CONSULTANCY SERVICES FOR ASSESSING FACTORS HINDERING THE PRODUCTION OF ORGANIC INPUTS AND ANALYZING TOOLS/EQUIPMENT FOR FACILITATING THE ADOPTION OF SELECTED AGROECOLOGICAL PRACTICES IN UASIN GISHU, LAIKIPIA AND MERU COUNTIES

FINAL REPORT

SUBMITTED TO: CEREAL GROWERS ASSOCIATION

SUBMITTED BY:

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This study has been carried-out in partnership with:

1. INTRODUCTION

This report details the consultant's findings of the study titled, 'Assessing Factors Hindering the Production of Organic Inputs and Analyzing Tools/Equipment for Facilitating the Adoption of Selected Agroecological Practices in 3 Counties in Kenya'. It also outlines actionable recommendations for the improved adoption of agroecology practices (AEPs) among farmers specifically organic input production and upscaling the current organic input production among the agroecology champions (AECs). The report also has a detailed tool/equipment fact sheet describing tools/equipment resourceful in AEP among smallholder farmers.

1.0. Background

Since 2022, the Cereal Growers Association (CGA) and Fert have been promoting AEPs in Meru and Laikipia Counties through; demonstration plots, trial and learning sites and training. Some of these AEPs piloted and promoted include; the production and use of bio-fertilizers and bio-pesticides, soil protection and water management (mulching, crop residues, terracing, basins), crop rotation, soil fertility improvement through manure/ compost, planting of beneficial trees and hedge crops (such as; Tithonia, Tephrosia, Leucena etc.) and minimum soil disturbances practices. In 2023, 40 AECs received hands-on training on the production of bio-inputs and were equipped with a start-up kit comprising of knapsack sprayers, worms, seeds and seedlings of bio-fertilizers and bio-pesticides and an agroecology manual containing methods of preparing the bio-inputs. This training aimed to enable the AECs to produce organic inputs in volumes that would allow for subsistence and surplus for possible sale to other farmers. However, in March 2024, it was noted that very few AECs have fully adopted these practices. One of the major challenges cited by the AECs is that some of the practices are labour-intensive hindering its large-scale adoption, especially among elderly farmers who are the majority in groups working with CGA. This among many other factors affecting the implementation of AEPs necessitated the need for this study to unearth the key drivers and challenges to the production of organic inputs and come up with practical recommendations and analyze the tools and equipment to improve and scale the adoption of organic inputs production and minimum soil disturbance practices.

1.1. Overall Objective

The overall objective of this study was to analyze the success factors and constraints for the adoption of organic inputs and non-motorized minimum soil disturbance practices, analyze existing solutions and/or propose solutions to facilitate the adoption of the same. This was achieved through the following specific objectives:

a) To analyze the difficulties faced by AEC in adoption and promotion of AEPs.
b) To analyse the critical success factors and the constraints for upscaling the production of organic inputs.
c) To evaluate and provide recommendations for upscaling production of organic inputs.
d) Through literature, interviews with farmers and other stakeholders, elaborate a benchmark of needed or existing solutions for small-scale farmers in terms of tools and

equipment (manual, ox-driven etc.) for agroecological practices such as; minimum tillage, planting, harvesting biomass (ex: tithonia), chopping biomass, spreading manure and others according to the needs expressed by farmers. This benchmark will include information on cost, availability, characteristics, advantages and weaknesses

e) To identify willing fabricators for potential collaborations.
f) To analyze existing opportunities for the facilitation of the acquisition of AEP machines and equipment.

2. METHODOLOGY

This section describes the study area, study design and approach that were employed by the consultant to achieve the objective of the assignment which was to analyze the adoption of organic input production by the AECs. The methodology adopted by the consultant to achieve the objectives of this assignment is described below;

2.0. Study area

This assignment was conducted in Meru, Uasin Gishu and Laikipia Counties of Kenya.

2.1. Study design

This study employed a mixed-methods approach which entailed; a desktop review, survey questionnaire, Focus Group Discussions (FGDs), Key Informant Interviews (KIIs) and farm/field observations.

2.2. Study sample

This study employed a non-probabilistic sampling method. This sampling method was chosen since the target population included the trained AECs and other specific respondents such as; fabricators and CGA field staff. In non-probability sampling, the study samples are subjectively selected by the researcher as in the case of this study where the consultant with the help of CGA identified the AECs. Under this sampling technique, purposive sampling was used to select the trained AECs for individual interviews. The sample size of 23 trained AECs was distributed as follows; 5 AECs for Uasin Gishu County, 10 AECs for Meru County and 8 AECs for Laikipia County.

2.2.1. Data collection tools

Primary and secondary data were collected for the study. Secondary data was collected through a desktop review of available literature and reports. Primary data was collected using the following data collection tools;

- Semi-structured questionnaires- simple questionnaires targeting individual AECs to capture their key characteristics, the AEPs they engage in, their successes as AECs, and their challenges among others.
- KII Guide- this targeted key resource persons from the youth farmer groups, women farmer groups, fabricators, farmers who have used tools/equipment to aid AEPs, CGA staff and other experts in the field of agroecology. The consultant conducted in-depth

interviews with the key informants using the KII guides. This took approximately 1 hour per key informant.

- FGD Guide- targeted farmers who are members of CGA, mostly discussing their collective challenges, actions, opportunities, and lessons in their adoption of AEPs such as minimum tillage. The FGDs were used as a platform to share with the farmers some of the tools/equipment in the fact sheet to get their feedback and suggestions.
- A checklist served as an observation guide for the consultant as she interacted with a variety of respondents.

2.3. Data management and analysis

Quantitative data from the semi-structured questionnaires was coded and cleaned in Microsoft Excel and exported to the R statistical software version 4.3.3 for analysis. Data from the key informants and FGDs were translated into thematic areas. The field observations were summarized and carefully interpreted.

3. RESULTS

3.1. Socio-demographic characteristics of the AECs

The youngest AEC was 23 years whereas the eldest AEC was 77 years with a mean age of 39.4 years. Most of the AECs were falling between the ages of 35 to 55 years indicating that most of them across the three counties belong to the energetically active age group who would improve the productivity of agriculture upon application of the AEPs.

Table 1. Age (in years) of the AECs

Respondent Age:	
Mean	39.4
min	23
max	73

Table 2. Demographic characteristics of the AECs

Most of the AECs across the three counties were found to have attained either a secondary or tertiary level of formal education. These education levels indicate that most of the AECs can read and write and may therefore accept new ideas and knowledge more avidly.

Demographic characteristics	Categories	Percentage
Gender	Female	53.3%
	Male	46.7%
Level of education	Primary	20%
	Secondary	40%

	Tertiary	40%
Marital status	Married	80%
	Single	20%
Position in the household	Child	20%
	Household head	40%
	Spouse	40%

3.2. Characteristics of the AEC's Farming Practices.

2.1. Land ownership and farm size

Land ownership influences managerial practices and the adoption of a new agricultural technology. Farmers who own land are likely to apply practices like agro-forestry, fallowing and integration of landscape into agriculture fields as they are sure of getting benefits for a long time as compared to hired land whereby farmers may not be willing to invest in practices that take relatively longer time to realize the benefits (Constantine et al., 2021). The findings of this study revealed that 73% of the AECs either owned and/ or leased their farmland with either a lease certificate or a title deed as shown in Figure 1. This shows potential for the growth of biomass for use in organic input especially for farmland owned by the AECs as opposed to communal land which requires a group of people in the community to decide on what to plant or how the land can be utilized. It was also noted that 7% of the AECs who use family land for farming were mostly youths, using mostly their parents' farms.

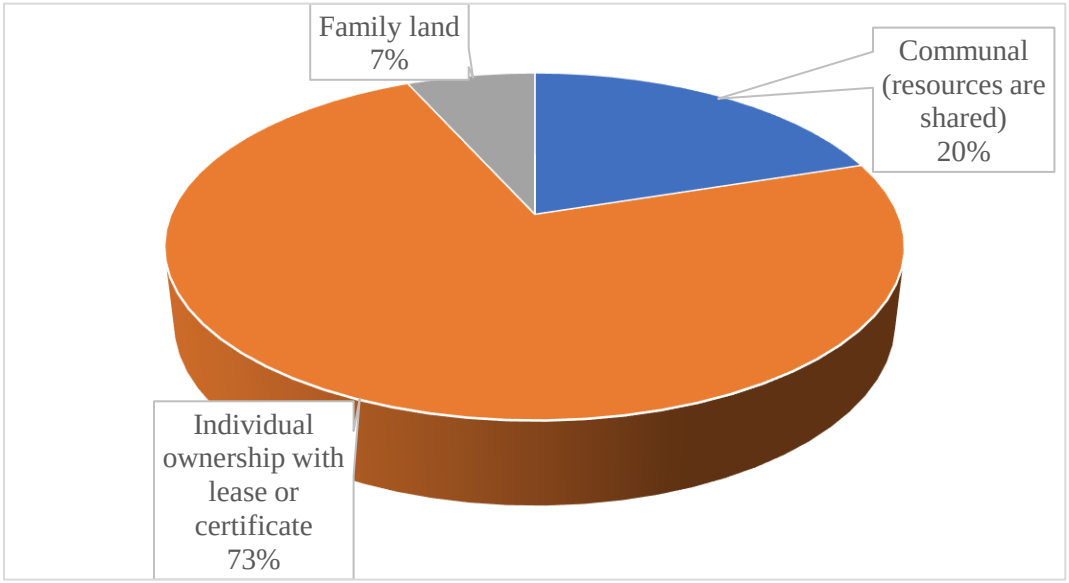

Figure 1. Land ownership among the AECs

The results indicated that across the 3 counties, most AECs are small-scale farmers with a mean of 2.38 acres of agricultural land owned and 2.37 acres of agricultural land rented. Among the AECs, the smallest land size owned was 0.25 acres while the largest agricultural land owned was 9 acres (Table 3). These findings depict a true picture of the Kenyan agricultural terrain where small-scale farmers carry a larger share of agricultural production than large-scale farmers. Other studies have shown that small-scale farmers have a greater possibility of adoption of relevant AEPs such as crop rotation compared to large-scale farmers (Constantine et al., 2021). This is mainly because smallholder farmers are more likely to adopt new technologies as small farms are flexible in accommodating new changes compared to large farms. However, this is dependent on the level of investment required by smallholder farmers to adopt the AEPs. Since small-scale farmers at times can be averse to take risks because if they fail, their food safety might be at higher risk.

Table 3. Size of agricultural land owned/leased by the AECs

	Acres of agricultural land owned	Acres of agricultural land rented
Mean	2.38	2.37
Median	1.75	2
min	0.25	1
max	9	6

3.2.2. Main value chains of the AECs

Across the 3 counties, the AECs mainly planted maize, beans and vegetables as shown in Figure 2. Most of the AECs were also found to be carrying out several farming activities which could hinder their adoption of some AEPs that require a lot of time in their implementation. Some parts of Uasin Gishu and Laikipia counties had AECs engaged in potato, wheat and sorghum farming. Majority of the AECs report planting the cereals such as maize, beans, wheat and sorghum in leased farms for mostly commercial purposes. Vegetables and other short-term horticultural crops were mostly planted in the individual-owned land for mainly subsistence and for selling at the farm gate to locals around them. This shows a greater potential for increased adoption of AEP mostly in this short-term for high value crops such as vegetables among the AECs.

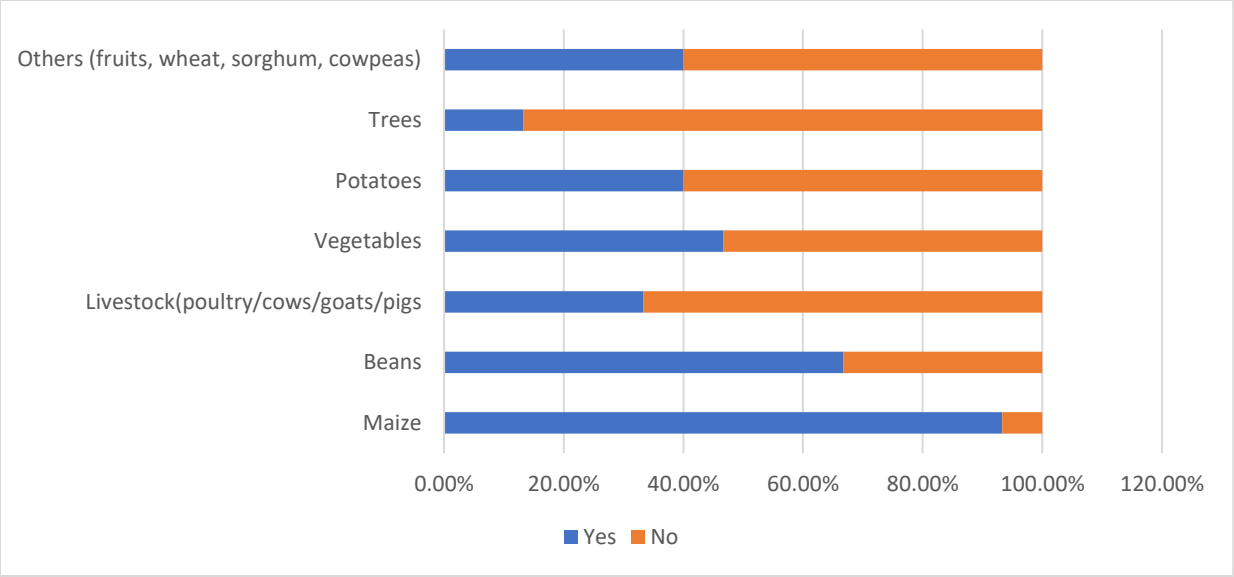

Figure 2. Value chains engaged in by the AECs

3.2.3. Type of AEPs adopted by the AECs

Figure 3 shows the adoption rates of different AEPs among the AECs across the three counties. The practices are categorized into two responses: "Yes" (indicating adoption) and "No" (indicating non-adoption). The majority of the farmers, over 80%, have not adopted crop rotation or mulching practices. Despite their known benefits for soil fertility and moisture retention, the low adoption rate suggests inadequate awareness, training, or perceived benefit from these methods. It could also indicate a preference for more immediately impactful practices.With regards to agroforestry, about 80% of the farmers have not adopted agroforestry. Agroforestry, which integrates trees into farming systems, may be less appealing due to longer-term benefits rather than short-term gains. Farmers may avoid agroforestry because it requires space and time investment before the benefits are realized, which could be challenging for those with smaller landholdings. However, there are aspects of agroforestry in the counties that have not been considered as agroforestry by farmers. Instances include volunteer shrubs around the fences that provide fodder for livestock and shade trees such as grevillea integrated within the farming systems.

Roughly half of the farmers use intercropping as a farming practice. Intercropping has a higher adoption rate, likely because it is a relatively easy practice to implement and offers immediate benefits like improved pest control, increased yield diversity, and better resource use. AECs may find it more manageable compared to other AEPs. With regards to minimum tillage, around 40% of the AECs have implemented this technique. Minimum tillage adoption shows promise but still lags. Farmers may be cautious due to traditional plowing methods or lack of equipment for effective minimum tillage. However, the relatively high adoption rate could indicate increasing awareness of the soil health benefits. Over 80% of the AECs have adopted organic input production (biopesticides, biofertilizer, compost, bokashi) at small scale.

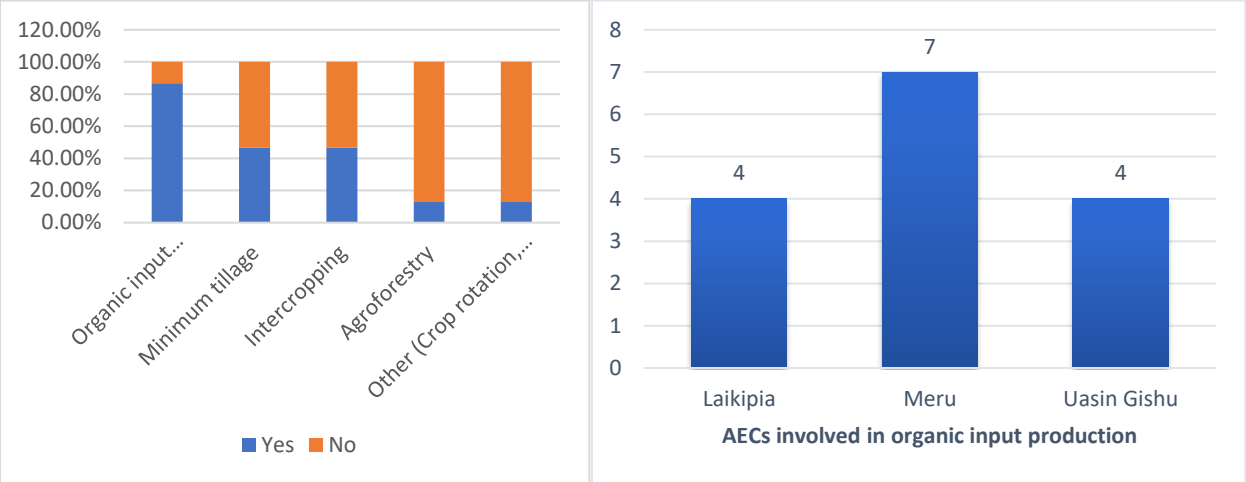

Figure 3. Types of AEPs adopted by AECs

3.2.4. Size of land used for AE

The average size of land committed under AE by the AECs is 1.08 acres with a minimum of 0.25 acres and a maximum of 3 acres. This shows that most AECs practice AE in small portions of agricultural land, which could explain the low organic input production as most AECs produce the inputs for their consumption.

Table 4. Size of land used for AE

	Size of land used for AEP (acres)
Mean	1.0833
Minimum	0.25
Maximum	3

3.2.5. Perceived Benefits of AEPs by the AECs

Figure 4 depicts the perceived importance of various benefits of agroecology practices among smallholder farmers. The AECs stated the importance of AEP, the 5 major points mentioned by most AECs were then each allocated a Likert scale by the consultant to ease in analyzing the most vital benefits. The findings revealed that ‘better health’ was the least considered "Extremely Important" by the AECs. The less interest in health likely reflects minimal concerns about the use of harmful chemicals in conventional farming. Additionally, ‘environmental protection’ was also ranked highly by the AECs. Agroecology often emphasizes sustainability and reduced environmental impact, making this a significant priority for farmers. Another benefit highly ranked by the AECs is AEPs as a ‘cheaper farming method’, nearly 50% of the AECs considered cheaper farming methods as "Extremely Important." This reflects the reality of resource constraints faced by smallholder farmers, where cost-effectiveness is critical. About 20% rated

cheaper farming methods as "Important," demonstrating that affordability plays a major role in farming decisions. Furthermore, increased income was considered a key priority, with around 40% of the AECs perceiving it as an "Extremely Important" benefit of AE and a significant number choosing "Very Important." Income growth is a clear driver for adopting AEPs, suggesting that farmers are looking for ways to improve profitability while adopting more sustainable practices. Increased yield stood out as another top priority, with about 50% of the AECs rating it as "Extremely Important." This likely stems from the need to ensure food security and make farming efforts more productive, a key consideration for smallholder farmers.

This data indicates that while all benefits are important to varying degrees, cheaper farming methods, increased yield, and income generation are the most pressing factors for the AECs and the smallholder farmers they represent. These results align with the economic realities smallholder farmers face, where profit margins are small, and resources limited. Additionally, the emphasis on better health and environmental protection suggests that farmers are not solely profit-driven but are also aware of the environmental and health impacts of their practices.

Farmers who prioritize income, yield, and affordability might be more likely to adopt AEPs if these practices can **demonstrate clear economic benefits**. However, the interest in environmental protection and health shows that there is a broader understanding of the long-term benefits of sustainable agriculture. This suggests that training focusing on both the economic and environmental impacts of AE could be effective in driving further adoption.

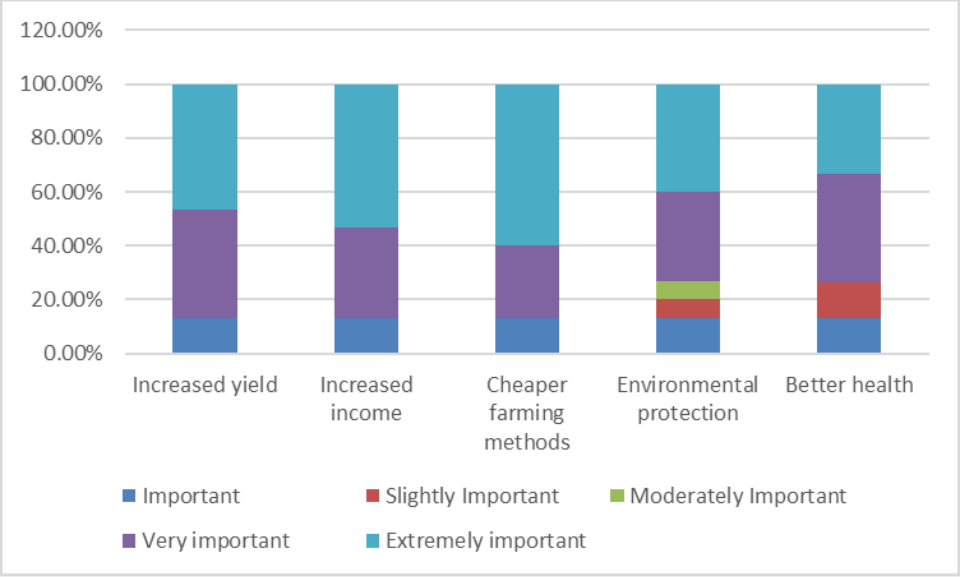

Figure 4. Benefits of practicing AE as perceived by the AECs

3.2.6. Types of organic pesticides commonly used by AECs

Name of organic pesticide	Percent

Tithonia tea	73%
Chilli (*pilipili*)	53%
Ash	20%
Garlic	13%
Mexican merigold	13%
Paw paw leaves	13%
Aloe Vera	13%
African tissue leaves	7%
Black jack tea	7%
Tobacco	7%

Tithonia Tea (73%) was the most produced and used organic pesticide among the AECs. *Tithonia* is a common plant in Kenya, and its leaves are known for their strong pesticidal properties. The high percentage of AECs producing it suggests it is both effective and readily available to them, making it a popular choice. Chilli (53%) was another widely used organic pesticide. Its strong compounds deter pests, and being a common crop, most of the AECs grow it themselves or source it locally. Its high usage points to its effectiveness in managing a variety of pests. Ash is known for its ability to deter soft-bodied pests and serve as a desiccant. While not as popular as *Tithonia tea* and chilli, it was still used by a notable percentage of AECs, possibly because it's a by-product of household activities, making it cost-effective. Garlic, Mexican Marigold, Pawpaw Leaves, and Aloe Vera (13%): These four pesticides were used by a similar percentage of AECs. Garlic is known for its insect-repelling properties, while Mexican marigold and pawpaw leaves contain compounds toxic to pests. Aloe vera has antibacterial and antifungal properties. Their moderate use suggests that although effective, they may be less accessible to the AECs than *Tithonia* and Chilli. African Tissue Leaves, Black Jack Tea, Tobacco (7%): These pesticides are less commonly used. Tobacco is known for its strong alkaloid content, which is toxic to insects, while African tissue leaves and blackjack tea may be less well-known or harder to source, contributing to their lower usage.

3.2.7. Organic fertilizers

Compost was the most commonly used organic fertilizer with 40% of the AECs producing it, this is likely because it can be produced from a wide variety of farm and household waste. This practice reflects AECs' efforts to recycle organic material, improve soil health, and reduce dependence on chemical fertilizers. Composting is cost-effective, sustainable, and enhances soil structure and microbial activity. This overwhelming preference for compost reflects a strong reliance on traditional and accessible methods to manage soil fertility.

Tithonia was also common with around 25% of the AECs using it as a biofertilizer. *Tithonia* is a plant that is frequently used not only as a pesticide, as seen earlier, but also as an organic fertilizer due to its rich nutrient content, particularly nitrogen, phosphorous, and potassium. Most AECs use it to boost soil fertility, which highlights its versatility in small-scale farming.

The use of cow manure and other animal manure as organic fertilizers was also quite common, reflecting the importance of livestock in these farming systems. These materials add valuable nutrients and organic matter to the soil. Although widely used, their application was lower than compost due to the need for livestock and availability constraints. Vermiliquid, a liquid form of vermicompost (produced through worms) was the least used with around 5% of the AECs having used it. Its lower adoption was mainly attributed to the perceived 'complexity' of its production due to inadequate support given to the AECs compared to compost or animal manure, though it is highly effective in providing plants with readily available nutrients. Therefore, more support in form of training is needed to by the AECs with regards to vermicomposting.

3.2.8. Challenges faced by the AECs in the production of organic inputs

Figure 5 presents the key challenges that the AECs outlined with regards to the production of organic inputs. Similar to the perceived benefits, the AECs outlined their challenges and the five commonly mentioned challenges were ranked in a Likert scale for the consultant to identify the most significant ones. Inadequate financial capacity was the most critical challenge cited by the AECs, with a significant portion (more than 50%) identifying it as a "Very significant challenge." Many farmers lack the financial resources needed to invest in organic input production, which mostly includes acquiring labour and, tools/equipment. Only a small percentage viewed this as "Slight" or "Not a challenge at all," indicating that financial constraints are almost universally felt.

Inadequate knowledge and skills were also significant barriers, with a high percentage of the AECs perceiving this as a "Very significant" or "Significant challenge." This implies that many AECs still need more training or education in producing these biofertilisers and biopesticides. For instance, concerning vermicomposting, the AECs across the 3 counties identified inadequate knowledge of the management of worms as a main hindrance in the production of vermicompost and vermiliquid. Most of the AECs excessively wet the worms' habitat with water which led to the death of the worms, others left the habitat too dry which also destroyed the worms whereas others did not elevate and close the habitat causing other predators to attack the worms. Another grey area was about the harvesting of the vermiliquid, most AECs mentioned the need for more training on vermiliquid harvesting and vermicompost harvesting. In addition, the interviews with the AECs especially the older AECs revealed that more training and learning are still needed in matters of organic input production. The farmers pointed out that the 2-day training in Meru County on AEPs in December 2023 was heavily loaded with new knowledge on different types of organic inputs and thus follow-up training was needed to enable farmers to comprehend and adopt the various techniques.

Inadequate access to raw materials (e.g., tithonia, tephrosia, cow dung) was also highlighted as another major issue. More than 40% of farmers consider this a "Very significant challenge." Access is critical because organic input production depends on the consistent availability of biomass. Some AECs, however, do not find it a challenge, which could be due to geographical differences in material availability. For instance, in Laikipia County, Laikipia West sub-county, the major challenge is the access to the raw material (tithonia), some AECs have tried planting

Tithonia but due to the climatic conditions, the plant did not grow. On the other hand, in Meru County, tithonia is freely available in the farms of the AECs and the surrounding environment, their major challenge is the intensity of labour needed in producing the tithonia tea. In Uasin Gishu County, the major challenge is similar to Laikipia concerning access to raw material, only two AECs in the county have access to tithonia.

Lack of tools/equipment was another significant challenge, with many AECs seeing this as "Very significant." The absence of basic tools necessary for organic input production, such as composting equipment, biomass shredders, storage tanks etc., severely hampers production capacity. A small proportion of farmers feel this is a minor challenge, possibly because they have access to some tools. Generally, financial constraints are the most pressing issue, followed closely by lack of tools/equipment and knowledge gaps. There is also a significant issue regarding the availability of raw materials, though this may vary across regions depending on local resources. These challenges highlight the need for targeted interventions, including access to finance, farmer training programs, better distribution of organic input materials, and provision of tools and technology.

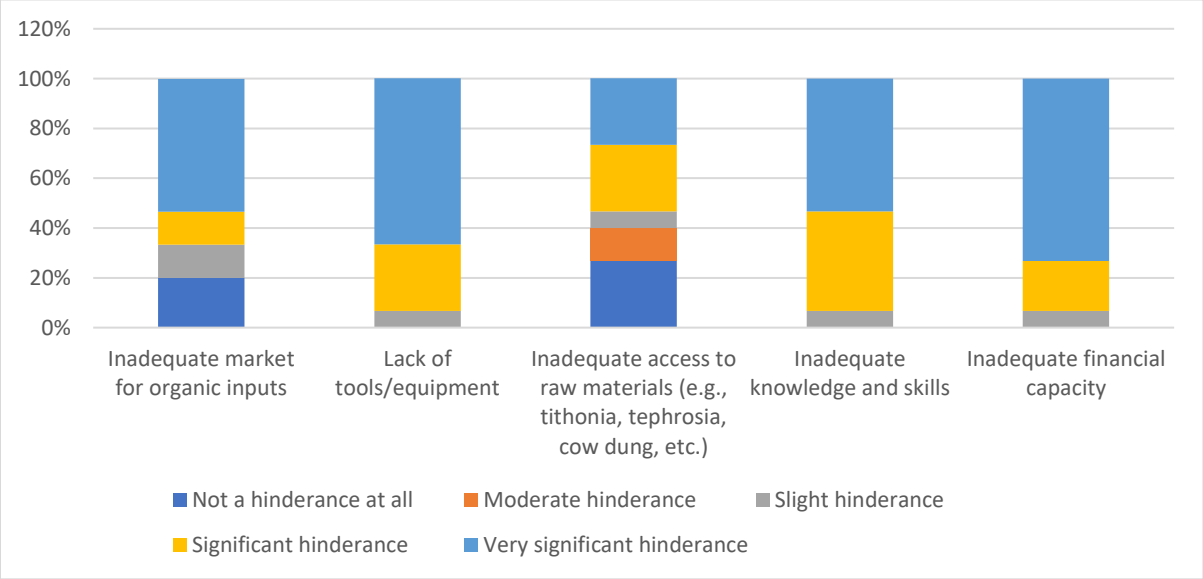

Figure 5. Challenges faced by AECs in organic input production

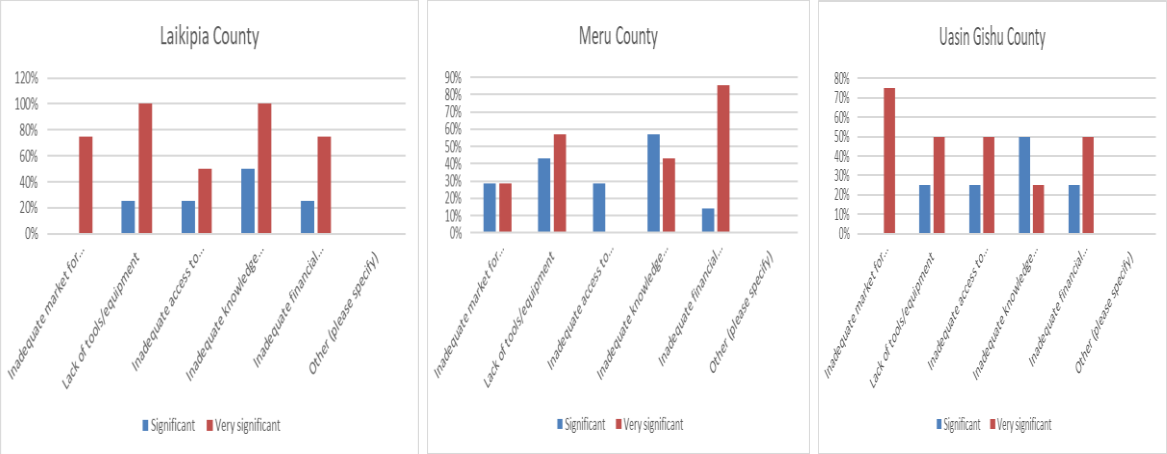

Figure 6. County specific challenges

Figure 6 highlights significant challenges faced by agroecology champions in the production of organic inputs across Laikipia, Meru, and Uasin Gishu Counties. In Laikipia, inadequate knowledge and financial resources are the most critical barriers, with over 80% of respondents considering them "very significant." Challenges such as inadequate markets and lack of tools or equipment are also present but less severe. In Meru, financial constraints dominate, with 90% rating them as "very significant," alongside notable gaps in knowledge and tools. A high ranking of "other" challenges suggests unique, county-specific issues that require further investigation, such as policy barriers or environmental constraints.

In Uasin Gishu, the lack of tools and equipment emerges as the primary challenge, followed by significant knowledge gaps and market limitations for organic inputs. Financial constraints are less pronounced than in the other counties, suggesting relatively better resource mobilization. Across all three counties, knowledge gaps and financial challenges are consistent themes, indicating the need for targeted interventions. Additionally, the inadequate market for organic inputs, particularly in Uasin Gishu, reflects broader systemic issues in market development and demand creation. Together, these findings underscore the diverse and interrelated barriers limiting AECs capacity to scale up organic input production.

3.2.9. Factors hindering the upscaling of organic input production among the AECs

The AECs mostly cited financial limitations as a key barrier to upscaling organic input production with an emphasis on access to equipment. The most significant barrier was the lack of financial resources, which limited investment in organic input production. Without addressing this issue through access to credit or subsidies or tools/equipment, it will be difficult for AECs to scale up their production. Inadequate knowledge and skills were also another significant challenge cited by the AECs. Training and education are crucial. AECs need to understand how to produce, apply, and market organic inputs effectively. Extension services and knowledge-sharing initiatives could help overcome this hurdle. While some of the AECs had no issues sourcing raw materials, others struggled. This disparity may be due to geographic location, seasonal availability, or competition

for resources. Local sourcing solutions or better distribution networks could help address this. Smallholder farmers often lack the tools necessary to produce organic inputs efficiently at scale. Subsidies or cooperative ownership of equipment might alleviate this barrier. Furthermore, even if production is scaled up, farmers may not have access to viable markets for organic inputs. Developing market linkages, raising consumer awareness, and providing incentives for organic farming could help create more demand for these products. In conclusion, addressing these barriers will require an integrated approach that includes financial support, knowledge dissemination, better access to resources, provision of tools, and market development to help farmers successfully upscale organic input production.

3.2.10. Findings from FGDs with AECs

It was fascinating to learn about the collective preferences and challenges faced by farmers in organic input production. Across the three counties, just as found in the baseline survey, the farmers preferred the production of *Tithonia Tea* as an organic fertilizer (foliar) and as a biopesticide. In Meru, farmers reported adding other ingredients such as; chilies (*pili pili*) and baking powder to the *Tithonia tea* to increase its effectiveness as a biopesticide. Another interesting finding reported by the farmers in Meru was the use of powdered detergent (specifically *Omo* or *Ariel* brands) mixed with chilies as a pesticide against fall armyworms in maize. Other farmers in Laikipia, mentioned the addition of garlic (*saumu*) to the *Tithonia tea* to aid its effectiveness against pesticides in vegetables.

One of the main discussions in the FGDs was exploring the main reasons why *Tithonia tea* was the organic input of choice across the three counties yet the AEP guide has many other types of organic inputs e.g.; *Bokashi.* Most of the farmers reported that; *Tithonia* was easily available and accessible compared to *Tephrosia*, especially in Meru and Uasin Gishu Counties; *Tithonia* functions as foliar and as a biopesticide and is therefore considered time-saving and efficient once produced; *Tithonia* as a biofertilizer only uses one raw material compared to *Bokashi* and accelerated compost that require a mixture of 3 or more raw materials.

Some of the main challenges reported by the farmers in the production of organic input include; high labour especially during mass production, lack of big containers/tanks for producing large quantities of Tithonia Tea, lack of incinerators for burning biochar, time-consuming, biomass not easily available in Laikipia County and lack of adequate knowledge on specific biopesticides and vermicomposting. The farmers mentioned the need for mechanization in the production of these organic inputs. The common tools listed to ease the organic input production were a chaff cutter or shredding machine to aid in chopping the biomass, large storage tanks (500 litres capacity) and wheelbarrows. Concerning the field preparations, farmers reported the need for hand-driven and ox-driven rippers in Meru, and jab planters in Meru, Laikipia and Uasin Gishu Counties. Most of the farmers in Uasin Gishu and Laikipia reported difficulty in accessing oxen or donkeys for use in farms, they therefore preferred hand-driven tools to animal-driven tools.

The farmers' perceptions of the use of organic inputs on their farms sparked some interesting discussions. The farmers stated that they have noted that since the use of organic inputs in their

farms, the leaves of their vegetables have been dark green, larger in size, softer and sweeter compared to using inorganic inputs. Others reported that there has been a reduction of pests in their farms and the soils have become better in texture and structure due to the organic matter introduced.

Most of the farmers reported a grey area on the use and effectiveness of the biopesticides indicated in the AEP booklet/guide. One of the arising questions was, 'Which biopesticides are post-emergence and which ones are pre-emergence?'. Other questions raised by the farmers were, 'How effective are these biopesticides compared to chemical pesticides?', 'What is the number of times/intervals needed to spray the biopesticides on the farm?' and 'Which biopesticide is specific for whiteflies?'. These questions shed some light on the need for follow-up training on most of the biopesticides adopted by the farmers and those recommended in the AEP booklet.

RECOMMENDATIONS

To address the challenges faced by the AECs in producing and upscaling the production of organic inputs, several solutions and strategies can be considered. Outlined below are some of the actionable recommendations from the challenges cited by the AECs in producing organic inputs:

1. Farmer training and capacity building: Organizing regular workshops, field days, and training sessions on organic input production techniques (e.g., composting, vermicomposting, and biopesticide preparation) is essential. These can be facilitated by CGA and Fert across the three target counties.
2. Demonstration farms and learning sites: Establishing demonstration farms or learning sites in each of the target counties where AECs/FAs can observe organic input production and AEPs firsthand can be an effective way to build knowledge and practical skills.
3. Peer learning networks: Each county can have a mentor to the upcoming AECs. Creating farmer-to-farmer learning networks will encourage knowledge sharing within the AECs across the three counties. Experienced AECs can mentor others on best AEPs. More emphasis be placed on practical hands-on, on the select AEPs
4. Use of mobile-based apps or online platforms to provide AECs with easy-to-access information, tutorials, and updates on organic input production techniques. In addition, step-by-step guides and videos (in local languages) can be developed to assist the AECs with proper organic input production and application, targeting those who may have literacy challenges.
5. Provide specialized training for elderly farmers on techniques that minimize labor demand and emphasize the benefits of less strenuous practices, such as mulching and minimum tillage.
6. Conduct regular follow-ups and check-ins with AECs and other farmers to identify bottlenecks early and provide additional support as and when needed.

7. Incentive programs can be adopted to offer recognition, rewards, or financial incentives for AECs who successfully adopt and scale AEPs, such as producing surplus organic inputs.
8. Barter or exchange systems: AECs/FAs can establish exchange systems or trade networks within their farmer groups where raw materials eg; *tithonia* or livestock manure are shared among farmers who need them for organic input production.
9. Promoting the use of locally available materials: for instance, in Meru County, *tithonia* is easily available thus it is possible to empower AECs from that area to specialize in the production of *tithonia tea* and even package it to sell to other AECs in Laikipia County and some parts of Uasin Gishu County where the resource is scarce. In Uasin Gishu County, due to the availability of livestock manure and maize cobs in plenty, AECs in this area can be supported to specialize in large scale production of compost and accelerated compost such as bokashi and use of rumen juice as well as producing of biochar from the maize cobs. These AECs can even be supported to carry out laboratory analysis of their organic input products and even package them for selling to farmers around them.
10. Develop farmer-to-farmer market linkages by facilitating market linkages between AECs producing organic inputs and other farmers to create a clear pathway for surplus sales and income generation.
11. Since *Tithonia Tea* was the most preferred biopesticide across the 3 counties, CGA and Fert can encourage tithonia-based business models. Once AECs master *Tithonia tea* production, they can produce it in larger quantities for sale to neighboring farmers. Training can be provided on how to package and market it.
12. Initiatives that encourage local cultivation of raw materials (e.g., growing tithonia, tephrosia, chillies, comfrey, fern etc) would help. However, this will mostly be effective for the production of organic input for subsistence rather than large scale. This is because most AECs have small parcels of agricultural land therefore these raw materials can only be planted along the fences to avoid competition with the main cash crops. Supporting the FA/AEC to train and encourage farmers within their farmer groups to plant these raw materials along their fences and upon harvest aggregate them and produce the biopesticides and biofertilizers at one point might be a solution upscaling the organic input production.
13. AECs and their farmer groups can pool their financial resources to collectively buy tools and equipment useful for organic input production and thus reduce the financial burden on individual farmers. Furthermore, CGA/Fert can encourage local artisans or engineers within their network to fabricate low-cost farming tools from available materials making essential tools more affordable and accessible to the AECs. Another viable option that CGA and Fert could consider is the rent-to-own schemes, where AECs rent tools over a set period and eventually own them after paying a certain amount to CGA/Fert or to the fabricator.
14. AECs can establish community-based tool-sharing initiatives, where expensive or scarce tools such as the chaff cutters, two-wheel tractors among others are shared among a group of farmers.

15. Farmer testimonials via social media by use of a common WhatsApp group or other platforms to share success stories and tips from AECs who have successfully adopted labor-saving practices.

To address the challenges faced by the AECs regarding access to tools/equipment necessary for implementing AEPs, the following recommendations can be adopted;

1. Support access to mechanized equipment by strengthening farmer groups and cooperatives working with CGA to invest in shared tractor-driven machinery (e.g., chisel, rippers) especially in Uasin Gishu County where adoption of minimum tillage remains relatively low.
2. Facilitate partnerships between service providers and AECs, ensuring access to tractor-driven equipment at affordable rates.
3. Pilot ox or donkey-drawn and manual alternatives: consider conducting demonstrations using these tools to highlight cost-effectiveness and labor savings over time. On the demo-plots, data can be collected to analyze the performance of mechanized and manual alternatives so as to test and evaluate the effectiveness of donkey/ox-drawn, manually operated, and tractor-driven equipment for different farmer groups, including labor efficiency, costs, and yield improvements.

ANNEXES

Annex 1: Tool used for the interviews

FA/AECs Questionnaire

Interviewer's name: …… Farmer's identification code: …… Date: ……

County: …… Sub-county: …… Ward: ……

SECTION A: FARMER'S DEMOGRAPHICS

1. How old are you (in years)?
2. What is your gender? (Male, Female, Other)
3. What is your current level of education? (Primary, Secondary, Tertiary)
4. What is your marital status? (Single, Married, Divorced/Widowed)
5. What is your position in the Household? (Household Head, Spouse, Child, Other (specify))
6. Are you a trained agroecology champion (AEC)? (Yes, No)

SECTION B: AGROECOLOGY PRACTICES (AEP)

I would like to ask you some questions about your agricultural practices.

1. What is the form of ownership of your land?

(Individual ownership with lease or certificate, Individual ownership under customary law,

Communal (resources are shared), State ownership, Other (specify) _____)

2. How many hectares of agricultural land do you own?
3. How many hectares of agricultural land do you rent, borrow or have the right to use?
4. What are your main productive agricultural outputs or value chain? Select as many as necessary (*Maize, Beans, Livestock-poultry/cows/goats/pigs, Vegetables, Potatoes, Trees, other(specify)*)
5. Which type of AEPs have you adopted on your farm? (*Organic input production-biopesticides/biofertilizer/compost/bokashi, minimum tillage, intercropping, agroforestry, other(specify)*)
6. In this agricultural land, approximately how much of it is used for AEP?
7. How would you rate the importance of using AEPs on your farm for the following reasons? (*Please rate on a scale from 0 to 5, with 0= "Not important at all", 1= "Slightly Important", 2= "Very Important", 3= "Important", 4= "Moderately Important" and 5= "Extremely important"*)
   i. Increased yield
   ii. Increased income
   iii. Cheaper farming methods
   iv. Environmental protection
   v. Better health
   vi. Other (please specify)
8. Are you currently practicing minimum tillage in your land? (*Yes, No*)
9. If 'No', what are some of the factors hindering you from practicing minimum tillage in your land?

SECTION C: ORGANIC INPUTS

1. *Kindly list all the types of organic inputs you are currently using on your farm. For each organic input, kindly inform me of its source, the quantity produced, the quantity used and the amount of land in which the input is used.*

Name of organic pesticide	Source: Self-Produced or Purchased?	Quantity Produced (*In*	Quantity Used (*In Liters or Kilograms*)	Amount of area in which the pesticide has been used (*acres*)

		Liters or Kilograms)		
1.				
2.				
3.				
4.				
5.				
Name of organic fertilizer	Source: Self-Produced or Purchased?	Quantity Produced (*In Liters or Kilograms*)	Quantity Used (*In Liters or Kilograms*)	Amount of area in which the fertilizer has been used (*acres*)
1.				
2.				
3.				
4.				
5.				

2. Where did you learn how to produce the organic inputs mentioned in *Question 1*? (*CGA/Fert, Agricultural Extension Officers, NGO/CBO, Group/Cooperative Society, Other(specify)*)
3. Which Challenges/Constraints are you facing in the Production of Organic Inputs on your farm?

Please rate the following challenges/constraints faced in the production of organic inputs: (*Please rate on a scale from 1 to 5, with 1= "Not a challenge at all", 2= "Slight challenge", 3= "Moderate challenge", 4= "Significant challenge", and 5= "Very significant challenge"*)

i. Lack of tools/equipment
ii. Inadequate access to raw materials (e.g., tithonia, tephrosia, cow dung, etc.)
iii. Inadequate knowledge and skills
iv. Inadequate financial capacity
v. Other (please specify)

4. Factors Hindering the Upscaling/Increased Production of Organic Inputs:

Please rate the following factors hindering the upscaling/increased production of organic inputs in your farm: (*Please rate on a scale from 1 to 5, with 1= "Not a hindrance at all", 2= "Slight hindrance", 3= "Moderate hindrance", 4= "Significant hindrance", and 5= "Very significant hindrance"*)

i. Inadequate market for organic inputs
ii. Lack of tools/equipment
iii. Inadequate access to raw materials (e.g., tithonia, tephrosia, cow dung, etc.)
iv. Inadequate knowledge and skills

v. Inadequate financial capacity
vi. Other (please specify)

SECTION D: TOOLS/EQUIPMENT

1. List all the tools/equipment that you use in the production of your organic inputs.
2. How accessible are the tools listed in *Question 1*? (*easily accessible, moderately accessible, not accessible*)
3. From the tools provided in *Question 1*, are there any tools/equipment that you have innovated/fabricated by yourself? (Yes/No) If '*No*' move to *Question 4*
4. If 'Yes', what is the tool/equipment used for? Do you think this tool/equipment can be produced and sold to other farmers?
5. Which tools/equipment do you think are needed in your farm to ease the production of organic inputs?

Observation Guide

1. Ecological management of pests

Observe the farm visited and select the techniques systematically applied within the system. Tick as many as needed. (Take pictures upon consent from the farmer)

	Cultural control (more resistant varieties are chosen for production; plants and fruits presenting signs of disease are removed manually; crops are grown in crop rotation and intercropping schemes, etc.)
	Plantation of natural repelling plants
	Use of cover crops to increase biological interactions
	Favour the reproduction of beneficial organisms for biological control
	Favour biodiversity and spatial diversity within the agroecosystem
	Other (Specify)

2. AEP practices in the farm

Observe the farm visited and take note of the organic inputs produced. List all the organic inputs produced and used. (Take pictures upon consent from the farmer)

3. Tools/Equipment used in the farm

Observe the farm visited and take note of the tools/equipment used in the production of organic inputs. List all the tools/equipment used. (Take pictures upon consent from the farmer)

FGD GUIDE

FGD tool

i. Group /Village name/County:

_____

ii. Date of the interview:

_____

iii. Total attendee's male (>35) _____female (>35) _____youths (=<35) _____total_____

iv. Leadership if group male (>35) _____female(>35)_____youth(=<35)_____total_____

v. **Participants Roster**

No	Name	Age	Gender	Position if group
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

SECTION A: PRELIMINARIES

i. When was the group started? (*If applicable*)

ii. How many women are in leadership positions? How many youths hold leadership positions?

iii. Rank five main agricultural value chains in this area.

AGROECOLOGY PRACTICES

A0. How has the journey of engaging in AEPs been? Which AEPs are the most preferable to you and why?

A1. In your opinion, what were the main challenges affecting the members in your region before the inception of AEPs? Specifically what challenges did you face in each of the value chains specified?

A2. Are there any challenges that you face as a farmers in the production of biofertilizers and biopesticides in your farms?

A3. Which organic inputs do you prefer producing and why?

Prompt: In the first phase of data collection, we noted that tithonia tea is the most common biopesticide produced, why is this the most preferred? Has anyone tried other organic inputs indicated in the AEP booklet?

A4. What is the average yield per acre and how does this compare to before training on AEPs?

A5. Can you share any stories or experiences related to AEPs specifically organic input production in your farms?

A6. Do you feel you have the capacity to sustain the AEP operations trained by CGA and Fert? Which ones are sustainable?

A7. Do you feel you have the skills and capabilities to maintain the benefits realized as a result of the AEPs? Which ones are sustainable?

A8. What is your perception about the future of the AEPs you engage in?

FARM TOOLS/EQUIPMENT

A9. What tools/equipment would enhance your resilience in AEPs as farmers?

Prompt: Highlight the kinds of tools that would assist farmers in building greater resilience.

A10. Which tools/equipment do you need to produce biofertilizers and biopesticides?

A11. Are these tools mentioned in *A10* above easily accessible/ available and affordable for farmers?

Prompt: Do you think the collective purchase of these equipment/tools can be a viable solution for accessibility?

Prompt: For the chaff cutters, for example, have they looked for their price? Or hired people to produce a large quantity of input once? (are they convinced?)

A12. Do you know of any fabricators or farmers near you who fabricate tools/equipment that can aid in AEPs?

A13. Have a look at these pictures of selected tools/equipment, do you think these tools can be of benefit in aiding AEPs in your farms?

KII GUIDE

KII tool for leaders of farmer groups/CGA staff

i) Organization/Group Name: _____

ii) Respondent Name: _____

iii) Date of the interview: _____

iv) Gender of the Respondent: _____

v)Position: _____

SECTION A: PRELIMINARIES

i. Rank five main agricultural value chains in this area.
ii. Which are the main AEPs adopted by farmers in your group?

AGROECOLOGY PRACTICES

1) What were the main challenges affecting farmers in this region before the training on AEPs? Has the training on AEPs addressed them? How?
2) Specifically, how is your group participating in solving these challenges?
3) Have the needs and priorities of the farmers changed during the implementation of AEPs taught by CGA and fert (crop or animal diseases, etc)?
4) Which mechanisms are in place to ensure women and youth are involved in the AEPs activities?
5) What are the main strengths of the AEPs trained? And challenges?
6) In light of the challenges, what should be done differently?
7) Do you think as a result of the training and implementation of the AEPs women have more access to assets, resources and services? Give examples. How about the youth?
8) Has the initiation of these AEPs led to an increase in crop productivity?
9) Overall has the activities contributed to the resilience of farmers in these areas? How?
10) Do you think that the intervention led, or contributed to unintended negative effects? If yes, Which ones?

KII tool for fabricators

i) Respondent Name: _____

ii) Date of the interview: _____

iii) Gender of the Respondent: _____

SECTION A: PRELIMINARIES

1) Rank the five main agricultural tools/equipment you fabricate in your workshop. (*Take photos of the tools upon consent from the respondent*)

AGROECOLOGY PRACTICES

2) Which tools/equipment are the most preferred by farmers engaged in organic input production? Why do you think this tools/equipment listed are the most preferred by farmers? (*Take photos of the tools upon consent from the respondent*)
3) What is the price range of the tools listed in *Question 1* above? Would you say that these prices are affordable for small-scale farmers?
4) Do you fabricate non-motorized tools/equipment that aid in farming, planting, weeding or harvesting? List each of the tool and their use. (*Take photos of the tools upon consent from the respondent*)
5) Are you willing to partner with other organizations to fabricate tools/equipment for farmers to aid in organic input production and consequently advance AEPs?

Annex 2: List of Respondents

COUNTY	SUB-COUNTY	WARD	NAME	CONTACTS
UASIN GISHU	Turbo	Kiplombe	Alfred Mutai	0706099602
	Soi	Kiunet/Kapsuswa	Noel Too	0721330852
	Ainabkoi	Ainabkoi/Olare	Caroline Tikoko	0725526904
LAIKIPIA	Kirima	Olmuran	Martha Wanjiku	0729702528
	Laikipia West	Igwamiti	Kariuki	
	Laikipia East	Nanyuki ward	Eunice	
	Laikipia central	Tigithi	Samuel Kiarie	0700798822
	Laikipia East	Umande	Albert	0725290151
MERU	Tigania west	Mbeu	Polycarp Kobia	0700090978
	Tigania West	Mbeu	Patrick Kimathi	0704725665
	Tigania West	Mbeu	Tabitha	
	Buuri fast	Kirua narii	Purity Karambu	0728322669
	Buuri East	Ruuri rwarera	Stella Kathambi	0728286164
	Tigania West	Akithi	Judith Makena	

Annex 3: Photo Gallery of some of the outstanding AEP

	
Martha, an AEC from Laikipia County with 100 litres of Tithonia Tea produced for foliar use in her farm	*Kiarie, an AEC from Laikipia at his vermicompost unit*
	
Patrick, an AEC from Meru County on his compost heap	*Alfred, an AEC from Uasin Gishu County, has planted Tithonia along his fence for Tithonia tea production*