be described as an institutional dynamics of linkage between National Agricultural Research Institutes (NARIS), Agricultural Development Programmes (ADPs), farmers and input agencies. It is and organization of research, extension and input agencies to improve productivity of farmers. Effective collaboration among the relevant stakeholders must therefore be put in place to implement the *Voluntary Guidelines on Sustainable Soil Management* [8] and to contribute significantly to climate-smart agricultural system As different actors involved in SSM uptake have different opportunities to exert on the system, it is germane to have a deeper understanding of the REFILS actors' collaboration, linkage and interaction. Deeper understanding of the appropriateness of the identified SSM technologies among the farmers is also germane for a wider advances in Climate Smart Agriculture.

Objectives of the study:

a. To identify the Climate-Smart SSM technologies disseminated and adopted among the actors in Oyo state, Nigeria
b. To assess the appropriateness of the Climate-Smart SSM practices disseminated among the farmers through the linkage activities of the actors in the study area.

2. Research Methodology

Table **1** showed the distribution of respondents sampled for the study. The target population of the study consist of the extension personnel in Agricultural Development Programme (ADP) zones and the ADP contact farmers in Oyo state. The study population was 2,420. The study area has 33 Local Government Areas (LGAs) with four Agricultural Development Programmes (ADPs) zones located at Saki, Ogbomoso, Oyo and Ibadan. There was a total of 88 EAs in Oyo state ADP (village extension agents, block extension agents and supervisors). For the contact farmers, there were 80 contact farmers per block and for 28 blocks (agrarian LGAs) in Oyo ADP, the total number of contact farmers is 2,240.

The sampling procedure was multi-stage sampling technique where at the first stage, stratified sampling technique was used to delineate the actors' categories into two as mentioned above. For the extension agents, a proportion of 50 percent of the total population were randomly sampled across the four zones, based on the numbers of blocks per zone. In Ibadan/Ibarapa zone, 16 EAs were sampled, 9 EAS sampled in Oyo zone, 6 sampled in Ogbomoso while 13 sampled in Saki zone making a total number of 44 EAs sampled for the study. For the farmers,14 blocks (50 percent of the blocks) were selected, with 80 contact farmers per block, out of which 30 percent of the contact farmers were randomly selected per block. This made a total of 336 farmers as respondents. In all, 380 respondents were selected for the study.

Research Instrument and Data Collection

Structured interview schedule and questionnaire with open and closed ended questions was used to elicit quantitative data from the respondents. Information from the farmers were gathered by using open and closed ended questions For the Extension agents, structured questionnaire was used while interview schedule was used to elicit information from the farmers. Focus Group Discussion (FGD) guide was used to obtain qualitative data on the appropriateness of SSM technologies, based on the perception of the farmers. The discussions were facilitated with the use of a FGD guide prepared beforehand and was moderated by introducing the topics for discussion and ensuring all the group members participate actively in the discussion. A total of five FGD sessions were conducted among farmers (between 6-8 members per group) in Ibadan/Ibarapa zone (Lagelu and Eruwa communities), Ogbomoso zone (Igbo-ileoje community), Saki zone (Iseyin) and Oyo zone (Oyo). Secondary data and information were also harnessed for the study from past theses, REFILS and OYSADEP in-house reports and journals, together with publications from other research institutes in the study area.

Descriptive statistics such as frequency counts, percentages, mean and standard deviation were used to analyse the Quantitave data collected. All the statistical computations were done using the version 16 of the statistical package for social sciences (SPSS).

Table 1 : Distribution of respondents sampled for the study

Category	Institution	Population	Sampling	Total sample size
Extension Agents of 3.14 per block	Ibadan/Ibarapa Zone	88	5 blocks x 3.14	16
	Oyo Zone		3 blocksx 3.14	9
	Ogbomoso		2x3.14	6
	Saki		4x3.14	13
			total	**44**
Farmers	Ibadan/Ibarapa(24 farmers per block)	2,240	Akinyele	24
			Ido	24
			Lagelu	24
			Ibarapa East	24
			Ibarapa Central	24
	Oyo 24 farmers per block)		Oyo East	24
			Oyo West	24
			Atiba	24

Ogbomoso 24 farmers per block)	Surulere	24
	Ogooluwa	24
	Saki East	24
Saki 24 farmers per block)	Saki west	24
	Iseyin	24
Olorunsogo	Olorunsogo	24
	total	**336**
	TOTAL SAMPLE	**380**

Source: Field Survey, 2021

3. Results and Discussion

Identified Climate-Smart SSM Technologies:

The findings of the study revealed that 24 SSM technologies were identified among the farmers to have been disseminated by the extension agents and adopted by the farmers. These technologies were categorised into 5 based on the principles of Voluntary Guidelines for Sustainable Soil Management of the Food and Agriculture Organization [12]

3.1. Soil erosion control

As shown in figure 1, for Soil Erosion Control-related technologies disseminated to the farmers , 72.7 percent of extension agents disseminated Mulching and Ridging across the slope technologies while for semi-circular bonds, erosion chambers and use of vetiver grass, 56.8 percent, 54.5 percent and 34.1 percent of the extension agents respectively disseminated the technologies to the farmers. For technologies adopted in this category, 59 percent of the farmers have practised semi-circular bonds, 56.8 percent tried ridging across the slope and 52.3 percent tried mulching. Erosion chambers and use of vetiver grass had responses below average (34.1 percent each of the farmers). This result is an indication that out of the 5 technologies in the soil-erosion control category, mulching and ridging across the slope were more disseminated by the Extension Agents (EAs) as well as practiced/ adopted by the farmers. This could be associated with the low cost of disseminating the technology and the perceived appropriateness of the technologies by the end-users.

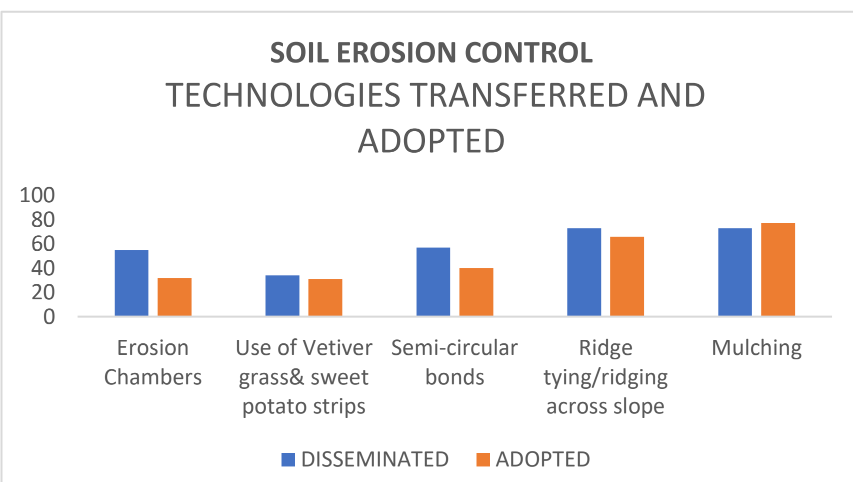

Figure 1: Soil Erosion Control Technology disseminated and adopted
Source: Field survey, 2021

3.2 Soil nutrient management:

Results in figure 2 shows that for soil nutrient management-related technologies, 75.0 percent of the EAs have disseminated composting technology to their end-users, followed by production and application of organic fertilizer which recorded 65.9 percent. Use of bio-fertilizer, precision fertilizer use and Production and use of biochar had 63.6 percent, 61,4 percent and 54.5 percent responses respectively. The result of the findings revealed that precision in fertilizer use recorded the highest with 61.3 percent of the EAs having disseminated it as a technology to the farmer. Application of organic fertilizer recorded barely average of 52.1 percent while others had low responses. For the adopted technologies by the farmers, 61.3 percent of the farmers indicated the practice of precision in organic and inorganic fertilizer use, 52.1 percent indicated production and application of organic fertilizer, while for composting, use of bio-fertilizer and production& use of biochar, only few of them indicated with 33.0 percent, 27.4 percent and 26.5 percent respectively. This result is an indication that out of the 5 technologies in the Soil Nutrient Management category, more farmers adopted precision in fertilizer use and application of organic fertilizer. This could be attributed to the ease of application and economic benefits of these technologies. There is however low adoption rate of biochar by farmers as compared with the high response recorded for the dissemination of the technology by the EAs. The perceived appropriateness of the technology could have influenced this.

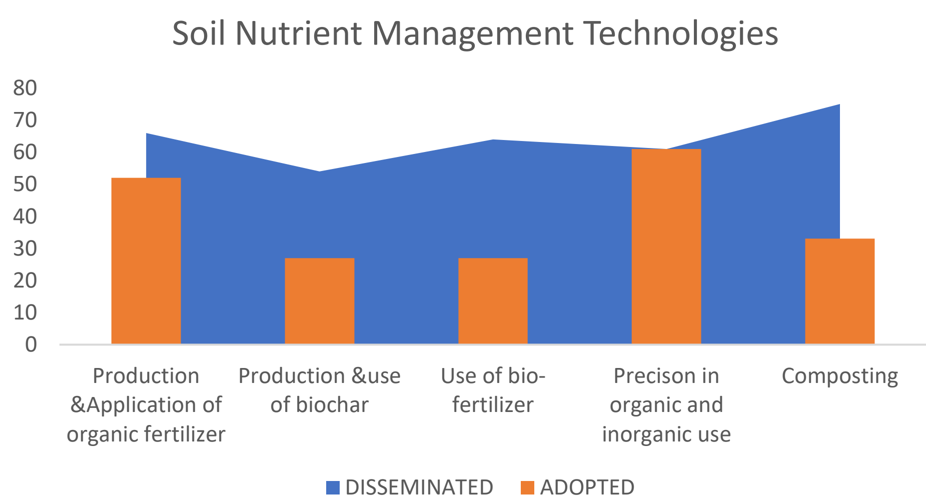

Figure 2: Soil Nutrient Management Technologies disseminated and adopted
Source: Field survey, 2021

3.3. Minimum soil disturbance

For the technologies under minimum soil disturbance category (minimum tillage and no-till), 81.8 and 59.1 percent of EAs respectively disseminated the technologies to the farmers while 66.1 and 18.8 percent of the farmers respectively adopted the technologies. The reason for the low turn-out in the adoption/use of no-till as a means of soil management could be associated with its sole dependence on herbicides for weed management, as the cost of herbicide purchase is presently on the high side and most of the farmers do not have access to farm input subsidy.

This finding contradicts the position of Khairul Alam *et al.* [13] that farmers interest is now being shifted from 'extreme tillage' to 'no-tillage' method for erosion control purposes. As several research have compared the effects of minimum/no tillage with the conventional tillage system, the farmers for this study might have shown less interest in 'minimal soil disturbance' as SSM technology owing to the disadvantages associated. These conservation tillage system as a form of CSA practices has been reported to be part of the solution to mitigate climate change effect and ensure sustainable agriculture through reduction in soil erosion and improvement of soil organic matter content and water storage [14]. Kruger [15] however posited that the system is not without its side effect which include the dependency on herbicides for weed management and problems with different insect, disease, and weed species.

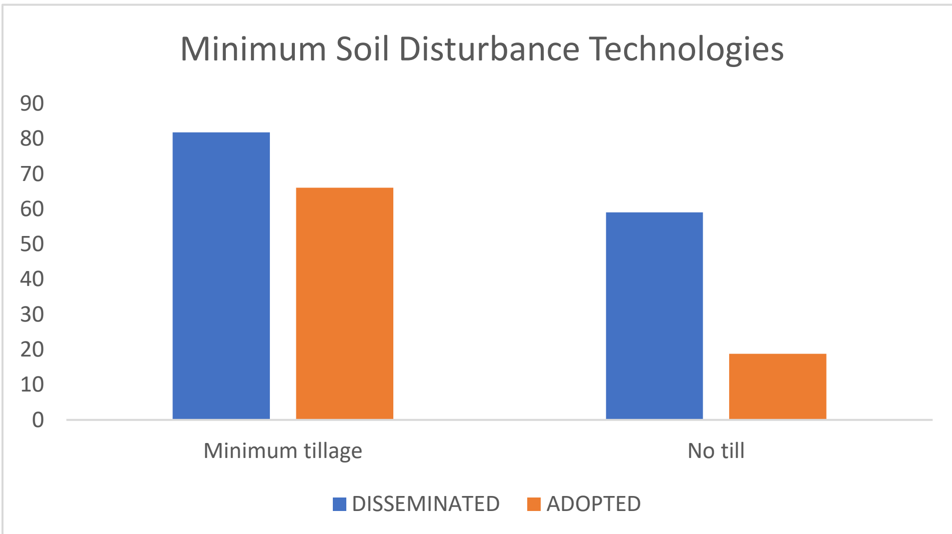

Figure 3: Minimum Soil Disturbance-related Technologies disseminated and adopted
Source: Field survey, 2021

3.4. Water management technique

For the technologies under water management technique, 56.8 percent of the EAs disseminated 'water harvesting from concentrated run-off' to the farmers. However, very few of the farmers (11 percent) adopted the technology. For 'Micro check dams', 34.1 percent of the EAs disseminated the technology while only 7.1 percent of the farmers adopted it. 45.5 percent of the extension agents disseminated tube wells and low-cost PVC-based sprinkler technologies respectively with 12.8 percent and 10.4 percent of the farmers adopting the technologies respectively. This findings among the contact farmers for the study is a clear indication that these 4 technologies under the water management technique were not well adopted/ practiced by the farmers. This could have a correlation with lower percentages recorded for researchers that generated and EAs that disseminated those technologies. High cost of fund associated with the generation, dissemination and practice of water management-related technologies could have also led to the poor responses from the actors.

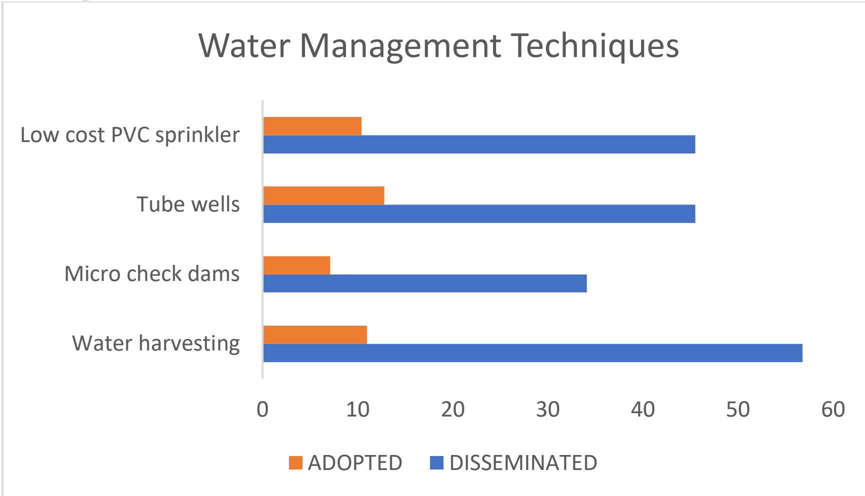

Figure 4: Water Management techniques disseminated and adopted
Source: Field survey, 2021

3.5. Vegetation management

For this category of CSA- sustainable soil management technology, it was observed that most of the extension agents (90.9, 88.6 and 84.1 percent) disseminated 'multiple cropping/ inter-cropping', 'use of improved hybrids planting materials' and 'shifting cultivation' respectively to farmers. Appreciable number of the farmers (84.5 %, 59% and 64 %) also adopted these two technologies respectively. For 'short term fallow with the planting of legumes', barely average of the extension agents (50%) disseminated the technology with less than average of the farmers (44%) adopting the technology. It could however generally be deduced from this result that for SSM technologies in this category, more than average of the farmers were involved. This could be associated with the ease of application and perceived economic benefits of these technologies.

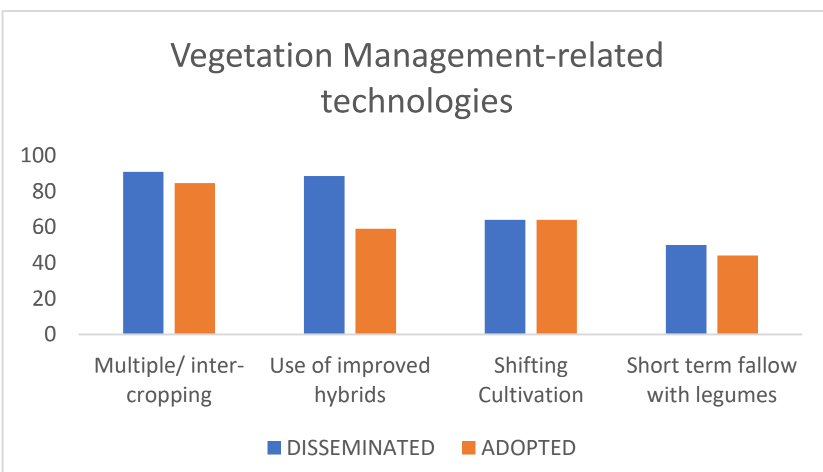

Figure 5: Vegetation Management Technologies disseminated and adopted
Source: Field survey, 2021

3.6. Agroforestry systems

Result in figure 6 showed that majority (86.6%) of the EAs disseminated 'planting of leguminous shrubs' as one of the agroforestry related SSM technologies with majority (78.6%) of the farmers having adopted it. 84.1 percent of the EAs disseminated 'planting of tree crops with barely above average of the farmers (50.3%) adopted the technology. However, the dissemination and adoption of 'trees for bio-drainage' recorded low response with just average (50%) of the EAs having disseminated the technology and 47.9% of the farmers adopted it. This result though is still an indication of farmers' acceptance of agroforestry system as one of the CSA agricultural practices. This appreciable response of farmers in the practice of agroforestry could be justified with the assertion of Amonum *et al.* [16] that Agroforestry is an 'old time' practice that farmers have applied throughout the world. It can be regarded as a societal response, with the primary aim of fulfilling the immediate basic human needs of fuel, fodder, food, shelter, e.t.c.

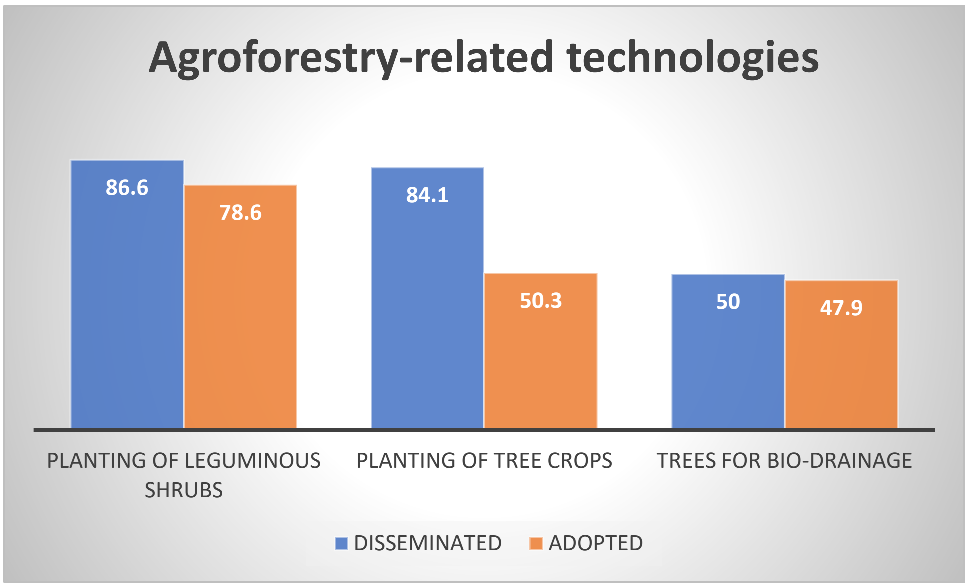

Figure 6: Agroforestry-related Technologies disseminated and adopted
Source: Field survey, 2021

3.7. Appropriateness of SSM technologies disseminated among farmers through the REFILS activities

As noted by Delaney (10), an appropriate technology should be accessible, affordable, easy to use and maintain, effective and serves the real need. These are reflected in tables 2,3,4 and 5 as application suitability, ecological importance, economic importance and sociocultural acceptability.

3.7.1 Application suitability of SSM technologies

Table 2 revealed that 8 (eight) technologies had application suitability, as perceived by the farmers: crop rotation, multiple cropping, planting of legumes, minimum tillage, mulching, use of improved hybrids, precision use of fertilizer and use of vetiver grass. These were all with mean >2.5. This result is a clear indication that farmers perceive these technologies that are easy to adopt or practice as suitable and appropriate and they tend to engage more in them

Table 2: Appropriateness of SSM technologies (application suitability)

SSM Technologies	Perceived Appropriateness (ease of application)	
	Mean	Std. Dev
Soil Erosion Control		
Erosion Chambers	2.17	1.07
Use of vetiver grass and sweet potato strips	2.51*	1.32
Semi-Circular bonds (for slopy areas)	1.59	0.89
Ridge tying and (or) ridging across the slope	1.85	1.12
Mulching	2.96*	1.05
Soil Nutrient Management		
Production and Application of organic fertilizer (Cassava-based and vetiver-based compost)	1.84	1.08
Production & use of biochar	1.37	0.86
Use of bio-fertilizer (Noodles in the roots of plants, Rhizomes)	1.76	0.96
Precision in organic & inorganic fertilizer use (application rate, type and timing)	2.63*	1.10
Composting (Partially Aerated Composting Technique and Accelerated Composting Technique to reduce the period of composting)	1.76	1.06
Minimum Soil disturbance		
Minimum Tillage	2.98	0.97
No-till	2.00	1.19
Water Management		
Water harvesting from concentrated run-offs (for irrigation)	1.75	1.10
Micro-check dams (for irrigation)	1.43	0.79
Tube wells	1.50	0.70
Low-cost PVC-based sprinkler irrigation	1.47	0.84
Vegetation Management		
Choice plant species/ use of improved hybrids	2.84	1.06
Crop rotation	3.20*	0.84
Short term fallow with planting of legumes	2.18	1.11
Multiple cropping, inter-cropping	3.13*	0.90
Shifting cultivation	2.42	1.08
Agroforestry systems		
Planting of leguminous herbs (Moringa, Leucaena, glyricidia, e.t.c	2.98*	0.98
Planting tree crops on croplands	2.84	1.04
Trees for bio-drainage (Live fences and hedge rows)	1.81	1.02

Source: Field Survey, 2021
Mean>2.5=Appropriate

3.7.2. Ecological importance of SSM technologies

Results in Table 3 showed the list of SSM technologies that were perceived by the farmers to have more ecological benefit, with mean >2.5. These were: planting of leguminous herbs, mulching, Multiple cropping, short-term fallow, use of improved hybrid, shifting cultivation, Minimum tillage, use of vetiver grass, precision in fertilizer, and planting of tree crops on cropland . In all, 10 SSM technologies were adjudged by the farmers to have appreciable ecological benefits and importance. This implies that the farmers will tend to adopt more of these identified technologies than others.

Table 3: Perceived appropriateness of SSM technologies (ecological importance)

SSM Technologies	Perceived Appropriateness (ecological benefit)	
	Mean	Std. Dev
SOIL EROSION CONTROL		
Erosion Chambers	2.27	1.33
Use of vetiver grass and sweet potato strips	2.50*	1.31
Semi-Circular bonds (for slopy areas)	2.08	1.03
Ridge tying and (or) ridging across the slope	2.26	1.08
Mulching	2.91*	1.08
Soil Nutrient Management		
Production and Application of organic fertilizer (Cassava-based and vetiver-based compost)	1.60	0.77
Production & use of biochar	2.20	1.24
Use of bio-fertilizer (Noodles in the roots of plants, Rhizomes)	2.50*	2.00
Precision in organic & inorganic fertilizer use (Application rate, type and timing)	2.06	0.98
Composting	2.56*	1.00
Minimum Soil disturbance		
Minimum Tillage	2.58	1.00
No-till	1.66	0.88
Water Management		
Water harvesting from concentrated run-offs (for irrigation)	1.85	1.07
Micro-check dams (for irrigation)	1.5	0.88
Tube wells	1.4	0.78
Low-cost PVC-based sprinkler irrigation	1.83	0.94
Vegetation Management		
Choice plant species/ use of improved hybrids	2.81*	1.03
Crop rotation	3.1	0.90
Short term fallow with planting of legumes	2.84*	1.10
Multiple cropping, inter-cropping	2.85*	0.94
Shifting cultivation	2.81*	1.08
Agroforestry systems		
Planting of leguminous herbs (Moringa, Leucaena, glyricidia,	2.98*	0.84
Planting tree crops on croplands	2.50*	0.90
Trees for bio-drainage (Live fences and hedge rows)	2.08	0.87

Source: Field Survey, 2021
Mean>2.5=Appropriate

3.7.3. Economic importance of SSM technologies

From the results presented in table 4, 12 (twelve) SSM technologies were perceived by the farmers to have higher economic importance. These include crop rotation, planting of leguminous herbs, use of improved hybrids, multiple cropping, minimum tillage, shifting cultivation, short term fallow, planting of trees on cropland, ridging across slope, erosion chambers, and composting. The end-users of these technologies tend to adopt them based on the economic yield and returns derivable from them.

Table 4 : Appropriateness of SSM technologies (economic importance)

SSM Technologies	Perceived Appropriateness (economic benefits) Mean	Std. Dev
SOIL EROSION CONTROL		
Erosion Chambers	2.51*	1.26
Use of vetiver grass and sweet potato strips	2.42	1.26
Semi-Circular bonds (for slopy areas)	2.26	1.08
Ridge tying and (or) ridging across the slope	2.53*	1.12
Mulching	3.18	1.05
Soil Nutrient Management		
Production and Application of organic fertilizer	2.50*	1.23
Production & use of biochar	1.80	0.98
Use of bio-fertilizer (Noodles in the roots of plants, Rhizomes)	1.94	1.10
Precision in organic & inorganic fertilizer use	2.71	1.22
Composting (Partially Aerated and accelerated)	2.50*	1.23
Minimum Soil disturbance		
Minimum Tillage	2.85	1.16
No-till	1.72	0.98
Water Management		
Water harvesting from concentrated run-offs (for irrigation)	2.08	1.16
Micro-check dams (for irrigation)	1.74	1.03
Tube wells	1.68	0.93
Low-cost PVC-based sprinkler irrigation	1.94	1.09
Vegetation Management		
Choice plant species/ use of improved hybrids	2.93*	1.20
Crop rotation	3.20*	1.05
Short term fallow with planting of legumes (to be ploughed back into the soil as manure)	2.70*	1.09
Multiple cropping, inter-cropping	2.91*	0.87
Shifting cultivation	2.74*	1.06
Agroforestry systems		
Planting of leguminous herbs (Moringa, Leucaena, glyricidia, e.t.c	3.16*	0.92
Planting tree crops on croplands	2.64*	1.07
Trees for bio-drainage (Live fences and hedge rows)	2.34	1.34

Source: Field Survey, 2021 *Mean>2.5=Appropriate

3.7.4. Socio cultural acceptability

The SSM technologies perceived to be appropriate by the farmers based on their acceptability socio-culturally include mulching, crop rotation, Planting of leguminous herbs, shifting cultivation, multiple cropping, short term fallow, tree crops on crop lands, minimum tillage, use of improved hybrid, Precision fertilizer application, use of vetiver grass or potato strips, erosion chambers and ridging across the slope. FGD information revealed that these listed SSM technologies had their histories in their indigenous ways/ practices of soil improvement. The technologies were seen to be adopted by farmers as 're-introduction' by the extension agents to the farmers. This is a clear indication that farmers who are the end-users/ direct beneficiaries of the SSM technologies will adopt and promote those practices that have antecedents in their socio-cultural beliefs and norms. Thus, the research scientists and Extension Agents are supposed to build on this to upscale these identified technologies among the farmers.

Table 5: Appropriateness of SSM technologies (socio-cultural acceptability)

SSM Technologies Perceived Appropriateness (socio-cultural acceptability)	Mean	Std. Dev
SOIL EROSION CONTROL		
Erosion Chambers	2.57*	1.31
Use of vetiver grass and sweet potato strips	2.65*	1.38
Semi-Circular bonds (for slopy areas)	2.25	1.10
Ridge tying and (or) ridging across the slope	2.53*	1.21
Mulching	3.22*	1.15
Soil Nutrient Management		
Production and Application of organic fertilizer	2.19	1.13
Production & use of biochar	2.12	1.13
Use of bio-fertilizer (Noodles in the roots of plants, Rhizomes)	1.84	0.84
Precision in organic & inorganic fertilizer use	2.69*	1.07
Composting (Partially Aerated and accelerated	2.39	1.17
Minimum Soil disturbance		
Minimum Tillage	2.73*	1.05
No-till	1.55	0.85
Water Management		
Water harvesting from concentrated run-offs (for irrigation)	1.70	0.91
Micro-check dams (for irrigation)	1.55	0.75
Tube wells	1.69	0.96
Low-cost PVC-based sprinkler irrigation	1.86	1.95
Vegetation Management		
Choice plant species/ use of improved hybrids	2.70*	1.07
Crop rotation	3.13*	0.82
Short term fallow with planting of legumes	2.88*	1.15
Multiple cropping, inter-cropping	3.00*	0.91
Shifting cultivation	3.06*	1.08
Agroforestry systems		
Planting of leguminous herbs (Moringa, Leucaena,	3.07*	0.88
Planting tree crops on croplands	2.82*	0.89
Trees for bio-drainage (Live fences and hedge rows)	2.40	1.04

Source: Field Survey, 2021* Mean>2.5=Appropriate

4. Conclusions and Recommendations

Findings of the study identified a total of 24 Climate-Smart SSM technologies categorized as Soil Erosion Control, Soil Nutrient Management, Minimum Soil Disturbance, Water Management Techniques, Vegetation Management and Agroforestry System to have been disseminated and adopted among the farmers. Some of the technologies were perceived to be appropriate by the farmers based on their application suitability, ecological importance, economic importance and socio-cultural acceptability. Some of these technologies such as mulching, ridge tying, and composting were identified to be indigenous technologies, hence their cultural acceptability by the end users. It is concluded that the farmers' perceived appropriateness of the technologies disseminated influenced their efforts towards involvement in activities that would promote the widespread adoption. For a CSA transition.

It is therefore recommended that Research institutes and Extension Personnel in ADP should synergize efforts towards the promotion of SSM technologies that are perceived to be appropriate by the farmers, especially in terms of 'ease of application and socio-cultural suitability. As the upscale of SSM technologies requires a multi-stakeholder' approach, implementers of the Research-Extension-Farmer-Input Linkage System (REFILS) should ensure adequate synergy among Sustainable Soil Management (SSM) actors. The participation of farmers in linkage activities that promotes SSM technologies should be ensured through proper integration of the contact farmers of ADP into REFILS programme and sponsorship to attend REFILS activities, especially the annual REFILS workshop and Agric shows. It is also recommended that policy on Research-Extension-Farmer-Input Linkage system (REFILS) should be developed to achieve a well-organized structure and delivery of SSM upscale and governance among the end-users. As the adoption of Sustainable Soil Management Technologies is a nexus of Climate Change adaptation and mitigation strategies, the identified appropriate SSM technologies should therefore be prioritized by SSM implementers to achieve the targeted advances in Climate Smart Agriculture (CSA). Adoption of the identified and appropriate SSM technologies should be promoted among the farmers as a necessity for the transition to CSA.

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