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Dissemination Approaches that Enhance Adoption of Climate Resilient TIMPS for Pigeon Pea, Sorghum and Green Grams Value Chains in Machakos County, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Dissemination approaches play a key role in facilitating the adoption of climate smart technologies, innovations and management practices among farmers. Various approaches used in Kenya include the top down approaches and bottom up approaches. This study was conducted to determine and

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validate dissemination approaches that enhance sustainable adoption of climate resilient TIMPs for Sorghum, Green grams and pigeon peas value chains among farmers in Machakos county. The objectives included: to Identify dissemination approaches for TIMPS in sorghum, green grams and pigeon peas in Machakos county, to assess the frequency of use of dissemination approaches for TIMPS by stakeholders and to determine the stakeholders' perception on the effectiveness of the dissemination approaches for TIMPS. The study used a survey research design where 27 key informants comprising champion farmers and extension service providers were purposively selected for data collection. The descriptive analysis was conducted using the SPSS version 16. A weighted index was computed to aid comparison for various values chains and categories. The results showed that farmer-to-farmer (96%) and T&V (88.9%) dissemination approaches were the frequently used dissemination approaches whereas education institution (14.81%) was the least used dissemination approach in the three value chains in the county. Farmer to farmer effectiveness was ranked highest in Sorghum and Green grams while the T&V was highest for Pigeon peas Enhanced utilization of farmer-to-farmer, T&V and demand driven dissemination approaches for enhance adoption of green grams, pigeon peas and sorghum for improved productivity and household income.

Keywords: Climate smart TIMPS; dissemination approaches; utilization; adoption.

1. INTRODUCTION

Agricultural dissemination approaches in developing countries play a key role in facilitating the adoption of climate smart technologies, innovations and management practices among farmers. Over the years, agricultural organisations in the public and private sector have developed different extension approaches for disseminating information to farmers. The extension approaches mainly focuses on how knowledge and skills are shared with farmers [1]. Extension aims to increase the efficiency of the family farm, increase production and generally increase the standard of living of the farm family [2]. Various approaches used in Kenya include the top down approaches such as training and visit approach and farm visits and bottom up approaches such as commodity based approach [3]. Public extension service providers aim to empower rural farmers with knowledge and skills as a sustainable way of curbing chronic poverty prevalence [4]. In Kenya, the extension service providers include the Ministry of agriculture, livestock and fisheries (MoALF), Universities and Kenya Agricultural and Livestock Research Organisation (KALRO) while private service providers include non-commercial extension service providers such as non-governmental organisations, faith-based initiatives and community-based organisations (CBOs) and commercial providers such as private practitioners and input suppliers. The services are mainly commercial and profit oriented and they mostly afforded by successful farmers in high potential areas [5]. Various climate smart technologies, innovations and practices have been developed by KALRO in collaboration with other partners to improve green grams, pigeon peas and sorghum productivity and yields in the country [6]. They include improved varieties, integrated pest and disease and soil fertility management practices and use of ITK in production and postharvest management. However, most of the technologies, innovations and practices do not reach the farmers mainly due to weak link between research, extension and farmers resulting to inadequacy in accessing the technologies, innovations and management practices [7].

The low adoption of TIMPs has led to increased food insecurity and poverty among the rural people. Additionally, the applicable dissemination approaches and the effectiveness of the dissemination approaches needs to be determined. Increased adoption of the TIPMs is important for poverty reduction and increased food and nutrition security for farming households especially in Machakos County. For increase sorghum, pigeon peas and green grams' production, therefore, farmers need to be updated on information available regarding the various production processes and TIMPS.

The objective of the study was to determine and validate dissemination approaches that enhance sustainable adoption of climate resilient TIMPs for Sorghum, Green grams and pigeon peas value chains among farmers in Machakos county. This paper reports the dissemination approaches for TIMPS in sorghum, green grams and pigeon peas in Machakos county. The specific objectives included Identification of

dissemination approaches for TIMPS in sorghum, green grams and pigeon peas in Machakos county, assessment of the frequency of use of dissemination approaches for TIMPS by stakeholders and to determine the stakeholders' perception on the effectiveness of the dissemination approaches for TIMPS.

2. METHODOLOGY

2.1 Study Sites

The study was carried out in Machakos County which is part of the KCSAP Counties covered in the KCSAP Project. The county has an area of 6208.2 Km² most of which is semi-arid. The county has eight Sub counties/ constituencies namely; Masinga, Yatta, Kangundo, Matungulu, Kathiani, Mavoko, Machakos Town/ Kalama and Mwala. The county has a total of 40 Wards and 69 Locations. It lies between latitudes 0º45´South and 1º31´South and longitudes 36º45´East and 37º45´East. Kalama, Mwala, and Yatta Sub-counties were selected for the study (these are shown in Fig. 1). The three sub-counties fall within agro-ecological zones UM2-UM4 and LM2-LM5 [8]. Rainfall is bimodal with short rains from October to December and long rains from March to May. Rainfall varies between 500-750mm per annum. The soils are mainly sandy loam with marrum. The slope of the land ranges from gentle to fairly steep. The major economic activities in the Sub-counties include livestock production (dairy, local zebu animals, sheep, goats and indigenous poultry) and crop farming. The major crop enterprises include maize, beans, cow peas, pigeon peas, green grams, sorghum and horticultural crops such as mangoes, pawpaw, onions and tomatoes. The study focused on dissemination approaches for three values chains pigeon peas, green grams and sorghum.

2.2 Sampling Frame, Sampling and Sample Size Determination

The sampling frame consisted of champion farmers and extension service providers in the three sub-counties; Kalama, Mwala and Yatta in machakos county. The three sub-counties each had two KCSAP Wards where the targeted TIMPs were disseminated and were being produced in the selected sub-counties. The sub county agricultural officers guided the purposeful selection of 6 champion farmers and 3 extension service providers for each of the value chain. A total of 27 key informants were the respondents.

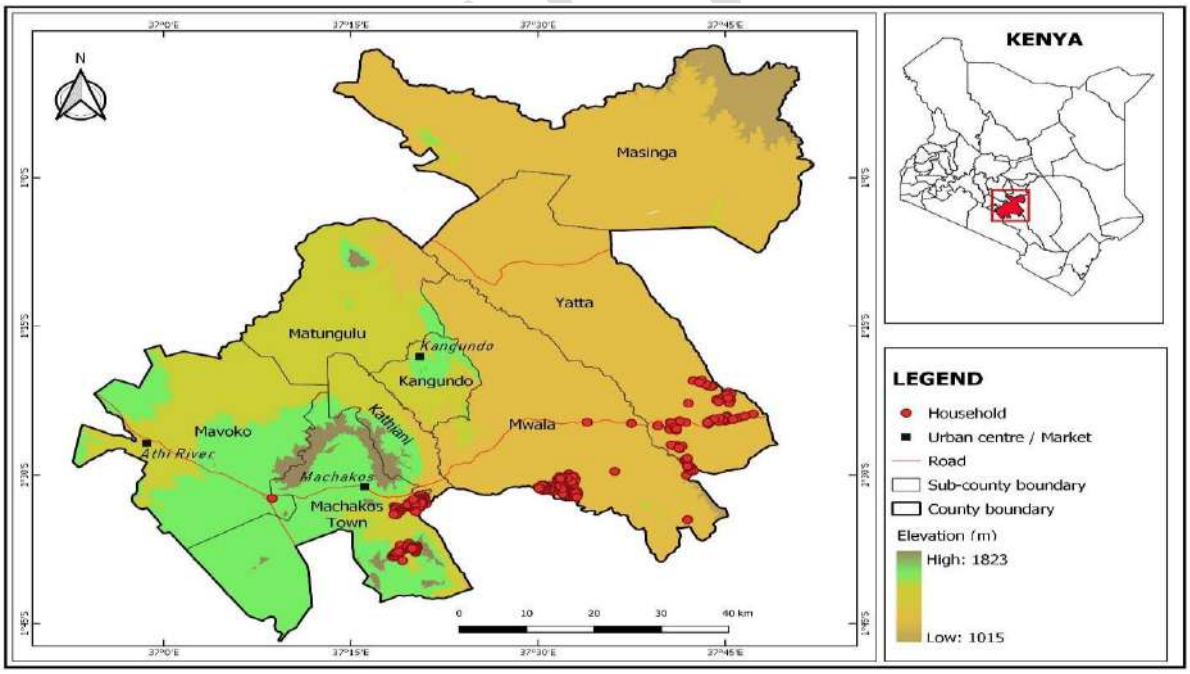

Fig. 1. Map of Machakos showing the study sites
Source: Survey data, map prepared by KALRO GIS Lab

The effectiveness of extension dissemination approaches for the TIMPs were evaluated using the following criteria; Increased technology uptake, Increased Production, Increased food availability, The Multiplier effect inn information sharing, Increased sales of commodities, Training Sessions, Workshops held, Research extension linkage meetings, Input Provisions, Credit Provision, Marketing outlets, Provision of essential services, Adoption of technology, farmer participation and Farm Productivity or Yield.

2.2.1 Data collection

The tool used for data collection was a questionnaire that was administered to the champion farmers and the extension service providers. The questionnaire was designed in search away that the respondent would identify a dissemination approach and score on the effectiveness of the criteria as listed. The scores scale was: 1 = decreased, 2= remained the same and 3= increased.

The enumerators were engaged and trained to assist in questionnaire administration and data collection. The training was conducted by the project PIs and the agricultural extension officers. The enumerators were drawn from the pool of individuals identified in KCSAP project areas and who were familiar with the project.

2.2.2 Data analysis methods

Descriptive analysis of the data collected was done using the statistical package for social sciences. The indices were generated for weighting and ranking of the dissemination approaches based on the aggregated score for each dissemination approach. Using the weighted mean as per the equation below, the ranking was done to show the preferred dissemination approach for each value chain.

W= sum(Wi. xi) / sum(n*wi)

W= weighted average
n= number of terms to be averaged
w=weights applied on x-values
x= data values to be average

Descriptive statistics was generated using SPSS version 16. Data was analysed to generate means and frequencies which gave the description of categories and the criteria pathways.

3. RESULTS AND DISCUSSIONS

3.1 Identification of Dissemination Approaches for TIMPS in Sorghum, Green Grams and Pigeon Peas in Machakos County

According to the results of the key informants' interviews, various dissemination approaches were identified (Table 1) for the selected value chains as follows; Farmer to farmer, Training and visit (T&V), General agriculture approach, Research Extension farmer linkage, Commodity based approach, Farmer participatory approach, farming systems, Demand driven, Farmer Field School, Innovation platform, Cost sharing, Education institution. These approaches were used in different proportions by different stakeholders in the selected value chains. Waddington et al. [9] reported that the ultimate goal of adoption of extension approach is to increase farmers' productivity and income.

Table 1. Identification of dissemination approaches

Dissemination Approach	Champion farmers	Extension Service providers
Farmer to farmer	1	1
Training and Visit	1	1
Demand driven	1	1
General agriculture approach	1	1
Research Extension farmer linkage	1	1
Farmer participatory approach	1	1
Innovation platform	1	1
Farmer Field School	1	1
Commodity based approach	1	1
Farming systems	1	1
Focal area/project	1	1
Cost sharing	1	1
Education institution	1	1

1= Identified; 0 = unidentified

3.2 Assessment of the Frequency of Use of Dissemination Approaches for TIMPS

The results of the pooled use frequency of the different dissemination approaches by the different user categories (champion farmers and extension service providers) showed that farmer-to-farmer was the most used (96%),

followed by T&V (88.9%) and Demand driven approach (70.4%) as shown in Table 2. In the championed farmer category, the same pattern was observed while in the extension service providers' category, the third dissemination approaches frequently used were farmer participatory and focal area. The user frequency of some of the dissemination approaches were less than 50%. These included educational institution, cost sharing, focal area, farming systems, commodity based and farmer field school. The findings confirms that the approaches with greater farmer contact and entails better trained extension agents [10] are preferred.

The results of the use frequency of the different dissemination approaches by the selected value chains showed that farmer-to-farmer (100%) was the most used in green gram, followed by T&V (87.50%) and Demand driven approach (75%). In the pigeon pea value chain, the most frequently used dissemination approach was farmer-to-farmer (90%), followed by T&V (90%) followed by demand driven (80%). In the sorghum value chains the most frequently used was the farmer-farmer extension approach (100%), followed by T&V (90%), followed by demand driven approach (100%) as shown in Table 3. According to Waddington et al. [9], various approaches are used simultaneously.

Table 2. Frequency of use of dissemination approaches by the champion farmers and extension service providers in Machakos county

Dissemination Approaches	Champion farmers		Extension service provider		Pooled	
	Frequency	%	Frequency	%	Frequency	%
Farmer to farmer	18	94.74	8	100	26	96.30
T&V	16	84.21	8	100	24	88.89
Demand driven	13	68.42	6	75	19	70.37
General agriculture approach	11	57.89	6	75	17	62.96
Research Extension farmer linkage	10	52.63	4	50	14	51.85
Farmer participatory approach	7	36.84	7	87.5	14	51.85
Innovation platform	8	42.11	6	75	14	51.85
Farmer Field School	7	36.84	6	75	13	48.15
Commodity based approach	9	47.37	3	37.5	12	44.44
Farming systems	6	31.58	5	62.5	11	40.74
Focal area/project	3	15.79	7	87.5	10	37.04
Cost sharing	3	15.79	4	50	7	25.93
Education institution	1	5.26	3	37.5	4	14.81

Table 3. Frequency of use of dissemination approaches in the selected value chains in Machakos county

Dissemination Approaches	Green Grams		Pigeon peas		Sorghum	
	Frequency	%	Frequency	%	Frequency	%
Farmer to farmer	8	100.00	9	90.00	9	100.00
T&V	7	87.50	9	90.00	8	88.89
Demand driven	6	75.00	8	80.00	5	55.56
General agriculture approach	3	37.50	7	70.00	7	77.78
Research Extension farmer linkage	3	37.50	7	70.00	4	44.44
Farmer participatory approach	5	62.50	7	70.00	2	22.22
Innovation platform	2	25.00	6	60.00	5	55.56
Farmer Field School	2	25.00	6	60.00	5	55.56
Commodity based approach	4	50.00	4	40.00	4	44.44
Farming systems	2	25.00	4	40.00	5	55.56
Focal area/project	3	37.50	4	40.00	3	33.33
Cost sharing	1	12.50	3	30.00	3	33.33
Education institution	0	0.00	2	20.00	2	22.22

3.3 Determination of the Stakeholders' Perception on the Effectiveness of the Dissemination Approaches for TIMPS per Value Chain

The results on the effectiveness of the dissemination approaches per value chains according to the perceptions of the champion farmers and the extension service providers were reported according to the effectiveness index.

3.3.1 Sorghum value chain

Most of the dissemination approaches were identified in the sorghum value chain. According to the perceptions of champion farmers, the most effective dissemination approaches was farmer to farmer, followed by T& V which was followed by General agriculture approach respectively Weighted effectiveness as shown in Table 4. The use of farmers to train farmers has been widely used especially in the context of a project and has been found successful in disseminating knowledge and technologies to other farmers. Study carried out in Uganda [11] showed that it depended on the farmer facilitators for its success.

According to the perceptions of the extension provider, the most effective extension approach in the sorghum value chain in Machakos County was the Focal area approach followed by general agriculture approach followed by Farmer field school approach as shown in Table 5. The focal area perform a significant part in enhancing the flow of data from farmers to researchers [12].

When the pooled sample was used (champion farmer and extension provider), the most effective approach changed. The farmer-to-farmer approach was ranked the best followed by T&V which was followed by general agriculture approach respectively as shown in Table 6. The approaches are more farmer engaging as reported by Ssemakula and Mutimba [11].

Table 4. Ranking of the effectiveness of dissemination approaches for sorghum value according to the Champion farmer in Machakos County, n=6

Extension approaches	Weighted effectiveness index	Rank
Farmer to farmer	6.78	1
T&V	5.83	2
General agriculture approach	4.75	3
Research Extension farmer linkage	3.75	4
Commodity based approach	3.61	5
Farmer participatory approach	3.61	6
Farming systems	3.42	7
Demand driven	2.42	8
Farmer Field School	2.31	9
Innovation platform	2.17	10
Cost sharing	1.25	11
Education institution	1.11	12

Table 5. Ranking of the effectiveness of dissemination approaches for sorghum value chin according to the Extension Provider in Machakos County, n=3

Extension approaches	Weighted effectiveness index	Rank
Focal area	7	1
General agriculture approach	6.39	2
Farmer Field School	6.22	3
Farmer to farmer	6.22	4
Innovation platform	6.17	5
T&V	5.89	6
Demand driven	5.17	7
Farmer participatory approach	4.67	8
Farming systems	4.56	9
Cost sharing	3.89	10
Commodity based approach	1.89	11
Education institution	1.39	12
Research Extension farmer linkage	1.06	13

Table 6. Ranking of the effectiveness of dissemination approaches for sorghum according to the perspective of both Extension Provider & Champion farmers in Machakos County, n=9

Extension approaches	Weighted effectiveness index	Rank
Farmer to farmer	6.59	1
T&V	5.85	2
General agriculture approach	5.30	3
Farming systems	3.80	4
Farmer Field School	3.61	5
Innovation platform	3.5	6
Demand driven	3.33	7
Commodity based approach	3.04	8
Research Extension farmer linkage	2.69	9
Focal area	2.33	10
Cost sharing	2.13	11
Farmer participatory approach	1.56	12
Education institution	1.20	13

Table 7. Ranking of the effectiveness of dissemination approaches for Pigeon pea according to the perspective of the Champion farmer in Machakos County, n=7

Extension approaches	Weighted effectiveness index	Rank
Farmer to farmer	5.81	1
T&V	5.76	2
Demand driven	5.10	3
Farmer participatory approach	4.00	4
Research Extension farmer linkage	3.98	5
General agriculture approach	3.45	6
Farmer Field School	2.21	7
Commodity based approach	2.07	8
Focal area	1.95	9
Innovation platform	1.86	10
Farming systems	1.00	11
Cost sharing	1.00	12
Education institution	0.00	13

Table 8. Ranking of the effectiveness of dissemination approaches for Pigeon pea according to the perspective of the Extension Provider in Machakos County, n=3

Extension approaches	Weighted effectiveness index	Rank
Farmer Field School (FFS)	7.11	1
Research Extension farmer linkage	7.06	2
T&V	7.00	3
Demand driven	7.00	4
Farmer participatory approach	6.94	5
Farmer to farmer	6.83	6
Innovation platform	6.83	7
General agriculture approach	6.33	8
Farming systems	6.06	9
Focal area	4.61	10
Commodity based approach	4.56	11
Education institution	4.56	12
Cost sharing	3.33	13

3.3.2 Pigeon pea value chain

In the pigeon pea value chain, the weighted effectiveness index indicted that farmer-to-farmer extension approach was the most effective, followed by T&V and which was followed by demand driven approach according to the perceptions of the champion farmers involved in the pigeon pea value chain in Machakos County as shown in Table 7. This confirms agrees with Ssemakula and Mutimba [11] that approaches with farmer contact are used frequently.

According to the perceptions of the extension providers in the pigeon pea value chain, the most effective extension approach was FFS followed by Research extension-farmer linkage, followed by T&V and fourth was demand driven approach as shown in Table 8. A farmer field school takes place in one of the farmer's fields for the duration of one cropping season. It is a form of participatory research that uses a season long group-based learning process [13].

According to the ranking by both Champion farmers and Extension providers, the most effective extension approaches were T&V, followed by demand driven extension approach followed by Research-Extension-Farmer-linkage respectively as shown in Table 9. Training and Visit informs on the adoption of improved varieties which concentrates on the transmission of knowledge through a top to the bottom (Davis et al., 2016).

3.3.3 Green gram value chain

In the green gram value chain according to the ranking done by the champion farmers and extension providers, the most effective extension approach was farmer to farmer, followed by T&V then demand driven approach respectively as shown in Table 10. The demand driven approach is mainly promoted through contracted farming as noted by Mukasa [14].

According to the ranking done by extension providers, the most effective extension approach in the green gram value chain was T&V followed by Farmer- to-farmer extension approach and thirdly Farmer participatory approach as shown in Table 11. In the case of green gram value chain, there were only four approaches, which the extension providers identified and ranked. The farmer focused approaches are more preferred as reported by Ssemakula and Mutimba [11].

Table 9. Ranking of the effectiveness of dissemination approaches for Pigeon pea according to both champion farmers and Extension Providers in Machakos County, n=10

Extension approaches	Weighted effectiveness index	Rank
T&V	6.13	1
Farmer to farmer	6.12	2
Demand driven	5.67	3
Research Extension farmer linkage	4.90	4
Farmer participatory approach	4.88	5
General agriculture approach	4.32	6
Farmer Field School	3.68	7
Innovation platform	3.35	8
Commodity based approach	2.82	9
Focal area	2.75	10
Farming systems	2.52	11
Cost sharing	1.70	12
Education institution	1.37	13

Table 10. Ranking of the effectiveness of extension approaches for Green gram according to the Champion farmer in Machakos County, n=6

Extension approaches	Weighted effectiveness index	Rank
Demand driven	6.50	1
Farmer to farmer	6.25	2
T&V	5.42	3
Commodity based approach	4.36	4
Research Extension farmer linkage	3.28	5
Farmer participatory approach	3.22	6
Innovation platform	3.19	7
General agriculture approach	2.36	8
Farming systems	2.28	9
Farmer Field School	2.19	10
Cost sharing	1.22	11
Focal area	0.92	12

According to the ranking by both Champion farmers and Extension providers, the most effective extension approaches in the green gram value chain were Farmer to farmer and T&V, followed by demand driven extension approach followed by Research-Extension-Farmer-linkage respectively as shown in Table 12. According to Davis et al. [13], new technologies and innovations such as improved from top to down are enhanced.

3.4 Assessment of the Effectiveness of Dissemination Approaches

Both champion farmers and Extension providers found that the most effective extension approach was farmer-to-farmer, followed by T&V and thirdly demand driven extension approach as shown in Table 13. In combined (both the champion farmer and the extension) category, the most effective extension approaches are the

Table 11. Ranking of the effectiveness of dissemination approaches for Green gram according to the Extension Provider in Machakos County, n=3

Extension approaches	Weighted effectiveness index	Rank
T&V	6.50	1
Farmer to farmer	6.25	2
Farmer participatory approach	6.25	3
Focal area	6.08	4

Table 12. Ranking of the effectiveness of dissemination approaches for Green gram according to the perspective of both champion and Extension Provider in Machakos County, n=8

Extension approaches	Weighted effectiveness index	Rank
Farmer to farmer	6.25	1
T&V	5.69	2
Demand driven	4.88	3
Farmer participatory approach	3.98	4
Commodity based approach	3.27	5
Research Extension farmer linkage	2.46	6
Innovation platform	2.40	7
Focal area	2.21	8
General agriculture approach	1.77	9
Farming systems	1.71	10
Farmer Field School	1.65	11
Cost sharing	0.92	12

Table 13. Ranking of the effectiveness of dissemination approaches for both the champion farmers and extension providers in Machakos County, n=27

Extension approaches	Weighted effectiveness index	Rank
Farmer to farmer	6.31	1
T&V	5.91	2
Demand driven	4.65	3
General agriculture approach	3.89	4
Farmer participatory approach	3.51	5
Research Extension farmer linkage	3.44	6
Innovation platform	3.12	7
Farmer Field School	3.06	8
Commodity based approach	3.02	9
Farming systems	2.70	10
Focal area	2.45	11
Cost sharing	1.61	12
Education institution	0.91	13

Table 14. ANOVA table on the effectiveness of dissemination approaches

Dissemination approach	Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Farmer to farmer	Between Groups	40.34444	2	20.17222	0.25530	0.7768
	Within Groups	1896.32222	24	79.01343		
	Total	1936.66667	26			
Train and Visit	Between Groups	33.30278	2	16.65139	0.08874	0.9154
	Within Groups	4503.36389	24	187.64016		
	Total	4536.66667	26			
Farmer field school	Between Groups	814.22500	2	407.11250	1.00545	0.3808
	Within Groups	9717.77500	24	404.90729		
	Total	10532.00000	26			
Commodity based	Between Groups	33.07685	2	16.53843	0.03538	0.9653
	Within Groups	11220.33056	24	467.51377		
	Total	11253.40741	26			
General Agriculture	Between Groups	1999.66944	2	999.83472	3.13496	0.0617
	Within Groups	7654.33056	24	318.93044		
	Total	9654.00000	26			
Focal Area	Between Groups	53.62963	2	26.81481	0.06450	0.9377
	Within Groups	9978.00000	24	415.75000		
	Total	10031.62963	26			
Farmer participatory	Between Groups	1979.98796	2	989.99398	2.58457	0.0963
	Within Groups	9192.97500	24	383.04063		
	Total	11172.96296	26			
Research extension farmer linkage	Between Groups	1229.50741	2	614.75370	1.48241	0.2472
	Within Groups	9952.78889	24	414.69954		
	Total	11182.29630	26			
Farming systems	Between Groups	684.71111	2	342.35556	0.83689	0.4453
	Within Groups	9817.95556	24	409.08148		
	Total	10502.66667	26			
Demand driven	Between Groups	948.35185	2	474.17593	1.30335	0.2902
	Within Groups	8731.50000	24	363.81250		
	Total	9679.85185	26			

Dissemination approach	Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Cost sharing	Between Groups	228.84444	2	114.42222	0.36994	0.6946
	Within Groups	7423.15556	24	309.29815		
	Total	7652.00000	26			
Education Institutions	Between Groups	341.51111	2	170.75556	0.92193	0.4114
	Within Groups	4445.15556	24	185.21481		
	Total	4786.66667	26			
Innovation Platform	Between Groups	216.85463	2	108.42731	0.26369	0.7704
	Within Groups	9868.77500	24	411.19896		
	Total	10085.62963	26			

same that is the most effective approach was farmer-to-farmer followed by T&V extension approaches. The education institution was ranked as the least effective since the approach is quite costly and somewhat inflexible in its timing of scheduled visits as reported by Chambers et al. [15].

The analysis of variance shows that there was no significant variation among the value chains in farmer to farmer, Train and visit, Commodity based, focal area, cost sharing and innovation dissemination approaches at $\alpha < 0.05$ (Table 14). The bottom up farmer approaches applies among the value chains. This analysis agrees with Dube [16] that farmers have confidence with information from other farmers.

4. CONCLUSIONS

The champion farmers' and extension service providers' analysis showed that generally, all extension approaches were in use in Machakos County. Regarding the effectiveness criteria used in the analysis, green grams, sorghum and pigeon peas extension approaches tended to be more participatory. The most common extension approaches used by both champion farmers and extension service providers key informants were farmer to farmer, T&V, Demand driven, farmer participatory, research extension linkage, general agriculture and farmer field schools.

Various dissemination approaches were used in different proportions by different stakeholders in the selected value chains as follows; Farmer to farmer, Training and visit (T&V), General agriculture approach, Research Extension farmer linkage, Commodity based approach, Farmer participatory approach, farming systems, Demand driven, Farmer Field School, Innovation platform, Cost sharing, Education institution.

The farmer-to-farmer, T&V and demand driven dissemination approaches were the frequently used dissemination approaches whereas education institution was the least used dissemination approach in the three value chains in the county. Enhanced utilization of farmer-to-farmer, T&V and demand driven dissemination approaches for enhanced adoption of green grams, pigeon peas and sorghum for improved productivity and household income was recommended.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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