

Technical, Economic and Social Gaps and Information Needs among Smallholder Farmers in Practice of Ecological Organic Agriculture in Kenya

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Abstract – Food security is an issue of great and growing concern in many countries especially in Africa. Despite global pledges, study reports continue to reveal that the number of people suffering from hunger has continued to increase every year. Kenya, like many other sub-Saharan African countries faces a fundamental food security challenge. Feeding over 40 million people in the country requires a wide range of creative, sustainable agricultural systems which not only provide food but also factor in the economic value of nature-based services such as forests, wetlands and soil organisms that underpin agriculture. It is acknowledged that ecological organic agriculture can contribute to socioeconomic and ecologically sustainable development especially in poorer countries through increased agricultural productivity and raised incomes with low cost, locally available technologies, and without causing environmental damage. It is against this background that this study aimed to establish enabling gaps and information needs among smallholder farmers in the practice of ecological organic agriculture (EOA) in Kenya. A sample of 450 households selected by multi-stage sampling from six counties was interviewed using a pre-coded questionnaire. The findings revealed that the smallholder farmers in Kenya grow a wide variety of crops on their farms, which may comprise a valuable combination in the application of EOA strategies, especially with respect to controlling pest and diseases. However despite the wide diversity, the farmers showed limited understanding of potential of the various natural and environmentally practices in controlling pests and diseases and soil amendments. The study hence recommends support for innovative strategies to introduce and reinforce EOA practices already inbuilt in current smallholder farmer practices.

Keywords – Food Security, Ecological Organic Agriculture, Information Needs, Smallholder Farmers.

I. INTRODUCTION

Achieving food security continues to be a major challenge in many countries especially in Africa. Despite numerous efforts, various analytical reports continue to reveal that the number of people suffering from hunger has continued to increase every year (UNEP-UNCTAD, 2008; Government of Kenya (GOK), 2005; Kenya National Bureau of Statistics, 2010). In the last 10 years, progress in the drive to reduce hunger has been slow and has varied around the world. In sub-Saharan Africa the number of

hungry people has increased by 20 percent since 1990 (UNEP-UNCTAD, 2008). In the period 2000-2002, the proportion of undernourished people in the total population of Kenya was 33 percent, Uganda 19 percent and in the United Republic of Tanzania 44 percent. The number of underweight children has also increased in Central, Western and Eastern Africa compared to the decline in other developing regions such as Asia, South America and North Africa (FAO, 2005; von Braun, 2005; UN/SCN, 2004).

Kenya faces a fundamental food security challenge (Njoroge, Ombati & Oywaya-Nkurumwa, 2013). Despite declining fertility rates and family sizes in Kenya, the population continues to increase and so in parallel is the demand for food. Food demand will shift in the coming decades as economic growth increases people's purchasing power, growing urbanization encourages people to adopt new diets and climate change threatens both land and water resources. Alternative environmentally friendly practices resilient to shocks created by the global changes are urgently needed for sustained use in farming systems.

This paper is the outcome of a farmer survey commissioned by Biovision Africa Trust¹, Nairobi, to contribute towards the understanding of the enabling gaps and information needs among smallholder farmers in the practice of ecological organic agriculture (EOA). The purpose was to identify and prioritize needs and gaps (technical, economic, and social) that can inform development of appropriate training activities for farmers (especially women farmers) along the EOA value chains. Embracing EOA practices by smallholder farmers in the country can significantly contribute to the realization of a green economy that would result in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. Such an economy is characterized by low carbon, resource efficiency and is socially inclusive (Pearce, Markandya & Barbier, 1989; OECD, IEA, 2010; Global Green Growth Institute, 2012)

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The conventional wisdom is that in order to double food supply, efforts need to be redoubled to modernize agriculture. Such a strategy has been successful in the past (Ministry of Agriculture (MOA), (2008) but there are doubts about such systems being capable of reducing food insecurity and rural poverty. The greatest technological progress in the past half-century has not led to major reductions in hunger and poverty in developing countries (Trewavas, 2002; Smil, 2000; McNeely & Scherr, 2003). Feeding the over 40 million people in Kenya will require a wide range of creative, sustainable agricultural systems which not only provide food but also factor in the economic value of nature-based services such as forests, wetlands and soil organisms that underpin agriculture (Helgar & Minor, 2007). As observed by several researchers, simply applying the “industrial” agricultural models of the twentieth century into the twenty first century as a single solution to the agricultural production challenges will not work (Musyoka, Zundel, Cbi-Olaye, Muriuki, Mucheru, & Vanlauwe, 2007). There is need therefore to take food security seriously and search for sustainable solutions.

It is generally acknowledged that ecological organic agriculture can contribute to socioeconomic and ecologically sustainable development especially in poorer countries (van Bueren, Struik, & Jacobsen, 2002; IFOAM, 2004; Helgar & Minor, 2007). Ecological organic agriculture is a sustainable and environmentally friendly production system that offers Kenya, and other African countries, a wide range of economic, social, environmental and cultural benefits. It can increase agricultural productivity and raise incomes with low cost, locally available technologies, without causing environmental damage. Furthermore, evidence shows that ecological organic agriculture can build up natural resources, strengthen communities and improve human capacity, thus improving food security by addressing many different causal factors simultaneously (Helgar & Minor, 2007). Attention must therefore focus on the following three aspects:

- The extent to which farmers can raise food production and raise incomes with low cost, locally available technologies and inputs.
- Whether they can do this without causing further environmental damage ;and
- The extent of farmers’ ability to trade.

Agriculture, by its inherent multi-functionality, has the potential to both influence and address the factors that contribute to food insecurity. Ecological organic agriculture relies on five capital assets for success (natural, social, human, physical and financial) and so contributes to and builds up stocks of these natural, social, and economic resources over time thus often reducing many of the factors that lead to food insecurity (Ostrom, 1998; Pretty, 2003). This being the case, there was need to conduct a study to establish the information needs, as well as the knowledge smallholder farmers in Kenya have of ecological organic agriculture (EOA).

This study was premised on the conceptualization of EOA as any production system that is designed to sustain

the health of soils, ecosystems, and the people (IFOAM, 2004). Such systems mainly rely on ecological processes, biodiversity, and cycles adapted to local conditions, rather than the use of heavy chemical inputs with adverse effects (van Bueren *et al*, 2002). They combine traditions, innovations and science to benefit the shared environment and to promote fair relationships and good quality of life for all involved. The concept considers the agro-ecosystem in all its diversity. Therefore, although the smallholder farmers may not, in most cases, have received any formal training on “ecological organic agriculture” some elements of the practice may have developed over time through experiential and indigenous knowledge. The study sought to identify all smallholder practices on the farm, whether catalyzed by agricultural extension workers or farmers themselves had the capacity to promote the sustainability of health of soils, ecosystems, and the people.

The study took cognizance of the fact that the smallholder farm is a complex institution often with many interrelated enterprises. Accordingly, the study adopted the farming systems approach (Park and Lohr, 2005). The approach provides a useful entry point for understanding smallholders’ knowledge and practice of ecological organic farming. The farming system can be broken down into four interacting sub-systems. These are: (i) the cropping system, which comprises the crop(s) and the cultural practices applied in growing them including tillage, weed control, and rotation; (ii) the livestock production system, which comprise the mix of livestock reared on the farm and the livestock management practices used; (iii) bio-physical sub-system, comprising of the pest and diseases endemic in the area, the soil types and land topography as well as the rainfall pattern; and (iv) socio-economic sub-systems, comprising household specific factors, market and institutional factors. The farming system approach is relevant in the study of EOA on several grounds. The system is the arena within which farming decisions are made, including the methods and practices to use. It is also the arena of synergistic and competitive interactions relevant to EOA (e.g., livestock/crop nutrient recycling; nitrogen-fixing leguminous plants/non-fixing plant; crop residues for feeding livestock versus crop residues for mulching the soil) take place.

II. METHODOLOGY

Guided by the conceptualization of farming system, the study set out to collect farm-level data on all the four sub-systems. These included data on household-specific socio-economic attributes; priority crops and animals produced on the farms; bio-physical production problems facing the farmer and how the farmers dealt with them; and socio-economic constraints hampering farmers from accessing EOA services.

The study used a farm household sample survey method, with the farm household as the sampling unit. The sample was drawn from six counties, namely Embu, Homa Bay, Kajiado, Kisii, Meru, and Nakuru. The choice of the study area was informed by the need to ensure a good

representation of various parts of the country where arable agriculture form the major livelihood for smallholders. Meru and Embu counties were purposively selected to represent the Eastern part of the country, Kajiado and Nakuru counties represented the expansive Rift Valley, while Kisii and Homa Bay counties represented the western part that includes the Lake Victoria region.

A multi-stage sample selection method was used in selecting a sample of 75 farm households from each of the selected counties, making up a total sample of 450. The sampling proceeded as summarized in Table 1. The decision to use transects sampling method in selecting farm households from the sub-locations was informed by lack of comprehensive lists of farmers that would serve as a sampling frame.

Data were collected through personal interviews using a pre-coded questionnaire. The questionnaire was designed by the consultancy team in consultation with Biovision Africa Trust. It was then pre-tested to ensure its efficiency in eliciting the required data, after which it was administered by trained enumerators through personal interviews.

The questionnaire explored several aspects of smallholder farming including: the farm enterprises regarded as important by the farmers, the farmer's

perceived severity of common crop and livestock production problems, their knowledge and use of a select pesticidal plants and soil amendment methods, and the sources of knowledge for organic methods that they use.

In order to characterize the study area in terms of major crops grown, each of the respondents was asked to indicate, by order of importance, four principal crops the household produced on its farm. A four-point scale was used to capture the respondent's perception of the relative importance of the crops to the household. Accordingly, the crops were ranked 1st, 2nd, 3rd and 4th, with 1st being the most important.

To determine the seriousness of common problems faced by smallholder farmers in the study area, the respondents were asked to rate the severity of several crop production problems, on a scale of 1 to 5, with 5 being the most severe. The scores were used to compute weighted mean scores for use in making comparison of severity across the problems, as well as within and across the counties. The implication was that the higher the average weighted score, the higher the perceived severity of the problem relative to all other problems.

Data analysis was largely descriptive and involved data summarizing and display of summary statistics.

Table 1: Sampling procedure used to select respondents

Stage	List/units used	Sampling method	Sample Size
One	Administrative counties	Purposive sampling	6
Two	Administrative locations within the selected counties	Purposive sampling	6
Three	Administrative sub-locations within the selected locations	Purposive sampling	6
Four	5 Paired land marks were identified within the selected sub-locations. The land marks were selected in such a way that there was a virtual straight line between each pair, with a separation of about 5km.		30
Five	Then taking a pair of land marks, in turns, very 10 th farm was selected up to a total of 75 farm households		450

III. RESULTS AND DISCUSSION

A. Socio-Economic characteristics of respondents

A summary of important socio-economic attributes of the sampled households is presented in Table 2. The findings show that, overall about 2 out of every 5 farm households were female-headed. There was, however, significant ($\chi^2=93.76$); $p<0.001$) county differentiation. The percentage of female-headed households was relatively lower in Meru (13%), Embu (19%), and Kajiado (22%) counties. Nakuru County had the highest percent (67%) followed by Homa Bay (60%).

Overall, the average age of the head of the farm household was 44 years, and they had had about 17 years of farming experience. Further examination using one-way analysis of variance showed significant variations across the counties. Heads of households in Kisii had the lowest mean age (38 years), while those in Kajiado had the highest (52 years).

A majority of the heads of farm households had some formal education, with over 50% having primary school education and beyond. There was, however, significant

($\chi^2=125.04$); $p<0.001$) county differentiation. Kajiado County had the highest percent (37%) of heads of without any formal education, followed by Homa Bay County (21%). Conversely, Embu County had the highest percentage (31%) followed by Meru County (27%) of heads of households with tertiary level education.

Overall, farm holding averaged 10.25 acres, with a significant ($F=41.58$; $p>0.0000$) variation across the counties. Furthermore, the standard deviations within the counties were substantially higher implying that the overall means masked important details about the distribution. Accordingly, the distribution was further examined through grouping land holdings into *quintiles*. Table 3 shows the dominance of smallholder farming in all the six counties. Overall, 56% of the households had a mean land holding of about 2.64 acre (1-2 quintiles). Kisii County had the highest percentage of households with relatively small land holding. Land holdings of about 49% of the sampled farm households in the county had an average holding of 0.77 acres (1 quintile), while another 35% and an average land holding of 1.77 acres (2 quintiles).

Table 2: Sample Socio-Economic Characteristics (N=450)

Variable	Overall	Embu	Homa Bay	Kajiado	Kisii	Meru	Nakuru	Sig. test
• Proportion of female-headed household (%)	37.61	18.67	60.53	22.37	44.00	13.33	66.67	$\chi^2=93.76$; $\rho < 0.001$
• Mean age of head of household (No. of years)	44.2 (15.2) ^a	43.2 (15.0)	47.7 (16.5)	51.5 (13.6)	37.5 (13.0)	43.3 (12.9)	41.6 (16.5)	F=8.36; $\rho > 0.0000$
• Mean size of land holding (acre)	10.25 (28.34)	3.50 (2.70)	4.98 (5.52)	45.88 (56.21)	1.59 (1.32)	2.58 (3.23)	1.98 (2.67)	F=41.58; $\rho > 0.0000$
• Mean of farming experience (No. of years)	17.2 (13.2)	16.1 (14.0)	23.1 (16.9)	12.9 (6.6)	17.2 (12.0)	16.7 (11.6)	16.9 (14.2)	F=5.02; $\rho > 0.0002$
• Level of education (%)								
○ No formal education level	13.1	2.7	10.7	36.8	4.0	21.1	2.7	$\chi^2=93.76$; $\rho = 0.000$
○ Primary education level	38.1	25.3	58.7	29.0	37.3	56.6	21.3	
○ Secondary level	31.4	48.0	24.0	25.0	32.0	14.5	45.3	
○ Tertiary level	17.5	24.0	6.7	9.2	26.7	7.9	30.7	

Notes: ^aFigures in parenthesis are standard deviations

Table 3: Distribution of Land holding among households

Land Quintiles	Overall		Embu		Homa Bay		Kajiado		Kisii		Meru		Nakuru	
	acre	%hh	acre	%hh	acre	%hh	acre	%hh	acre	%hh	acre	%hh	acre	%hh
1	0.79	29	0.76	27	1.00	8	0.97	12	0.77	49	0.80	39	0.72	41
2	1.85	27	1.86	15	1.93	25	1.86	15	1.77	35	1.79	31	1.89	48
3	2.87	11	3.00	20	2.80	14	2.86	9	2.73	12	2.93	9	2.50	2
4	4.17	12	4.18	15	4.14	29	4.38	11	3.80	1	4.02	12	4.33	5
5	43.41	20	7.56	24	11.53	25	84.90	53	8.00	3	10.29	9	11.33	5

B. Major agricultural crops grown in the study area

Fig.1 shows the overall frequency distribution of respondents, in the six counties, by the principal crops grown on their farms. The results suggest that maize, beans and vegetables, in that order, were the most important crops grown by the sampled households. Overall, about 91%, 78% and 55% of the respondents identified maize, beans and vegetables, respectively, as among the top four major crops grown on their farms.

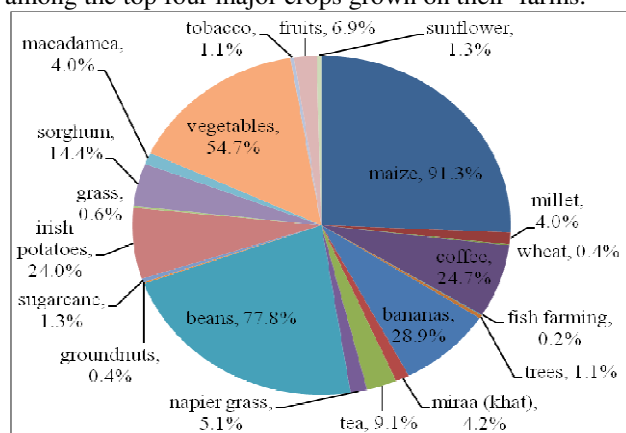


Fig.1. Major crops grown in the study area

The prominence of maize, beans, and vegetables in the study area's cropping pattern is further emphasized by the position ranking reported by the respondents. As shown in Table 4, about 61% of the total respondents identified maize as their top-most ranking crop enterprise. Beans

were ranking 2nd and 3rd by 32% and 31% of the respondents, respectively. Vegetables were ranked 2nd, 3rd and 4th by 12%, 21% and 27%, respectively. However, the specific crop's rank order of importance varied across the six counties as shown in Figure 2.

Table 4: Relative frequency distribution of respondents in different crop rank order, pooled sample (%)

Enterprise	Score rank			
	1 st	2 st	3 st	4 st
Maize	60.9	18.0	13.5	4.2
Coffee	15.9	3.5	4.2	3.1
Bananas	4.8	8.1	8.9	11.7
Tea	3.7	3.7	1.7	0.6
Napier Grass	0.5	1.8	1.5	2.2
Beans	1.8	32.0	31.0	23.6
Sugarcane	0.2	0.2	0.5	0.6
Irish Potatoes	0.5	5.1	8.9	14.7
Grass	0.2	0.4	0.0	0.0
Tobacco	0.5	0.5	0.3	0.0
Sorghum	5.3	8.1	0.7	1.2
Millet	0.0	1.2	1.2	2.5
Vegetables	3.7	12.0	21.6	27.6
Wheat	0.0	0.5	0.0	0.0
Fruits	0.9	0.9	3.9	2.2
Macadamea	0.7	3.2	0.0	0.3
Miraa (Khat)	0.5	0.7	1.5	2.5
Trees	0.0	0.0	0.3	1.2
Sunflower	0.0	0.2	0.3	1.2
Fish Farming	0.0	0.0	0.0	0.3
Groundnuts	0.0	0.0	0.0	0.6

Coffee featured prominently in Embu where it was ranked the most important crop by about 61% of the respondents as compared to Meru and Kisii counties where it was ranked the most important crop by only 28% and 3% of the respondents, respectively. None of the households sampled in the other three countries identified coffee as an important crop. Maize was an important farm

enterprise for many households in Nakuru, Kajiado, Kisii, and Homa Bay where 88%, 87%, &72% and 63% of the sampled households, respectively, ranked it as the most important crop. Conversely, only 42% and 12% of the households sampled in Meru and Embu, respectively, ranked maize as the most important crop.

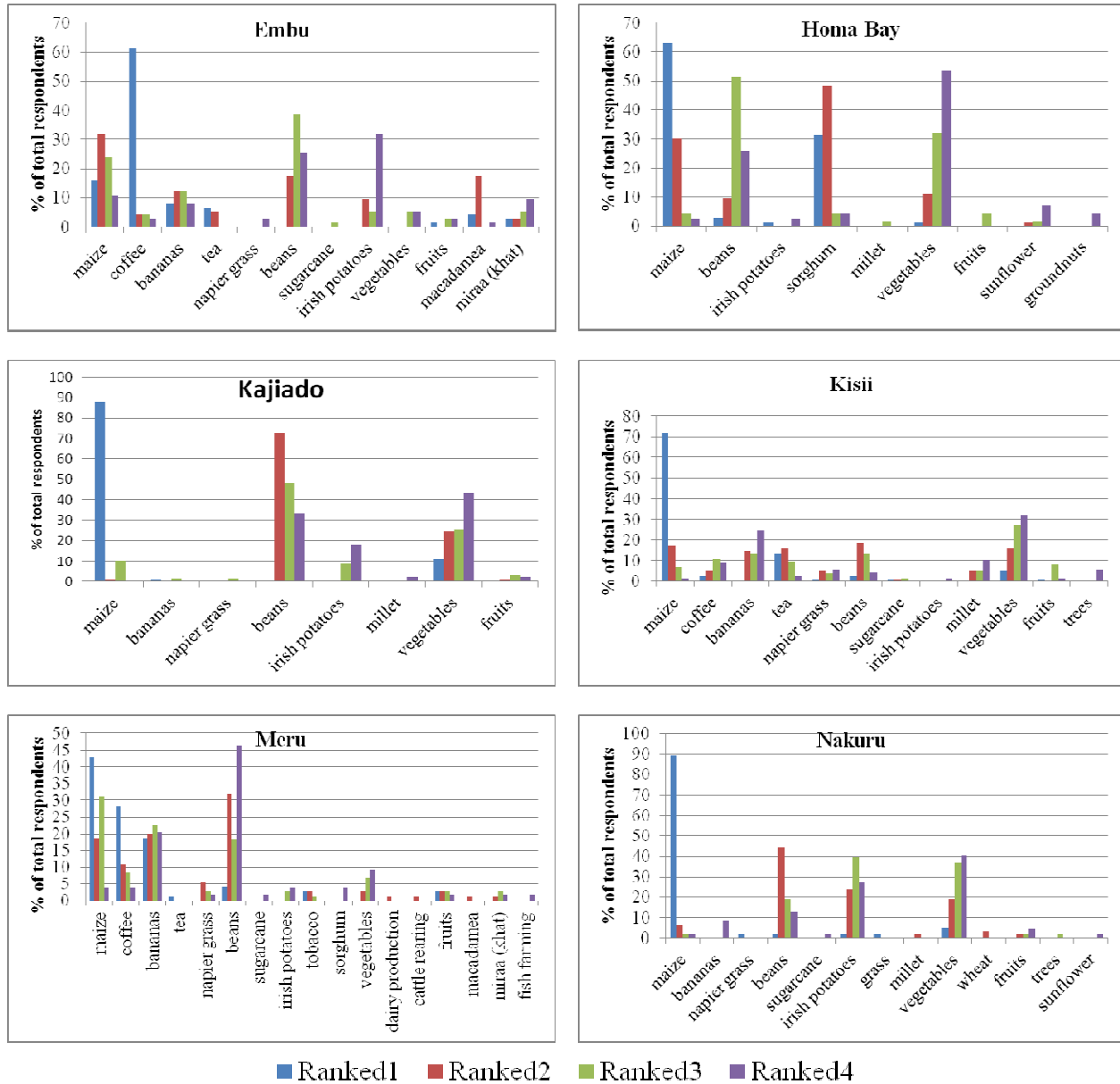


Fig.2. Percentage distribution of farmers by crop ranking

C. Crops and their relative importance

To gauge the relative importance of different crops to the households in the study area, relative score values were assigned to the ranks in reverse order. Thus, the crop ranked 1st was assigned a relative score of 4 points, the 2nd 3 points, the 3rd 2 points and the 4th 1 point. The allotted relative score values were then used to compute weighted mean scores for the respective crop and county. This was done by multiplying the respective score values with its

relative frequency count and then summing across the crop as shown in equation 1.

$$\sum \frac{f_{ij}}{n_c} \times s \quad (1)$$

Where: s is the score value, f_i is the frequency count of score value crop i in rank j , and n_c is the total number of respondents in county c , and $\frac{f_i}{n_c}$ is the relative frequency count of score value for crop i in rank j .

Figure 3 presents the crops, as already identified in Fig.2 arranged in rank order as determined by the computed mean scores. The figure brings out clearly the differentials in the relative importance of crops across the counties. The findings show that differences existed in the relative importance of the crops, with certain crops featuring more prominently in the top five ranking crops across all the counties. Most notable crops of importance were maize,

beans, and vegetables. Maize was rated the top most important crop in five (5) counties and second in the remaining one, while beans rated second or third most importance crop in 5 counties. Vegetable was among the five most important crops in 4 out of the 6 counties. This prominence of maize, beans and vegetable reflects the common eating habits in the area. Maize is a major staple that is consumed together with beans and/or vegetables.

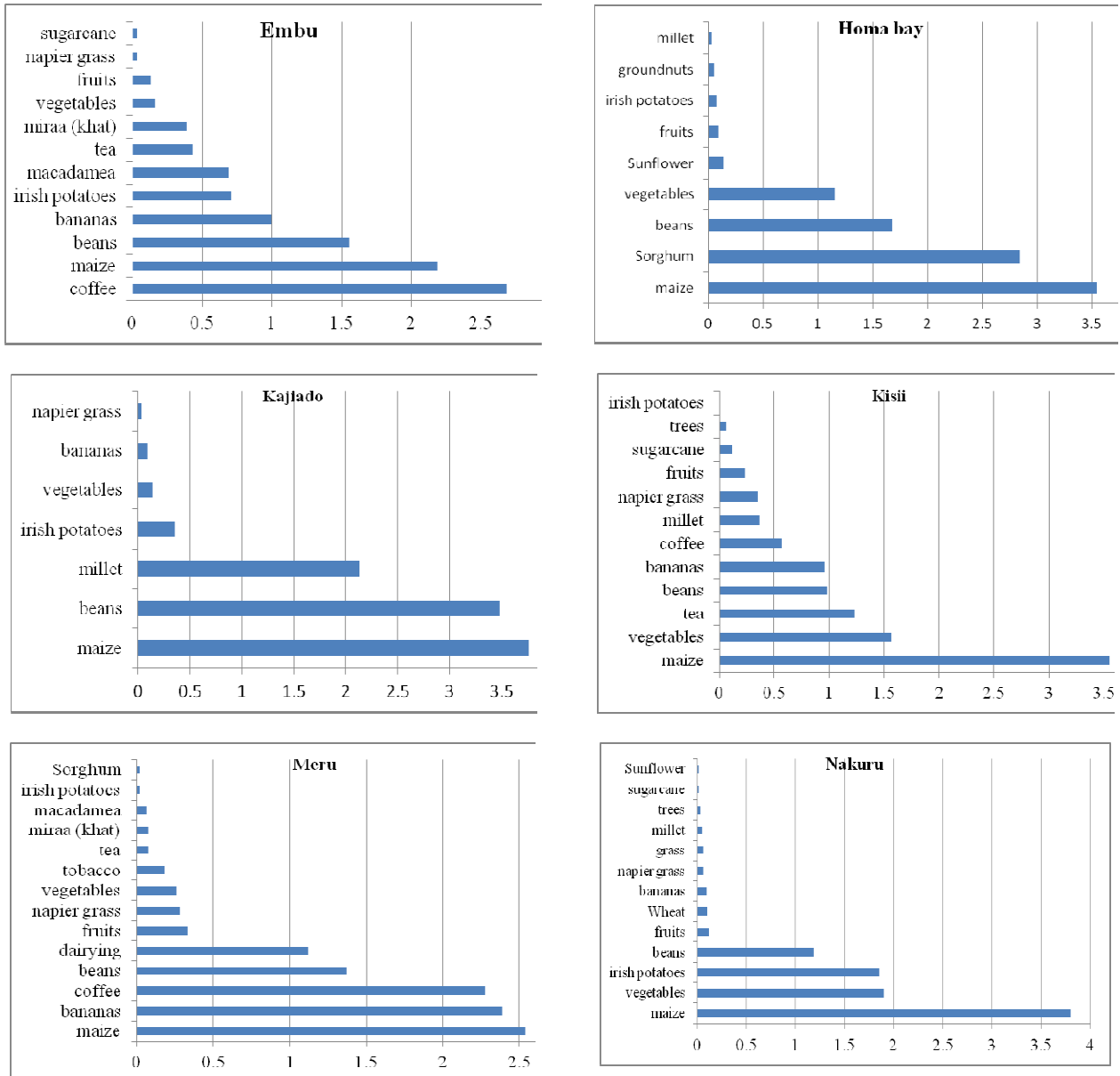


Fig.2. Major crops grown in the study area, by county and relative importance

D. Major crop production problems identified in the study area

Fig.4 depicts the relative severity of different problems in the counties studied. The findings show that, overall, weeds, birds, aphids, cutworm, and moles (in that order) were the most severe problems rated at 3.70, 3.68, 3.63, 3.56, and 3.50, respectively. However, there were marked area differences both in problems rated high in severity,

the order, and magnitude of severity. Water and cutworms rated highest in severity in Kisii at indices 4.59 and 4.04, respectively. Squirrels, aphids, and blight were rated the heaviest menace in Homa bay at indices 4.24, 4.1, and 4.06, respectively. Weeds and stem borers rated the highest in Embu at indices 4.46 and 4.10, respectively. These results are important in pointing at the problems that any agent promoting EOA should focus on.

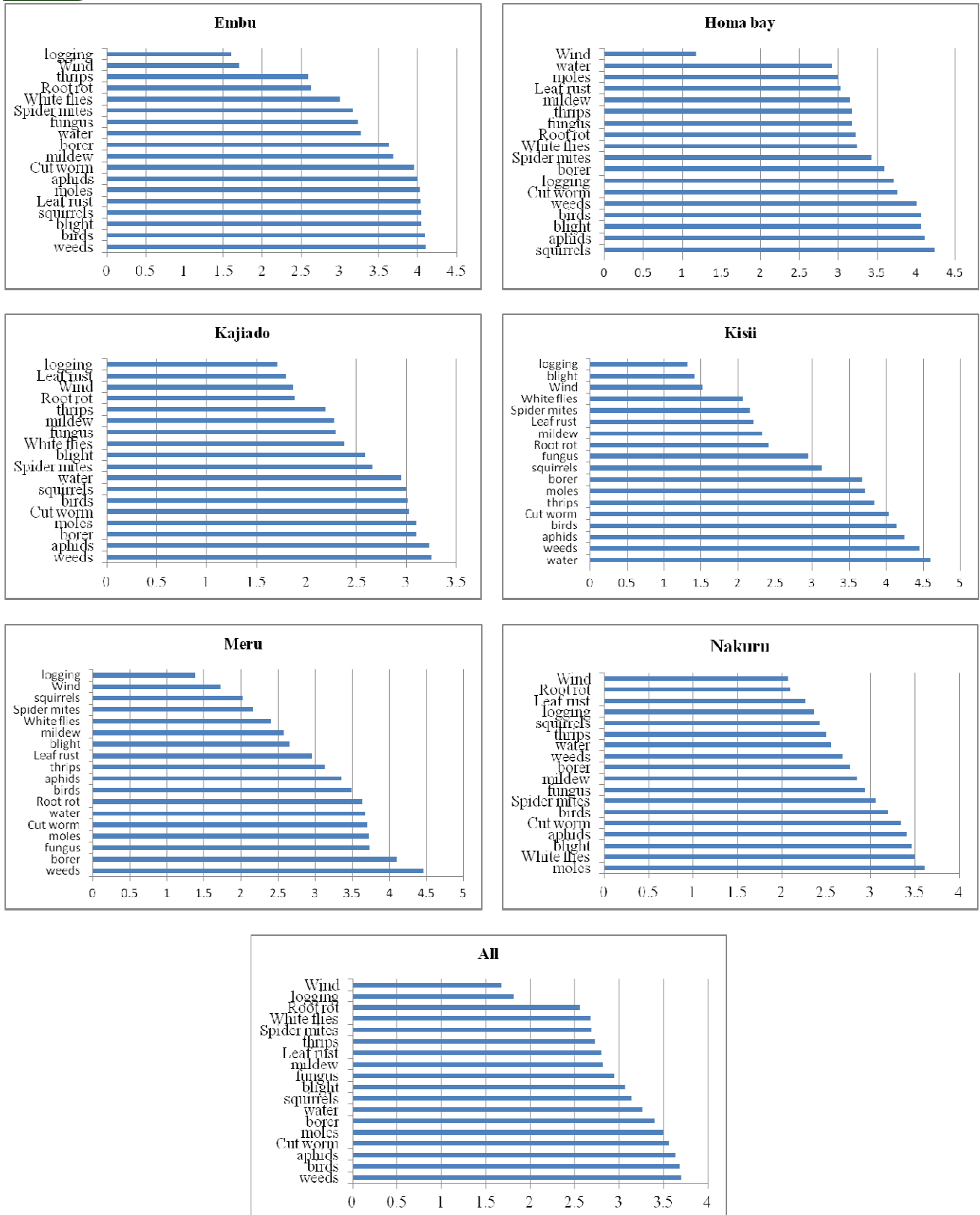


Fig.4. Ranking of severity of crop production problems

E. Major methods used to address production problems

To explain the different types of methods used by farmers in controlling crop production problems, the respondents were asked to state the major control method

they used in controlling each of the problems they identified as major. Results in Figs. 5 and 6 show that farmers used a mixture of methods to control each major problem. It was deduced that the farmers used a mixture of methods, but that there were clear distinctions in focus.

Problems of rodents, birds and soil erosion were mainly addressed through natural methods. On the other hand, problems associated with fungus, bacteria and insect pests were mainly controlled through use of chemicals.

Specifically, 63% and 23% of the overall sampled households reported that they used natural methods against moles. Kajiado, Kisii, and Embu, in that order, had the highest proportions of households reporting that they used natural methods to control moles. The proportions were 96%, 80% and 64%, respectively. Similarly, squirrels were primarily controlled through natural methods, with 76% of all sampled households indicating the methods and 15% reporting that they did nothing to control them. Homa bay, Kajiado and Kisii counties had the highest proportion of households reporting the use of natural methods to control squirrels. The proportions were 89%, 89% and 86%, respectively. On the other hand, Nakuru County had the highest proportion of households (67%) reporting that they

used chemicals in controlling squirrels. Birds were also mainly controlled through the use of natural methods, with 77% of all respondents reporting they used natural methods. Nakuru, Kajiado, Kisii, and Homa bay, in that order had the highest proportion of farmers reporting the use of natural methods to control birds. The proportions were 92%, 90%, 82% and 82%, respectively. Meru County had a high proportion (56%) of farmers reporting that they used a combination of natural and chemical methods to control birds.

With respect to controlling fungal, bacterial, and insect pest related problems, chemicals were the predominant means of control in all the counties. Overall, 90%, 92%, 84%, 92%, 86%, 92%, 88% of all respondents sampled reported that they used chemicals against fungus, aphids, cutworm, leaf rust, grain borer, spider mites, and white, respectively.

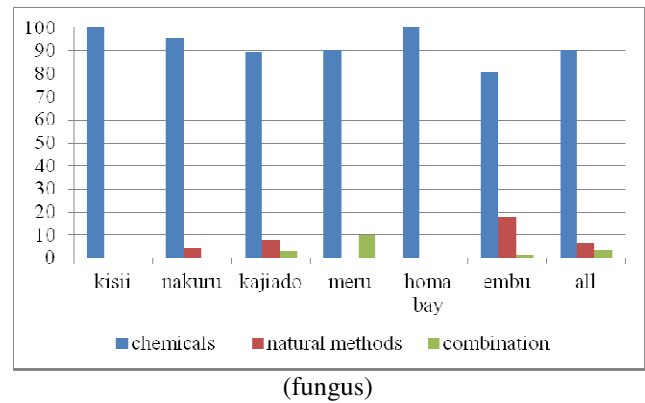
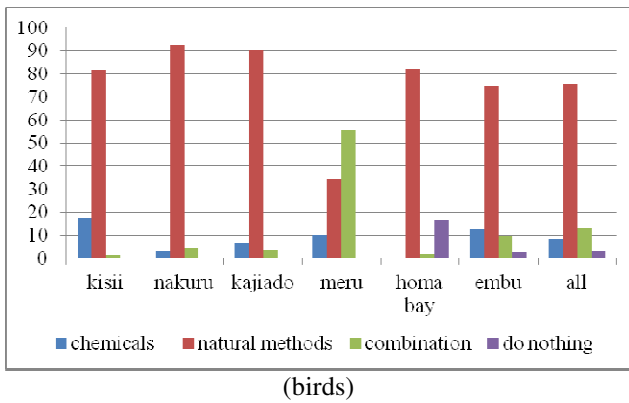
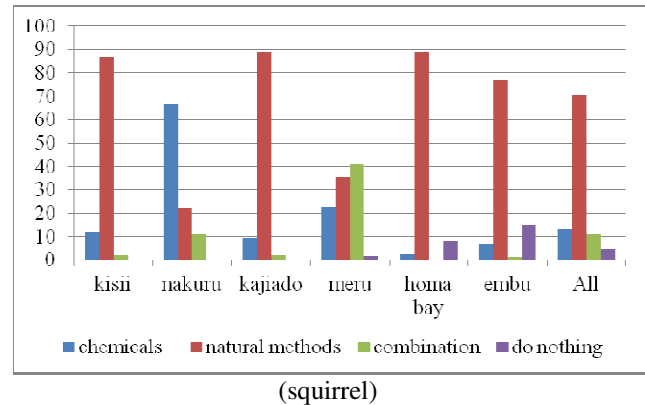
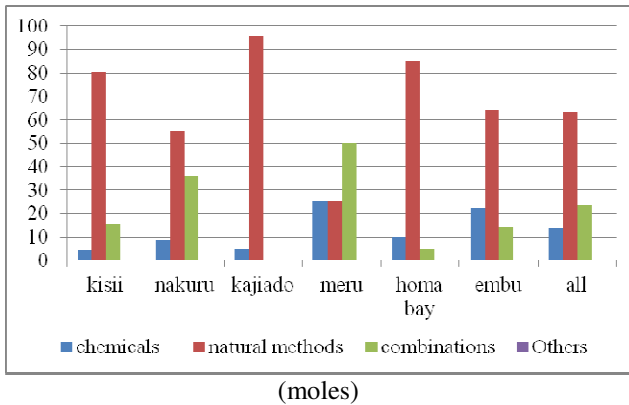
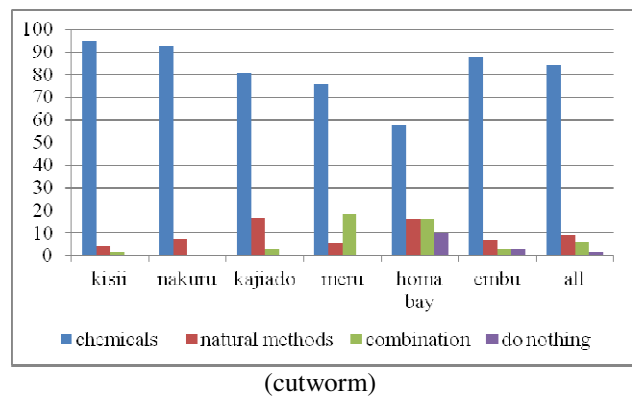
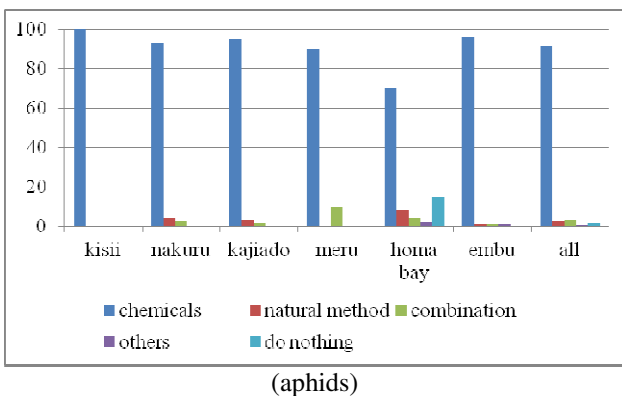


Fig.5. Distribution of household by common methods used to control problems associated with fungus, bacterial and insect pest



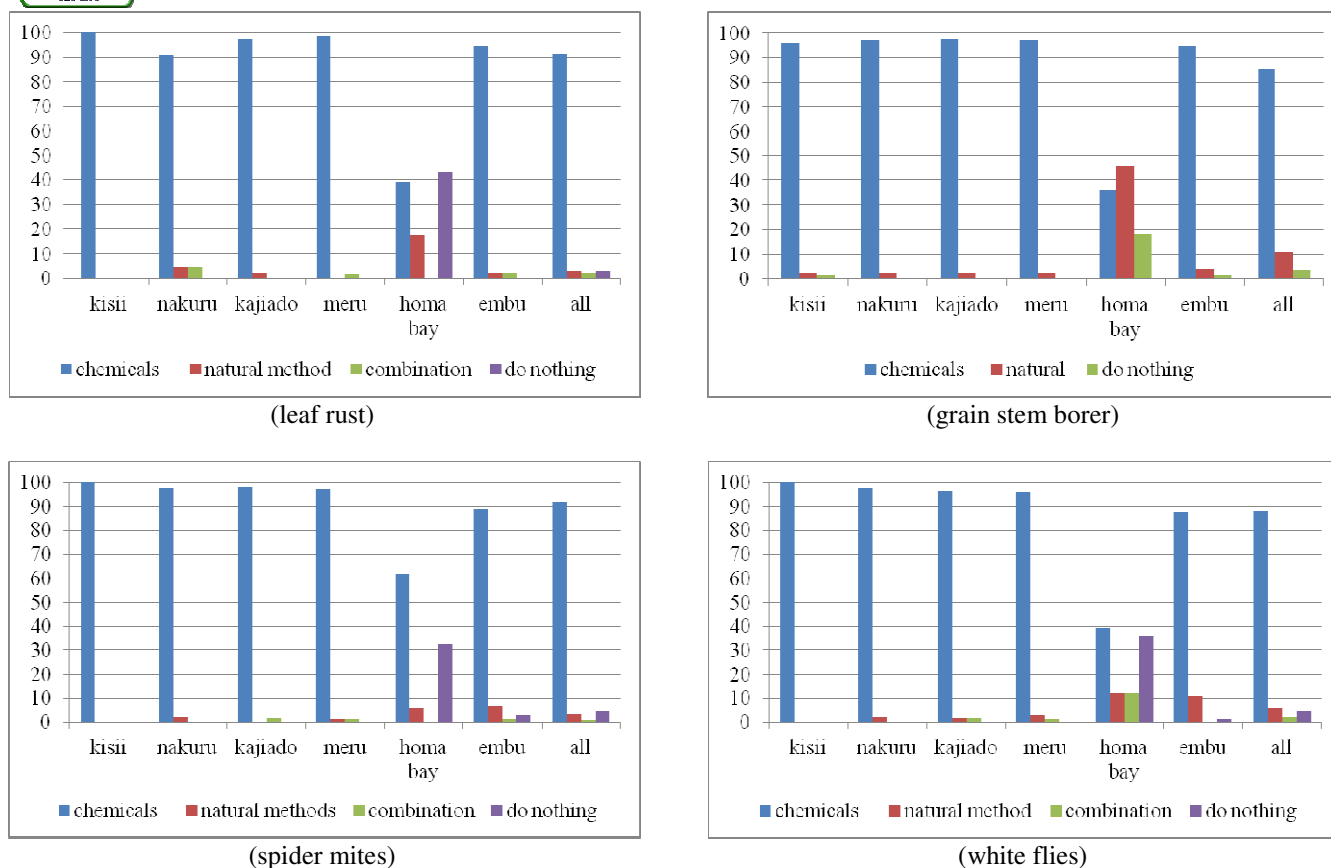


Fig.6. Common methods used to control birds, rodents and soil erosion

F. Farmers' knowledge and practice of ecological organic agriculture

To assess farmers' knowledge and use of EOA, the respondents were asked whether they had ever used any of the known EOA cultural practices. These included use of a select pesticidal plant and ashes in controlling insect pest, and use of a select soil amendment practices. Where the farmers indicated that they had never used any method,

they were asked to state why not. For those who had used, they were asked to state how they had learnt about its use. With respect to pesticidal plants, questions were posed on four plants including coriander, gallant soldier and tephrosia. Results in Table 5 show that overall, very few of the respondents had ever used the plants. Pepper, which showed better utilization level, had been used by only about 41% of the farmers. Ashes had been used by only 34% of the respondents.

Table 5: Percent distribution of household producer by use of select pesticidal plants

Pesticidal plant for pest control	Kisii %	Nakuru %	Kajiado %	Meru %	Homa bay %	Embu %	All %
Coriander	14.67	0.00	3.95	8.16	0.00	9.46	5.62
Gallant soldier	1.33	0.00	2.63	10.20	1.37	1.35	2.24
Tephrosia	1.37	0.00	2.63	22.45	1.37	0.00	3.61
Pepper	77.03	10.81	7.89	48.98	52.70	56.76	41.35

Concerning the use of soil amendments, the respondents were well-versed and had used many known soil and water conservation methods as shown in Table 6. It is however notable that, although the majority of the respondents reported they were using several soil fertility enhancing methods such as crop rotation indicated by about 96% of the respondents, intercropping by 94%, use of soil and water conservation (94%), soil conservation (88.8%), incorporation of farm residue (86%), cover crops (77.5%), animal manure (76%) and mulching (74.6%), the use was

probably not well-informed. This is deduced from the fact that very few (4.46%) had had their soil tested at any one time. Also notable is the discrepancy between the number of respondents that indicated they limed their soil and the number that indicated they corrected their soil pH. Overall, 12.30% of the respondents indicated they had limed their soil but only 3.79% indicated they had corrected their soil pH. This may mean that most of those who limed did not know why they were liming.

Table 6: Percent distribution of respondents' use of soils amendment methods in 6 counties (%)

Soil amendment strategy	Kisii %	Nakuru %	Kajiado %	Meru %	Homa bay %	Embu %	Overall %
Incorporation of farm residue to improve soil fertility	90.67	77.33	100.00	85.71	94.74	89.04	86.38
Compost to improve soil fertility	88.00	22.67	17.11	65.96	30.67	90.41	53.93
Mulching	94.67	38.67	81.58	93.88	55.26	89.04	74.55
Green manure	13.51	8.22	5.41	30.61	54.79	16.44	21.18
Intercropping	100.00	94.67	97.37	91.84	90.79	90.41	94.18
Crop rotation	100.00	78.67	98.67	89.80	86.84	95.89	95.89
Cover crops	100.00	80.00	54.05	91.84	62.67	94.52	77.53
Use of farm yard and animal manure	98.63	88.00	95.95	95.74	72.00	71.23	86.62
Green fallow period	1.33	1.33	25.00	14.89	39.19	12.33	15.03
Liming	5.41	1.33	1.33	21.74	0.00	50.68	12.30
Inorganic fertilizer	92.00	97.33	5.33	87.23	10.53	78.08	58.78
Animal manure	95.95	92.00	43.84	93.62	62.67	68.49	75.91
Soil testing	10.67	0.00	1.32	8.16	3.95	5.48	4.46
Correction of soil pH	6.67	0.00	1.32	10.20	1.32	5.48	3.79
Soil conservation measure	97.33	86.67	89.33	95.74	90.79	87.67	88.76
Nitrogen fixing plants	98.67	28.00	4.11	36.73	31.08	89.04	46.28
Ploughing in leguminous plants	74.67	5.33	15.28	8.16	76.00	57.53	39.50
Mexican sunflower	5.33	4.05	5.48	2.04	6.58	75.34	16.22
Zero tillage	42.25	5.41	47.95	25.53	17.57	12.28	24.11
Push pull	16.22	6.67	5.26	6.12	5.33	2.78	6.74
Compositing farmyard manure on the farm	90.76	28.00	60.53	57.14	41.33	94.44	63.78
Use of soil and water conservation technologies	100.00	91.89	98.68	81.25	94.59	91.67	93.91
Bio-slurry	28.00	1.35	8.00	6.12	4.11	11.11	9.50

Table 7 summarizes the reasons for non-use of the EOA cultural practices. Analysis of non-use of the methods suggests that lack of knowledge of the possible strategies was a major reason. Of the respondents who indicated that they had never used the pesticidal plants and ashes, over 70% stated that they had never heard that the plants could be utilized for pest control, while the rest said that they

lacked practical skills on how to use them. Similarly, non use of soil amendment methods was attributed to lack of knowledge, with the percentage of respondents who had never heard of the methods varying greatly. Of the respondents who had used the various methods, learning from other farmers was the most cited source of knowledge and skill.

Table 7: Distribution of respondents by reason for never having used any pesticidal plant

Status of practice use	Never heard of it	Lack of practical skills	Lack of capital	Labour constraints
Coriander for pest control	87.62	11.90	-	0.48
Gallant soldier for pest control	87.61	11.01	0.46	0.92
Tephrosia for pest control	87.12	11.71	0.70	0.47
Pepper for pest control	71.15	27.69	0.77	0.38
Ashes	76.64	21.31	0.41	1.23
Not incorporating farm reduce into soil	36.07	24.59	9.84	4.92
Non use of composite	37.07	39.51	0.98	18.05
Non use of mulching	30.70	22.81	4.39	22.81
Non use of green manure	61.27	26.3	6.94	4.05
Non use of crop rotation	27.78	47.22	2.78	16.67
Non use of cover crop	25.00	39.00	9.00	10.00

IV. CONCLUSIONS

The study revealed that the smallholders in Kenya grow a wide variety of crops on their farms, which may constitute a valuable combination in the application of EOA strategies, especially with respect to pest and disease control. However, despite the wide diversity, the

respondents interviewed showed little understanding of the potential of available diverse options of controlling pests and diseases. Chemical control methods were the most common methods of controlling insects and pests. On the other hand, the respondents seemed better informed about natural soil amendment methods, especially those that require intensive labour. Methods requiring technical

support such soil testing and pH correction were not well-known nor understood.

The wide cropping mix and wide application of soil amendment practices imply that the current cultural practices incorporate many aspects of EOA, especially those that are labour intensive. While this may not be by design, it is nevertheless important and forms an important entry point for intervention focus. Poor communication and lack of dialogue among research institutions, extension agents and rural farming communities could be contributing to this gap leading to perpetual food insecurity, low incomes and environmental degradation among smallholder farmers. There is need therefore to increase support of knowledge from research and demonstrated practice into use, and strengthening capacity of organizations to promote uptake of EOA practices. Thus the important recommendations emerging from the study are:

- Ways and means should be sought to reinforce EOA already inbuilt in current smallholder farmer practices. This can be done through awareness creation of EOA that are compatible with currently prevailing practices so that farmers can enhance on them and apply them with better knowledge and guidance.
- Farmer-to-farmer extension should be used as one strategy of up-scaling and replicating methods already in use among some farmers.
- Strategies should be designed of disseminating practices that require technical knowledge and skills.

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Note: Figs 1, 2, 3, 4, 5 and 6 are required in color printing.