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Research Article

Maize Farmers Perceptions towards Organic Soil Management Practices in Bungoma County, Kenya

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Abstract: The objective of the study was to evaluate maize farmers' perceptions towards organic soil management practices in Bungoma County. A simple random sampling technique was used to select a sample of 650 smallholder farmers and primary data was collected using observations and interviews with the help of a semi-structured schedule. In the analysis, a Likert-type five-point continuum scale was used to rank farmers perceptions with one (1) as the most and five (5) as the worst check. The results showed that farmers were invariably concerned about the environment and were interested in protecting agricultural resources both for the present use and for future generations. Application of green manure and cultivation of legume crops were perceived to improve soil fertility and soil structure. Further, agrochemicals were perceived to have a negative effect on both human and animal health and their over-application leads to development of pest resistance to pesticides. The study revealed a relationship between perception towards organic soil management practices and some socio-economic and institutional factors such as age, education, household size, extension, training and farm distance. The study recommends policy interventions in enhancing farmers' awareness through training and technical advice on organic farming practices through agricultural extension services and developing information networks among farmers.

Keywords: Maize farmers, organic soil management practices, perception

INTRODUCTION

Soil nutrient depletion and poor land management systems are among the major causes of low agricultural productivity in Kenya. To address the problem of nutrient depletion, majority of farmers apply synthetic fertilizer. However, the use of such inputs has led to environmental pollution, loss of indigenous crop diversity and poor health among rural people (Kimemia and Oyare, 2006). Alternatively, Organic Agriculture (OA) is a farming system that promotes and enhances an ecosystem's health while minimizing adverse effects on natural resources (IFOAM, 2006). Organic agriculture does not rely on synthetic materials but employs agronomic, biological and mechanical methods that are sustainable and environmentally friendly (FAO and IFOAM, 1998). High cost of inputs, especially fertilizer has led to decreased usage resulting to low production of staples such as maize and rice.

Organic soil management depends on natural breakdown of organic matter in the soil using techniques like green manure and compositing to replace nutrients taken from the soil by previous crops (FAO and IFOAM, 1998). To maintain and improve soil fertility status OA uses a range of techniques such as mulching, use of FYM, organic fertilizers, cover cropping, agro forestry, crop rotation, multiple cropping, planting of leguminous crops and agro forestry and incorporation of crop residues in the soil (GoK, 2007). In addition, organic farmers use dung and compost manures to provide nutrients and terracing or check-dams to prevent erosion and conserve groundwater (GoK, 2007). They also cover their soils with dead or living vegetation and therefore OSMP has been found to restore degraded lands to fertility (Kilcher, 2007).

To overcome declining output resulting from decreasing soil fertility and productivity, farmers need to improve their production techniques. The decision to participate in new agricultural technologies depends on farmer's perception which is a key determinant in influencing adoption (Negatu and Parikh, 1999; Adesina and Baidu-Forson, 1995). Technology adoption is also influenced perceived by profitability, costs of the technology and clarity at which the new knowledge and information is communicated in a recipient population (Boahene *et al*., 1999). Farmers' perceptions regarding compatibility of sustainable practices with their farming systems have emerged as the best predictor of adoption of such practices (Alonge

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and Martin, 1995). Since perception refers to an individual's current appraisal of an object or program, assessing farmers' perceptions is an important means to evaluate their knowledge level on a particular issue (Hikson and Keith, 2000). People base their perceptions on past experience and knowledge thus, if a person has limited knowledge and experience about a technology then he cannot accurately perceive it or form an opinion on it (May, 1969). If farmers are to adopt sustainable agricultural practices such as OSMP, they need to believe the practices are important.

Future strategies for increasing agricultural production should focus on using available natural resources more efficiently, effectively and sustainably than in the past (Gruhn *et al*., 2000). Given evidence indicate that OSMP have multiple benefits including reduction in production costs, environmental benefits and increased food production. The greatest constraints faced by poor farmers on the road to OSMP are lack of knowledge, access to markets, certification and agricultural inputs (Kilcher, 2007). In Bungoma County, OSMP has been supported by SACRED Africa, an indigenous NGO, with an aim of improving the livelihoods of resource-poor farmers, promote sustainable use of natural resources and agro-biodiversity that seek to enhance food security and safety. Farmers are trained on sustainable agriculture such as OSMP with emphasis on natural soil fertility management, integrated environmentally friendly weed, pest and disease protection, on-farm soil and water conservation techniques and farm level seed conservation. Restoration as well as maintaining soil fertility status is an important strategy towards achieving high farm productivity. Indigenous organic soil fertilization is common knowledge but this is practiced by a few farmers in Kenya. This study was therefore geared towards determining farmers' perceptions towards OSMP.

MATERIALS AND METHODS

Research site and data: The study covered Bungoma County which occupies a total of about 2,068.5 km^2 with a population of roughly 1,630,934 people and a population density of 482 persons/km^2 (KNBS, 2009). The County is endowed with well-drained, rich and fertile arable soils but poor husbandry methods and a bulging population has resulted to declining yields, deforestation and soil erosion.

Data for this study was obtained through a household survey that was conducted during the 2010 cropping season using a structured survey questionnaire. A random sample of 650 smallholder maize farmers was included in the survey using a systematic random sampling technique. The questionnaire included questions pertaining to organic soil management practices.

Data analysis: To determine farmers' perceptions towards OSMP, the respondents were asked to indicate the extent of their agreement on each indicator using a 5-point Likert-type continuum scale of Strongly Agree (SA), Agree (AG), Undecided (UN), Disagree (DA) and Strongly Disagree (SD) with assigning a weight of 5, 4, 3, 2 and 1, for positive statements S, respectively and vice versa for negative statements. For each indicator a weighted mean was obtained as follows:

$$WM = [(fSA * 5) + (fAG * 4) + (fUN * 3) + (fDA * 2) + (fSD * 1))] /n \quad (1)$$

where,

WM = Weighted mean
f = Frequency
values 5, 4, 3, 2, 1 = Attached weights
SA, AG, UN, DA & SD = Perceptions of strongly agree, agree, undecided/ neutral, disagree and strongly disagree

Adopting Bagheri (2010) and Bagheri *et al*. (2008) perception analysis, the means for all indicators were then categorized as follows; the means 1.00-1.49 = Strongly Disagree (SD), 1.50-2.49 = Disagree (DA), 2.50-3.49 = Undecided/Neutral (U/N), 3.50-4.49 = Agree (AG) and 4.50-5.00 = Strongly Agree (SA).

Regression analysis: The study also determined the factors that predict a farmer's perception towards OSMP. A multiple regression analysis model was used as shown:

$$Y_i = \beta X'_i + \mu_i \quad (2)$$

where,

Y_i = Dependent variable
X_i = A matrix of independent variables affecting farmers' perceptions towards OSMP
β = Vector of parameter estimates
μ_i = A random disturbance term

The dependent variable was the respondent's perceptions towards selected OSMP, which was defined as their scores obtained from the statements associated with twelve selected indicators. The empirical model is represented as follows:

$$Y_i = \beta_0 + \beta_1 \text{EducYrs} + \beta_2\text{Age} + \beta_3\text{Gender} + \beta_4\text{HhSize} + \beta_5\text{FmSize} + \beta_6\text{Offinc} + \beta_7\text{LdTenure} + \beta_8\text{FmgExper} + \beta_9\text{Extn} + \beta_{10}\text{Training} + \beta_{11}\text{GmShip} + \beta_{12}\ \text{FmDista} + \mu \quad (3)$$

RESULTS AND DISCUSSION

Socioeconomic characteristics: The socioeconomic characteristics of the respondents indicated that, the average age of the chief decision maker was about 47 years. The mean household had about 7 members. Majority of the households had formal education ranging from incomplete primary education to

Table 1: Socio-economic characteristic of the farmers in Bungoma County, Kenya

Variable	N	Mean	S.D.	Min.	Max.
Age (years)	650	46.98	13.74	27	83
Household size (no.)	650	7.21	3.19	3	18
Education (years)	650	13.70	2.79	7	18
Farm size (ha)	650	1.92	1.25	0.12	5
Experience (years)	650	18.45	13.10	3	55
Extension (contacts)	650	1.59	2.62	0	14
Training (contacts)	650	2.48	3.53	0	18
Farm distance (km)	650	0.93	2.25	0	11

S.D.: Standard deviation; Min.: Minimum; Max.: Maximum

university education. On average, farmers had about 14 years of formal education. The average farm size was 1.92 ha indicating they are mainly smallholders. The average length of farming experience was 18 years. In terms of extension services and training, the respondents had a mean of 2 contacts/year. The mean distance from the farmer's homestead to the fields was 1 km (Table 1).

Types of OSMP carried out by smallholder farmers in Bungoma County: Characterization of OSMP was performed in order to determine how the practices vary across farmers in the study area. The results in Fig. 1 show the proportion of maize farmers (in percentages) practicing the various OSMP in the study area. From the results, 87.3% of smallholder maize farmers planted agro forestry trees. This is because agro forestry helps in environmental conservation and produces organic matter which serves as fertilizer and saves the farmer from expenses of buying and transporting fertilizer from off-site. Wastes or surpluses from agro forestry trees are also used as fodder. In terms of services, agro forestry trees provide services as windbreaks and shades; they control soil erosion and also demarcate land when planted along the farm boundaries.

Early planting is one of the most important factors in production which can lead to high yields. The results show that 78.7% of the households practiced early planting. Early planting provides a greater window of an opportunity for replant decisions, minimizes the first yield-limiting barriers such as weeds and pest and diseases (Iken and Amusa, 2004; Legere, 1997).

Crop rotation was practiced by 76% of the households. Crop rotations help to reduce pests and diseases in the cropping system as well as controlling weeds by including smothering crop species or green manure cover crops in the rotation. In addition, crop rotations help to improve soil quality, better distribution of nutrients in the soil and increases biological activity (Liebman and Dyck, 1993; Litterick *et al*., 2002).

To improve soil fertility, Farm Yard Manure (FYM) was applied by 70.7% of the respondents, 62.7% incorporated crop residues into the soil, 60% applied animal manure, 55.3% planted leguminous crops and 42% used green manure on their farms. The practice of these activities helps to reduce the high costs of purchasing inorganic fertilizers. In addition to supplying nutrients to the soil, FYM improves the physical, chemical and biological properties of the soil which helps to maintain soil productivity and soil health (Tolessa and Friesen, 2001).

Cover cropping was practiced by 58% of the respondents while a few respondents (29.3%) practiced mulching on their farms. Cover cropping and mulching are important practices in crop production since they control soil erosion, suppresses the growth of weeds and improves soil moisture content during the season of inadequate rainfall.

Farmers' perception towards OSMP in Bungoma County: Twenty three statements listed on Appendix A on various OSMP were evaluated. The respondents' perceptions were prioritized according to the mean on

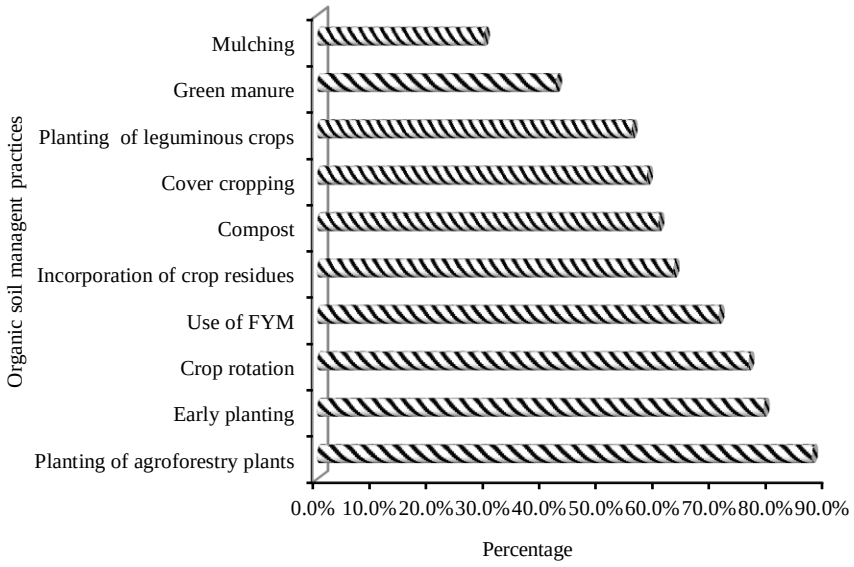

Fig. 1: Types of OSMP carried out by smallholder maize farmers in Bungoma County

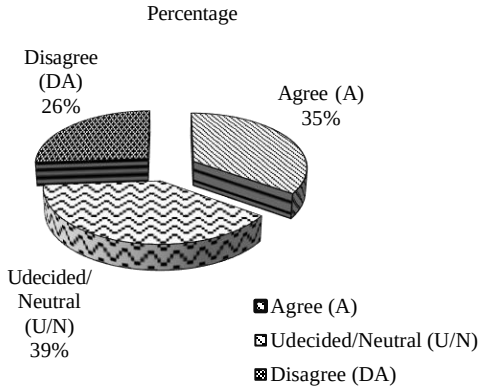

Fig. 2: Categorized perception results on OSMP in Bungoma County

these statements. The perceptions on OSMP were calculated by obtaining a weighted mean on the farmers' responses (Appendix B).

There was no general consensus on the practices perceived to contribute to organic soil management. The results presented in Fig. 2 show how the practices were perceived by farmers. The number of practices agreed upon was 35%. There was disagreement on 26% and farmers were undecided on 39% of the practices.

Perceptions of farmers agreeing on OSMP in Bungoma County: The major driving force behind farmers with a positive attitude towards OSMP was environmental concerns (Table 2). They perceived that natural resources should be protected both for the present use and for future generations even if this will lead to farmers incurring losses in the short run. These findings tally with those of Rahman (2003). Cultivation of legume crops and application of green manure was ranked third as practices which improve soil fertility, soil structure and help to suppress weed population. The results are consistent with those by Bagheri *et al.* (2008).

Crop rotation was ranked fourth as a practice that helps in weed control. Crop rotation makes rational use of the land, assures steady high yields and permits greater diversification. This is because different crops are planted, tilled and harvested at different times and agricultural work is spread out more evenly over the year. In addition to providing ground cover and in the case of a legume fixing nitrogen, cover crops also help suppress weeds and reduce insects' pests and diseases. These findings tally with those by Bagheri (2010) where potato farmers had a positive perception about the role of crop rotation in Ardabil Province of Iran.

There was a high perception that pesticide overuse may lead to pest resistance. A study by Roling and Pretty (1997) contrast these results by indicating that farmers insisted on insecticide application as the easiest way to combat against pests, despite the awareness that insecticides are the major environment pollutants and their over-application makes insects resistant. Farmers agreed that successive cultivation of a single crop increases pest invasion hence there is need to practice crop rotation as a way of reducing the build-up of pests. Agrochemical inputs were also perceived as environmental pollutants but only for human and animal health. These results tally those of Roling and Pretty (1997) and Rahman (2003).

Perceptions of farmers' undecided on OSMP in Bungoma County: The results on perception of farmer's undecided on OSMP are presented in Table 3. Farmers had a neutral perception on biological control as the best method of pest control. This was because of past unsuccessful experience of plant protection from stem borer. Perhaps this was due to lack of technical knowledge on how to apply the biological pest control

Table 2: Perceptions of farmers agreeing on OSMP in Bungoma County, Kenya

Statement	Mean	S.D.	Rank
Natural resources should be protected even if it will lead to incurring losses in the short run	4.35	0.91	1
Natural resources must be protected for the next generations	4.34	1.10	2
Soil fertility can be improved by application of green manure and cultivation of legume crops	4.21	0.98	3
Crop rotation helps in weed control	4.15	1.12	4
Pesticide overuse may lead to pest resistance to pesticides	3.88	1.15	5
Green leaf manure helps to improve soil structure and reduce weed population	3.81	1.05	6
Successive cultivation of a single crop increases pests' invasion	3.73	1.47	7
Agrochemicals have negative effects on human and animal health	3.66	1.23	8

Table 3: Perceptions of farmers undecided on OSMP in Bungoma County, Kenya

Statement	Mean	S.D.	Rank
Biological control is the best methods of pest control	3.41	1.48	9
Retaining plant residues may increase weeds (n*)	3.31	1.14	10
By decreasing chemical fertilizer, use in the long run, maize farmers' benefit will increase	3.31	1.26	11
Organic farming leads to reduced cost of production	3.29	1.42	12
Minimum tillage reduces soil erosion, disturbance and exposure	3.29	1.75	13
Retaining plant residues help in soil and water conservation	3.19	1.65	14
Application of animal manure cannot increase maize production (n*)	2.68	1.43	15
Application of animal manure can increase soil fertility	2.65	1.69	16
Preparation of farm yard manure is labor intensive	2.51	1.64	17

(n*): Negative statement

Table 4: Perceptions of farmers disagreeing on OSMP in Bungoma County, Kenya

Statement	Mean	S.D.	Rank
Cultivation of mixed crops not only increase total production but also reduces soil erosion	2.39	1.07	18
Plant residues are useless and hence they should be burned (n*)	2.37	1.16	19
Minimum tillage operation decreases soil fertility (n*)	2.33	1.02	20
Release of crop residues in maize farm will decrease soil fertility (n*)	2.29	1.21	21
Maize yield can be increased only by increased use of chemical fertilizer	2.18	1.18	22
Cover cropping cause soil erosion (n*)	2.15	1.16	23

(n*): Negative statement

Table 5: Correlation between perception and some explanatory variables in Bungoma County, Kenya

Variable	r-value	p
Age	0.188**	0.021
Education	0.324***	0.000
Household size	0.450***	0.000
Extension	0.344***	0.000
Training	0.165C*	0.044
Farm distance	-0.153*	0.061

*: Correlation is significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level

techniques. These results contrast those by Bagheri *et al*. (2008) who indicated that most of the respondents had a negative perception about biological control of pest in Mazandaran province of Iran.

Despite the numerous emphases on retaining plant residues in the preservation of soil texture and nutrients, the respondents were not sure if this could increase weed population during the next growing season. At the same time, farmers were uncertain if plant residues would help in soil erosion control as well as protect the soil from exposure to harsh environmental conditions. This calls for the need for extension agents to train farmers on importance of plant residues in crop production. The respondents were not sure if substituting chemical fertilizer use with organic fertilizer would increase maize output in the long run. Contrary to these results, a study by Bagheri *et al*. (2008) indicated that most farmers perceived agrochemicals as the best means to increase production in the short run.

Despite minimum utilization of external farm inputs under Organic Farming (OF), the farmers were neutral on the argument that OF would reduce the cost of production. Perhaps this is because more labour is required in preparation and application of FYM and compost manure which are the key sources of soil fertility under OF. The respondents were not sure if minimum tillage would reduce soil erosion, soil disturbance and soil exposure. However, the advantages of minimum tillage include reduced costs and time, betterment of soil structure and drainage (Hao *et al*., 2001). Similarly, they were uncertain if animal manure could lead to desired maize output and although they preferred adding it to the farm in order to supply deficit nutrients. These results contrast those of Bagheri (2010) where farmers had a positive perception about the contribution of animal manure on soil fertility.

Perceptions of farmers disagreeing on OSMP in Bungoma County: The perceptions of farmers disagreeing on OSMP are presented in Table 4. Although they agreed that mixed cropping increase total production, they thought it does not reduce soil erosion yet mixed cropping is an insurance against crop failure in case of abnormal weather conditions, pests and diseases (Gold, 1993; Fondong *et al*., 2002). It also reduces soil erosion and keeps down weeds due to improved soil cover (Howeler, 1998). In addition, it helps to increase the overall farm productivity as well as in the utilization of scarce resources to the fullest degree (Olasantan *et al*., 1994).

The respondents disagreed that plant residues are useless and should be burned and instead, they recognized the contribution of crop residues to soil fertility. They understood that crop residue can protect soil from water erosion and this is an important indicator of soil sustainability In addition to increasing soil fertility, the respondents also used crop residues as fodder. A study by Bagheri *et al*. (2008) indicated that most of the respondent of lowlands in Mazandaran province of Iran were opponents to retaining of plant residue and regarded setting fire on plant residue as the easiest way to get rid of stem borer. In addition, Tatlidil *et al*. (2009) argued that burning of plant residues in the fields is the easiest way of doing tillage practice although this ignores the long term impact.

Farmers disagreed that minimum tillage operations decrease soil fertility. Instead, they recognized their over-cultivation destroys the soil structure. These results tally with those of Bagheri (2010). In addition, Rabiee *et al*. (2006) indicated that minimum tillage gives the best paddy residual management in regard to reduced costs and time, betterment of soil structure and drainage.

The respondents disagreed on agrochemical use as the major farm input and therefore chemical fertilizer alone cannot lead to the highest yields hence, they advocate for OSMP. Excess or uncontrolled use of chemical inputs can spoil the soil properties such as water holding capacity. It may also affect adversely the population of micro-organisms in addition to damaging water resources (Kang, 1993). Regarding the role of cover cropping, the respondents disagreed that this practice would lead to soil erosion. This is because cover crops protect soil from erosion, improves soil fertility by reducing nutrient leaching, improve soil structure and water holding capacity.

Correlation analysis: The results of correlation analysis indicated a significant relationship between perception of OSMP and some institutional and socio-economic variables (Table 5). Age of the household

head positively influenced perception towards OSMP. Perhaps this is because as farmers get older they tend to intensify the practice of new agricultural technologies as a result of more years of farming experience (Maddison, 2006). These results contradict those of Fakoya *et al*. (2007) and Bagheri (2010) where age had a negative correlation with perception. Formal education of the household head, extension services and farmer training serve as sources of agricultural information and these variables correlated positively with perception towards OSMP. This could be attributed to the fact that farmers with more access to agricultural information have a higher ability to perceive, interpret and respond to better agricultural technologies such as OSMP. These results tally other related studies (Bagheri *et al*., 2008; Bagheri, 2010; Tatlidil *et al*., 2009). Household size had a positive correlation with perception towards OSMP. Given that a household is the most important source of labour among smallholder farmers, households with a high number of members working on the farm are more effective and this would influence their perception towards OSMP considering the fact that OSMP is a labour intensive technology.

However, the distance of the farm from the farmers homestead had a significant negative relationship with perception of OSMP. This is because plots far away present tenure security challenges due to difficulties in monitoring (Menale *et al*., 2009) hence farmers do not find an incentive to invest more sustainable practices such as OSMP.

CONCLUSION AND POLICY RECOMMENDATIONS

Environmental concern was perceived as the most important activity related to OSMP. Smallholder farmers were invariably concerned about the environment and were interested in protecting agricultural resources both for the present use and for future generations. Application of green manure and cultivation of legume crops were greatly perceived as organic practices that improve soil fertility and soil structure. Further, agrochemicals were perceived as farm inputs that have a negative effect on both human and animal health. In the same vein, over-application of pesticides was perceived as a practice that may lead to development of pest resistance to pesticides. The correlation analysis indicated that age, education, household size, extension, training and farm distance had a relationship with farmers' perception towards OSMP. The study recommends that efforts to promote OSMP on small-scale farms should focus on enhancement of farmer-awareness of the environmental, economic benefits of OA. There is need to provide training and technical advice on organic farming practices through agricultural extension services and developing information networks among farmers. Finally, seminars and workshops should held regularly where farmers can source important information on OF systems such as the technicalities involved in preparation of compost manure and FYM.

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Appendix A: Farmers' perception statements on OSMP in Bungoma County

Statement	Code
We have to protect natural resources even if it will lead to incurring losses in the short run	S1
Natural resources must be protected for the next generations	S2
Soil fertility can be improved by application of green manure and cultivation of legume crops	S3
Crop rotation helps in weed control	S4
Pesticide overuse may lead to pest resistance to pesticides	S5
Green leaf manure helps to improve soil structure and reduce weed population	S6
Successive cultivation of a single crop increases pests' invasion	S7
Agrochemicals have negative effects on human and animal health	S8
Biological control is the best methods of pest control	S9
Retaining plant residues increases weeds population (n*)	S10
By decreasing chemical fertilizer, use in the long run, maize farmers' benefit will increase	S11
Organic farming leads to reduced cost of production	S12
Minimum tillage reduces soil erosion, disturbance and exposure	S13
Retaining plant residues help in soil and water conservation	S14
Application of animal manure cannot increase maize production (n*)	S15
Application of animal manure can increase soil fertility	S16
Preparation of farm yard manure is labor intensive	S17
Cultivation of mixed crops not only increase total production but also reduces soil erosion	S18
Plant residues are useless and hence they should be burned (n*)	S19
Minimum tillage operation decreases soil fertility (n*)	S20
Release of crop residues in maize farm will decrease soil fertility (n*)	S21
Maize yield can be increased only by increased use of chemical fertilizer	S22
Cover cropping cause soil erosion (n*)	S23

(n*): Negative statement

Appendix B: Results on farmers' perceptions towards OSMP in Bungoma County

Code	Strongly agree	Agree	Undecided/neutral	Disagree	Strongly disagree	Mean	Category	S.D.	C.V	Rank
S1	86	40	15	8	1	4.35	A	0.91	0.21	1
S2	96	31	7	10	6	4.34	A	1.10	0.25	2
S3	66	67	5	6	6	4.21	A	0.98	0.23	3
S4	84	23	30	8	5	4.15	A	1.12	0.27	4
S5	50	64	13	14	9	3.88	A	1.15	0.30	5
S6	41	60	36	5	8	3.81	A	1.05	0.28	6
S7	69	31	6	28	16	3.73	A	1.47	0.39	7
S8	34	79	2	22	13	3.66	A	1.23	0.33	8
S9	50	34	18	24	24	3.41	U/N	1.48	0.43	9
S10	22	51	40	26	11	3.31	U/N	1.14	0.34	10
S11	30	49	18	43	10	3.31	U/N	1.26	0.38	11
S12	34	48	23	17	28	3.29	U/N	1.42	0.43	12
S13	66	16	6	19	43	3.29	U/N	1.75	0.53	13
S14	54	19	17	22	38	3.19	U/N	1.65	0.52	14
S15	5	68	4	20	53	2.68	U/N	1.43	0.53	15
S16	39	18	5	28	60	2.65	U/N	1.69	0.64	16
S17	29	27	2	25	67	2.51	U/N	1.64	0.65	17
S18	5	19	38	55	33	2.39	D	1.07	0.45	18
S19	7	30	6	75	32	2.37	D	1.16	0.49	19
S20	9	9	44	43	51	2.33	D	1.02	0.44	20
S21	15	9	20	67	39	2.29	D	1.21	0.53	21
S22	6	23	14	56	51	2.18	D	1.18	0.54	22
S23	6	17	26	45	56	2.15	D	1.16	0.54	23

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