Farmer-centred interventions : a key approach for agroecological transition in Meru and Laikipia counties

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ABSTRACT

In the context of climate change and low soil fertility, there is need to develop and/or cascade innovative farming systems and practices that take into account farmers' constraints and the current farming context.

Cereal Growers Association and Fert have initiated since 2021 a farmer-centred intervention in Meru and Laikipia counties in Kenya, aiming at improving farmers living conditions and revenue streams through agroecology. This intervention is composed of two main approaches : i/ farm advisory for farmer groups; and ii/ farmer-led research in partnership with *Meru University of Sciences and Technology* (MUST) and *African Plant Nutrition Institute* (APNI).

From the trials, preliminary results show that the use of mulching and drought-tolerant crops support food production in a depressed rainfall context. Diversification of farm income through vegetable production and tree nurseries enable farmers to improve their food security as well as their revenue. A diversity of tools are accessible to promote and cascade agroecological practices : demonstration plots, exchange visits, peer-to-peer learning, etc. Further, the adoption and sustainability of the new practices is enhanced by close support of groups and group collective actions and global farm advice.

INTRODUCTION AND RELEVANCE

Meru and Laikipia are predominantly agricultural counties. In Meru, 89% of the households practice agriculture and 63% of all enterprises owned are in the agriculture sector (Meru County Socio-Economic Indicators baseline survey, 2016). In Laikipia, 85% of the population is engaged in agriculture (Laikipia CIDP,2018).

The living conditions of the majority of the farming communities in Meru and Laikipia Counties have been significantly affected by climate change (Gina Waridi,2023; Njeru, 2017). Farmers are increasingly grappling with depressed and sporadic rainfall, longer and harsher heat conditions and drought, and increasing pest incidences, among others (Meru CIDP, 2018; Laikipia CIDP, 2018). In the past five cropping seasons, many farmers have hardly harvested any crop from their farms. Large parts of the two counties are being rendered uncultivable and unproductive, while this drought is also affecting pasture regeneration after grazing.

Consequently, food and fodder production have shrunk leading to massive undernutrition and malnutrition in households, a precursor for conflict, especially in Laikipia. It is estimated that 183,000 people have been affected by the drought, and 100,000 livestock lost in Laikipia alone, according to the NDMA report, 2022. Similarly, in Meru, 200,000 people are "facing starvation and in need of help" (Jane, 2022), and 34.2 % of the population is living in extreme poverty (KNBS,2019).

One of the main reasons exacerbating the effects of drought is the continued (over)use of soil and water resources, whose effects are further exacerbated by little or no soil water management systems and other detrimental farming practices ; constant ploughing, monocropping (spatially and temporally) or unbalanced and injudicious use of agro-inputs. Subsequently, many soils have become highly eroded and degraded (Ndiritu,2021) .

Mitigating climate change impact has called for an adaptation of farming systems and the adoption of more sustainable farming practices. Agroecology is defined and approached in this article as *a holistic and integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of sustainable agriculture and food systems. It seeks to optimize the interactions between plants, animals, humans, and the environment while also addressing the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced* (FAO,2018). Going beyond models of Climate Smart Agriculture, Regenerative Agriculture, etc, agroecology offers a relevant response to the current and oncoming challenges in farming communities in Laikipia and Meru counties.

Developing sustainable farming systems must hence be fuelled by a vibrant research. Agricultural research in Kenya is led by the Kenyan Agriculture and Livestock Research Organization (KALRO) and some universities. Unfortunately, most of the research remains academic and agricultural practitioners are not able to utilise the research results because they are not shared. Furthermore, in a the context of increased financial constraints and the cost of means of production, it is necessary to develop practices that will be not only technically but also economically advantageous for farmers and the environment.

Nevertheless, the uptake of new practices has always been a challenge especially, in a context of vulnerability and if the technology is perceived as foreign and lacking in local ownership during design. This calls for a shift in intervention design to allow farmers to become actors in their own development.

Cereal Growers Association (CGA) is a Kenyan national farmer organization of more than 250 000 members, created in 1996, and supporting farmers in 28 counties, including Meru and Laikipia, through field services such as trainings, linkages to inputs and output markets and extension, but also representation and advocacy at the county and national level.

Fert is a French non-governmental organization created in 1981, operating in 10 countries, supporting local farmer organizations to develop and sustain services to their members.

CGA and Fert, with the support of the Louis Dreyfus Foundation, have enriched their collaboration in Laikipia and Meru counties since 2021 to help farmers address the climatic crisis they face, through a tailored agroecology development scheme. CGA and Fert have purposively integrated farmers in the intervention design and implementation, to enhance their transition towards sustainable production practices. This will improve their food security and resilience towards climate change, as well as it will increase their revenue.

After exposing the methodology of the CGA-Fert intervention towards farming communities in Meru and Laikipia counties, this paper provides the preliminary results the intervention has obtained so far. Finally, the relevance and applicability of farmer-centred approaches in agroecological transitions will be discussed through its two complementary axis: i/ global farm proximity advisory and ii/ farmer-led research.

METHODOLOGY/APPROACH

The intervention focuses on Meru and Laikipia counties in Central Kenya on a pilot basis. This is because they have been significantly affected by climate change and land degradation, thus endangering the lives of hundreds of thousands of people.

Meru county is 7 006 km², while 25% of its surface is arable land. As opposed to Laikipia county, Meru is highly populated, with a population of 1 545 714 habitants (Meru County Government, 2019). The county is dominated by the Ameru people who have been farmers for a long time. The county contributes to high productivity levels compared to other counties in Kenya and is among the leading potato, tea, and milk-producing counties. The county benefits from favorable climatic conditions and fertile lands, that allow farmers to be more commercially oriented than their neighbours in Laikipia. However, lands are unevenly distributed. The lower midlands, in the northern area, categorized as semi-arid, experience dryer and adverse climatic conditions with floods and heat stress, compromising farmers' productivity. Moreover, the land is unequally distributed among farmers: a minority of large-scale farmers hold most of the land, while most households own small parcels of land. The average land holding size is 1.8 ha for small-scale farmers while for the large scale, it is 18.25 ha.

The total surface under food and cash crops is respectively 161,907 ha and 15,773 ha (GoK, 2013). The main challenges affecting farmers raised by climate change are (i) in the southern area: high-intensity rains, landslides, increased incidences of pests and diseases, and post-harvest losses associated with an important rate of aflatoxin contamination in most cereals and pulses; and (ii) in the northern and western areas: heat stress/drought and increased temperatures. The ecological zones and the risk profile are represented on Figure 1 below:

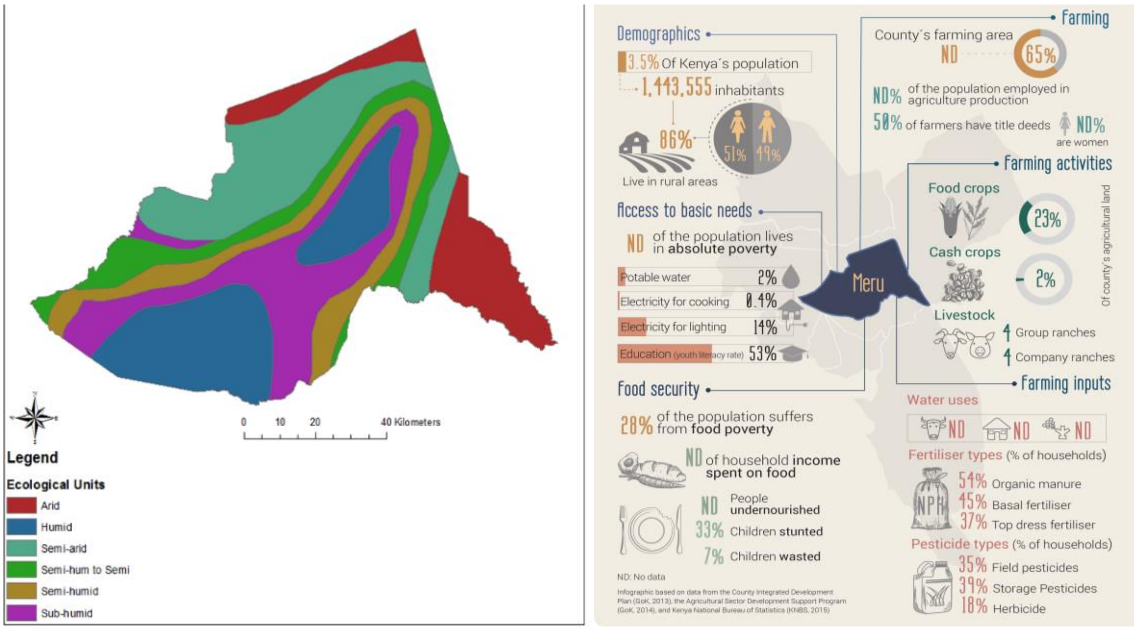


Figure 1.*Meru agroecological zones map and climate risk profile. Source : MoALF, 2016.*

Especially in 2021 and 2022, Meru County experienced unusual dry conditions, as the Combined Drought Indicator reveals in the Figure 2 below.

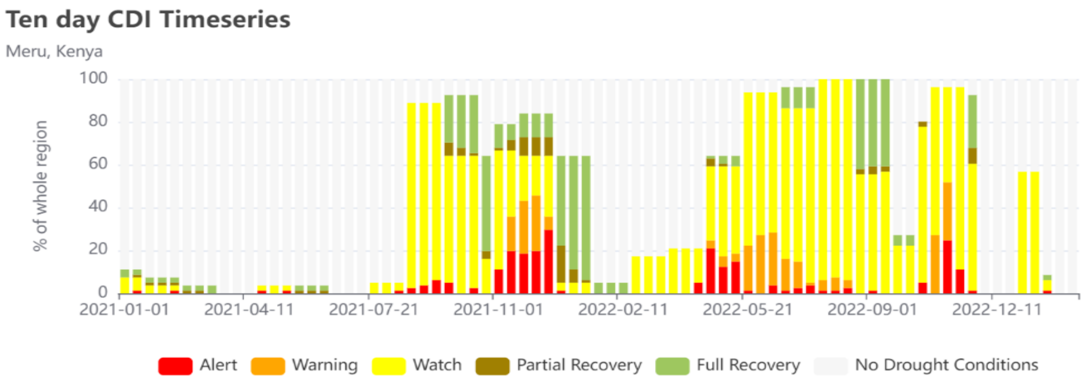
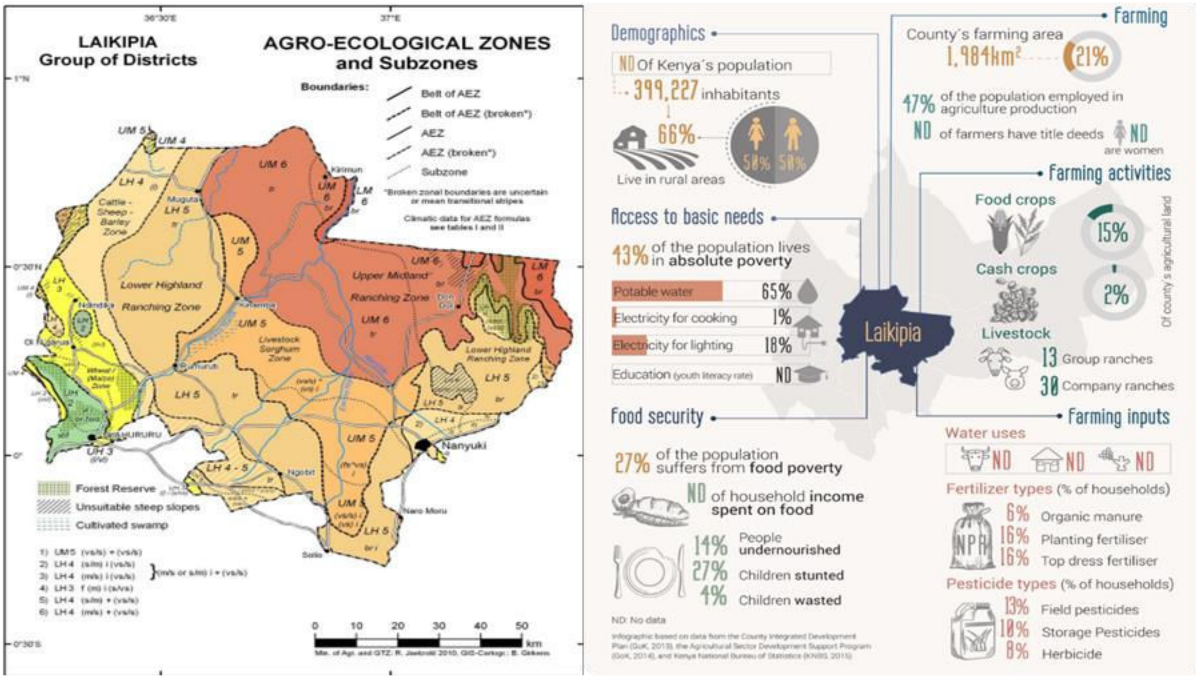


Figure 2*.Combined Drought Indicator for Meru County, IGAD Climate Prediction & Applications Centre (ICPAC), 2023*

Laikipia county is a wide county of 9 462 km², among which arable land represents 20,5%. The population is 518 560 habitants (County government, 2019).

Farming in Laikipia county started with the entry of European settlers, with an important dairy production and extensive beef ranching. After the independence, a significant portion of the land was purchased by large landowners and companies, opting for cereal production, excluding local pastoralist communities. Today, beside few big farms, most of farmers are small scale farmers, growing food crops on less than 1 hectare of land, or small livestock holders relying on pastoralism.

Geographically, the county is located in the upper Ewaso Nyiro basin and draws most of its water from Mt. Kenya Forest and Aberdare ranges (MoALF. 2017). The area is characterized by high exploitation rates of natural resources resulting from increasing land and water resource demand and land-use intensification (Njeru, 2005). Agriculture is a high-risk activity in most parts of the county contributed by (i) reducing rainfalls and water deficits; (ii) a growing population leading to overexploitation of the soil (land) and water resource (iii) a lack of knowledge on dryland farming (iv) a lack of skills to develop, assess and demonstrate potential production improvement strategies (Njeru, 2005). Agroecological zones, livelihoods and agriculture are presented in the Figure 3 below.



Legend of the Map

Source : MOALF,2016

UH=Upper Highland Zone;**UH2**=Wheat Pyrethrum Zone;**UH3**;Wheat-Barley Zone; **LH**=Lower highland Zone;**LH2**=Wheat/Maize-Pyrethrum Zones; **LH3**=Wheat/Maize-Barley Zones; **LH4**=Cattle-Sheep-Barley Zones; **LH5**=Lower highlands Ranching Zone; **UM**=Upper midland zones;**UM5**=Livestock-sorghum Zone;**UM6**=Upper Midland Ranching Zone; **LM**=Lower Midland Zone;**LM6**=Lower Midland Ranching Zone

***Figure 3**: Agroecological zones, livelihoods and agriculture in Laikipia County*

Seasonal climate watch reports have shown increased incidences of occurrence of drought in the county. This has been confirmed from various reports including the recent estimates from IGAD climate Prediction and Applications Centre (ICPAC),2023 report; see Figure 4 below.

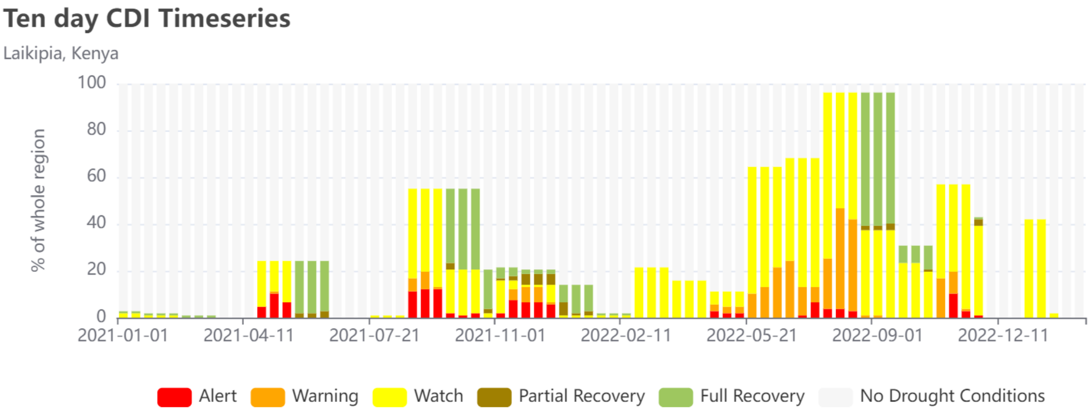


***Figure 4**: Combined Drought Indicator for Laikipia County*

Convinced that farmer-led interventions ensure relevance of development and advisory services, CGA - staff and local farmer leaders - and Fert have developed in 2021 an agroecology development scheme, based on a feasibility and relevance study carried-out by CGA between July and September 2021. The intervention started in October 2021 by trial sites installation and then in March 2022, the farmer groups empowerment was initiated with four pilot-groups in each county (see figure 5 below), representing more than 200 farmers.

The key objectives of this action are :

- Restoring/improving soil fertility
- Improving crop production and productivity (by a higher yield / lower cost)
- Diversifying sources of income thus improving food security through farm diversification
- Rationalizing costs through collective actions (e.g. shared equipment).

Among the agroecology practices identified we can cite:

- Efficient soil water management technologies : minimum tillage, early planting, mulching, water harvesting…
- Integrated soil fertility management practices: mix of organic (*Cajanus cajan, Tithonia divesifolia, Desmodium intortum*) and inorganic fertilizers
- Production and use of biopesticides plants (*Aloe vera, pepper, Tagetes nanuta, Neem, Tephrosia vogelli*) for integrated pest and disease management.

To increase farmers' food security, resilience and global farm income, the action also encompasses:

- Promoting small animal husbandry (rabbit, chicken, bee keeping,…)
- Multiplying and/or diffusing more adapted maize and beans seeds
- Promoting crop diversification : vegetables, sorghum, sunflower, soybean, trees (fruit, fodder, firewood) …

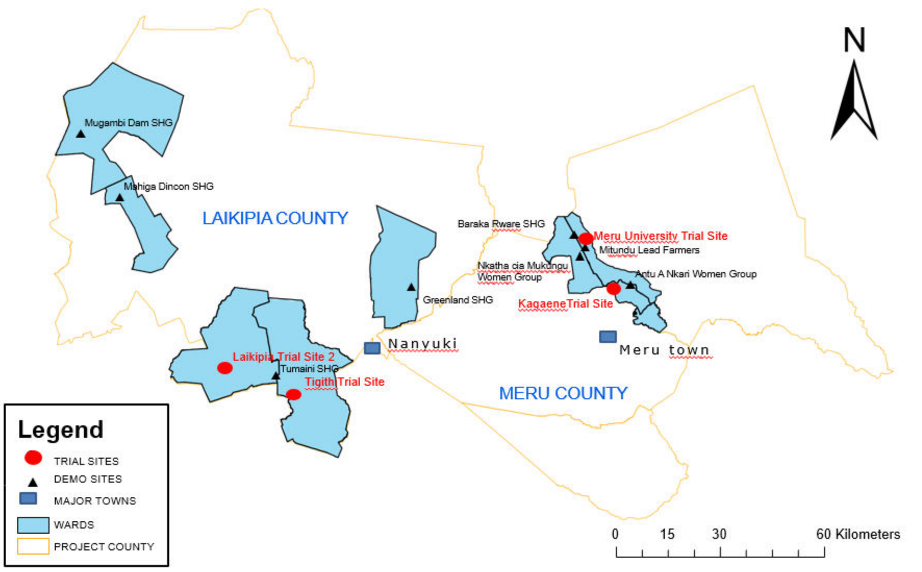


Figure 5. *Map showing the location of the pilot-groups and their demonstration-plot and the trial sites*

Farmer groups advisory and empowerment

Each group has been trained on agroecology and a demonstration plot (of an area of 0,5 acres) has been established for the group to "learn by seeing and doing" such practices as the use of biopesticides, minimum tillage or integrated pest and disease management. These demonstration plots also enable farmers to compare improved varieties (Pigeon pea, High Iron Beans, sorghum, sunflower among others) with traditional varieties in order to identify the most suitable for their agro-environmental context.

The topic of the demonstration is determined by the group, with support of CGA agronomist. Results are analysed at the end of the season, technically (yield, weight of stovers…) but also economically (gross margin). Locally available solutions are given priority for ease of adoption, but knowledge and technologies are also borrowed from other counties and even countries, as well benefiting from Fert expertise in other countries in sub-Saharan Africa .

Focus group discussions enable the group members to identify their empowerment needs and also their constraints towards adoption of some best practices. For example, an obstacle to mulching is the competition with the need for animal fodder. Another example is cashflow challenges to store produce at harvest. To tackle these constraints, a global farm advisory approach is adopted, meaning that the farm is addressed as a system where there are complementarities between all the farm enterprises and where technical and economic strategies are embedded. Therefore, farmers are supported in establishing a well-designed collective savings and loans mechanism and in building their farming system to maximize the complementarities. For example, they are encouraged to raise chicken in order to sell them at harvesting or when comes the time for input procurement for their crops.

Conscious of “farmers pace”, to maximize the impact of the intervention, its principles are proximity and progressiveness through close accompaniment of the groups, tailored services and support towards sustainability of the group and the services developed.

In that objective of reaching group and services sustainability, a field services officer is in charge of supporting the groups in their (projects of) collective action, for example procuring inputs or selling produce collectively, acquiring a farm implement, establishing a nursery, etc. To strengthen the group to allow for durable collective action, the intervention supports the group towards effective group governance and leadership, vision and action plan definition or business and running plan elaboration.
Each group has established a nursery. The nurseries are dedicated to vegetables, fruit trees (mango, avocado, pawpaw), agroforestry trees (*Grevillea Robusta, Leucena*) and useful crops such as *Tithonia diversifoli*a and *Tephrosia vogelli.*

Cascading agroecology through farmer advisors and learning sites

Peer-to-peer learning is promoted via the empowerment of *farmer advisors*, chosen by the group members themselves. The farmer advisors receive more dedicated trainings on the processing of bio-inputs, group training facilitation, group needs identification, record keeping, global farm approach among others.

It is expected that the farmer advisors, will become model farmers in their area, and therefore help in facilitating the cascading of agroecology practices to more farmers : farmers can visit their farms as well as they will visit other farmers in their zone to train and support them. The farmer advisors will also provide fellow farmers with bio-inputs or other related services such as ripping among others. It is expected that the inputs and services offered will offer some small revenue for the farmer advisor to ensure the sustainability of his/her engagement with fellow farmers . The farmer advisors will be equipped with a starting-kit such as worms to start vermicomposting, seedlings of useful crops or tanks for biopesticide processing.

To foster and leverage the adoption of agroecology practices, four agroecology learning sites will be established within the two counties, where farmers or extensionists will be able to come and learn practically some practices such as processing of accelerated compost with the use of rumen juice, producing vermicompost or liquid compost, processing of biopesticides and implementing conservation agriculture.

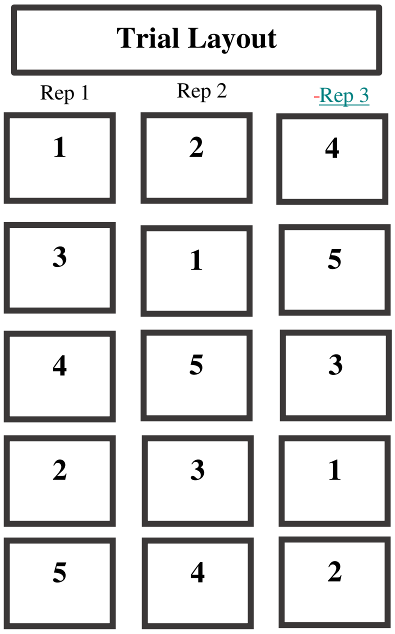
Farmer-led trials in Meru and Laikipia

As a cross-cutting action, in response to the felt disconnect between agricultural research and farmers, CGA and Fert, in partnership with Meru University of Sciences and Technology (MUST) and African Plant Nutrition Institute (APNI), have established since 2021, four farmer-led trials (see map 3 above), whose topics have been decided by CGA farmer leaders in response to their needs. These trials have proved effective in stimulating and increasing their critical thinking and analytical skills. Farmers are invited to observe the differences between the treatments and reflect about the possible reasons for the differences. Plant and soil functioning comprehension are key knowledge that many farmers lack.

Meru Trials

MUST Trial site on optimization of *Tithonia diversifolia* as an alternative nutrient source

The experiment was established in October 2022 and laid out in random complete block design (RCBD), with the plot sizes measuring 5m by 5m replicated thrice. An early maturing and high-yielding maize variety, Pan-3M05, commonly adopted by farmers in the region, was planted at a spacing of 0.75 and 0.5 m inter and intra-row respectively, with a single seed per planting hole. This trial seeks to test the use of *Tithonia diversifolia* as an alternative plant nutrient source. Though some research had been conducted by Mucheru-Muna et al (2006) in Meru county, there was the need to establish another trial to actualize the study, this time integrating farmers in the research designing process. Borrowing from Malagasy farmers' experience, Tithonia was incorporated at different rates and combinations with inorganic fertilizer (100% fertilizers, 100% Tithonia, 25% Tithonia and 75% fertilizers and vice-versa and 50% Tithonia and fertilizers) in the farrows, 14 days before planting. Treatments containing fertilizer addition were top-dressed with appropriate urea to supply the total nitrogen requirement for maize. This was not the case for the treatment with Tithonia. The trial layout is illustrated in Figure 6 below.



Where,

1. (DAP (TSP) + Urea)
2. (Tithonia)
3. (50 % - (DAP (TSP) + Urea)+ (50 % - Tithonia)
4. (75 % - (DAP(TSP) + Urea) + (25 % - Tithonia)
5. (25 % - (DAP(TSP) + Urea) + (75 % - Tithonia)

Figure 6*. Trial layout of MUST trial site*

Kagaene-Makandi Trial site on N input optimization

The second trial in Meru county for the October November December 2022 season was located in Tigania West, Mbeu ward. It responds to a lack of agronomic knowledge on what is the technical optimum amount of Nitrogen fertilizer input for maize in this area, which is representative of the larger Meru county soils and agroecological conditions. Also, in the context of sky-rocketing prices of fertilizers, farmers are interested to find the economic optimum for N-fertilizer purchases. Therefore, the trial was designed with six fertilizer treatments corresponding to incremental doses of nitrogen supplied at planting and at the top-dressing stage, from 35kg/ha to 180kg/ha, with each treatment receiving 198 kg/ha of DAP at planting. The trial layout is described below.

The trial was laid out in a randomized complete block design (RCBD). A total of six fertilizer application treatments were randomly allocated in three blocks totalling 18 experimental units. All plots measure 5m length by 5m width with the maize lines running along the length and always against the general gradient of the area. There is a total of 7 lines per plot. The treatments are expressed in the Table 1 below.

Treatment	Planting	Topdressing	Kg N ha^{-1}	Kg P ha^{-1}
1	**DAP (198 Kg ha^{-1})**	**No topdressing**	**35**	**40**
2	**DAP (198 Kg ha^{-1})**	**CAN (88 Kg ha^{-1})**	**60**	**40**
3	**DAP (198 Kg ha^{-1})**	**CAN (200 Kg ha^{-1})**	**90**	**40**
4	**DAP (198 Kg ha^{-1})**	**CAN (311 Kg ha^{-1})**	**120**	**40**
5	**DAP (198 Kg ha^{-1})**	**CAN (422 Kg ha^{-1})**	**150**	**40**
6	**DAP (198 Kg ha^{-1})**	**CAN (533 Kg ha^{-1})**	**180**	**40**

Table 1. *Treatment considerations for Kagaene trial site*

Laikipia Trials

Tigithi trial site 1 on mulching strategies

Two crops (maize & beans) were established separately starting 2021 October, November and December (OND) rainfall season, 2022 March, April, May June (MAMJ) season and the 2022 OND season. The mulching treatments were allocated randomly in each plot following the randomized complete block experimental design. The trial contained five treatments replicated three times thus totaling 15 plots per crop. The treatments are :

1. Treatment (Trt) 1 – No Cover
2. Treatment (Trt) 2 – Grass partial[1] @ 3 t ha^{-1}
3. Treatment (Trt) 3 – Grass full @ 6 t ha^{-}
4. Treatment (Trt) 4 – Grevillea leaves partial @ 0.7 t ha^{-1}
5. Treatment (Trt) 5 – Grevillea leaves full @ 11 t ha^{-1}[2]

All plots measure 10 m x 7m with the crop lines running along the length and always against the general gradient of the area. This was intended to prevent the loss of added nutrients and seeds in case of a heavy rainfall event soon after planting.

[1] *1 Hay bale (tractor pressed) = 12 kgs; Hay bale (manual pressed)= 8 kgs; Average of the two bale types is 10 Kgs.*

[2] *One plot requires about 80 kgs (fresh weight) of Grevillea leaves for full cover mulch. For partial mulch, it is about 60% of the full cover (based on what we have noted in the field).*

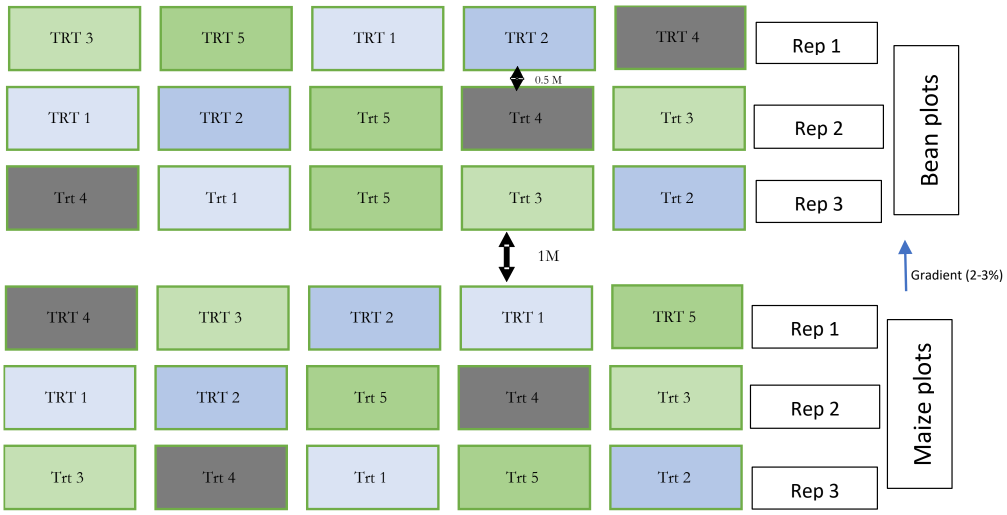


Figure 7*. Tigithi Trial site experimental Layout*

Ngobit Ward, Trial site 2 on alternative maize planting strategies

The second trial, located in Ngobit ward, Muhonia village, aimed at examining the effectiveness and practicability of maize transplanting in order to forestall depressed rains experienced in the location. The treatments were all laid out in RCBD experimental design as expressed in the Table 2 and Figure 8 below.

Treatment	Planting Date
Treatment (Trt) 1: Seed planting after 2 rains (early planting)	11/01/2022
Treatment (Trt) 2: 1st transplanting	11/01/2022
Treatment (Trt) 3: Seed planting at the onset of the rains	12/09/2022
Treatment (Trt) 4: 2nd transplanting	12/09/2022
Treatment (Trt) 5: 3rd transplanting	Not achieved

Table 2*. Treatments description for Laikipia Trail Site 2 during the 2021 OND season*

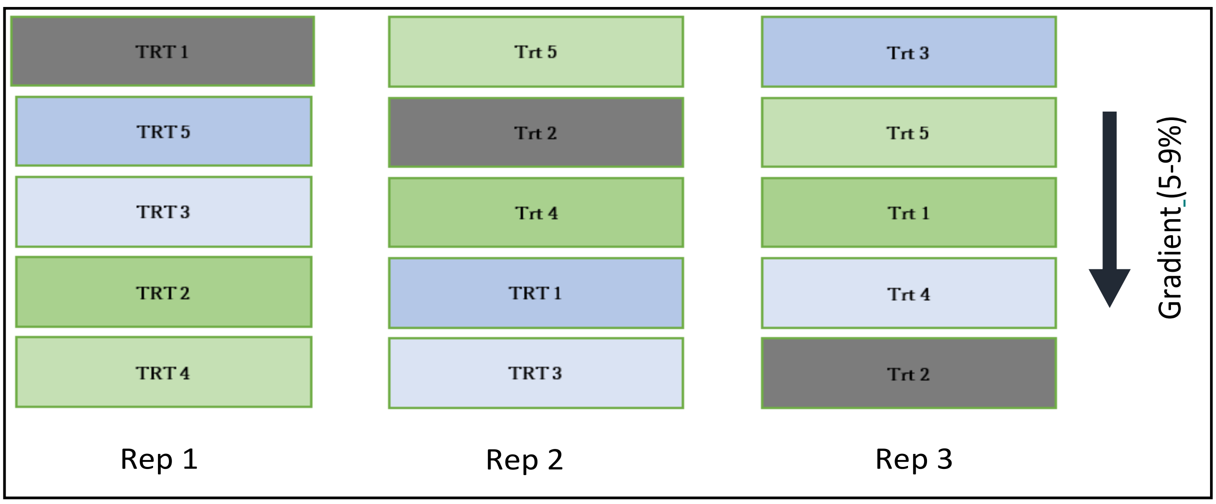


Figure 8*. Treatment layout of the trial site on maize transplanting*

For each trial, a protocol is elaborated. CGA-Fert partnership not only received technical support from African Plant Nutrition Institute in protocol design and results analysis but also from a French farmer-led applied research institute dedicated to arable crops, *Arvalis, Technical Institute*. The trials respect the principles of repetition of the treatments, randomization of the positioning of the treatments and statistical analysis of the data using Expe-R, a software developed by *Arvalis*. Data to collect vary according the trial and its objectives, but mostly are recorded : germination percentage, weed population, podding, biomass and grain weight.

RESULTS

Farmer groups empowerment

The following results reflect achievements after less than a year of intervention and have been mostly achieved during the October-November-December rain season, the March-April-May-June season having been too dry to enable crop growth in 7 out of the 8 demonstration plots[3].

Up to March 2023, the following results have been observed:
From trials and demonstration plots visits, more than 500 farmers have been sensitized on alternative mulching strategies and farm diversification in Meru and Laikipia.

The trial on mulching has sparked major changes in farmers' practices. From original core group of 20 farmers engaged in the designing of the trial protocol, there has been an additional 60 farmers who have adopted the practice after making frequent observational visits at the trial site, at different growing stages. These farmers, after realizing the benefits of mulching have spontaneously sought materials that are readily accessible in their farms as mulching materials, opening up the range of opportunities outside of crop residues or grass that have been commonly promoted so far by extensionists. They are considering tree species such as *Leucaena* or *Calliandra* which also provide highly nutritious fodder as an additional advantage.

The need to transit from pure cereal farming to additional enterprises in Meru and Laikipia was enhanced by the shifting rainfall events which have led to losses. Through group centred approach, at least 600 group members have had an opportunity to discuss what interventions provided the best opportunity to increase their resilience to changing climatic scenarios. 24 group meetings form the 8 pilot groups were structured in order to understand their interests

[3] Rainfall amounts have been collected at the four trial sites by rain gauges. They show the following data for rainfall for the OND 2022 season: MUST trial site : 600 mm, Kagaene trial site : 670mm, Tigithi trial site : 201mm, Ngobit trial site : 104mm.

and practices that could enable them transition towards agroecology. It was noted that groups nurseries formed a key strategy for increasing their cashflow due to the ease of establishment and the little water input required especially in the dry season. Out of this effort, 500 pawpaw seedlings have been germinated in a group nursery and transplanted. To maximize the revenue opportunity of the tree nurseries, 6000 avocado seedlings have also been planted from group tree nurseries. From the second cycle, sales of seedlings will ensure the financial viability of the nursery and will provide the groups with a source of revenue.

When deciding the desired lessons from the demos, farmers have been at the forefront in suggesting topics that answer directly to their challenges. So far 8 group demos have been set up with different topics of interest.

This shows that the critical thinking and analysis skills of farmers were enhanced through the group engagement model adopted for the design and management of the trial sites and the demonstration plots. The farmers decided collectively the type of technology to try, which relates to their local agro-social-economic contexts. Through their involvement in the management of the demonstration plots or their visits to the trial sites, they have enriched not only their agronomic skills but also their ability to analyze crops or production issue to develop relevant coping strategies.

The eight (indigenous) vegetable nurseries ensure the provision of vegetables for consumption or sale to 160 households after the first cycle.

In anticipation for the need for biofertilizer, mulching or biopesticide materials, 3 nurseries and 4 seed multiplication sites are functional and will provide at least 220 farmers with useful trees or crops : *Grevillea Robusta, Tithonia diversifolia* (biofertilizer), *Aloe Vera or Tephrosia vogelli* (biopesticide). Additionally, 4 demonstration plots for promotion of *Grevillea* as an alternative mulching material to grass, as per lessons from Tigithi trial site, will be set up in various parts of Laikipia county.

After a convincing demonstration on a native Meru bean variety and local *Dolichos lablab* that have shown improved resistance to pests and diseases and drought tolerance, seeds will be multiplied to fulfil the need of 50 farmers at least.

To cascade the adoption of bio-inputs, mulching and other agroecological practices, 18 farmer advisors have been trained and they will support 500 farmers in their respective groups.

Results from the trials

Results from the OND season 2021 were not usable because of biases in the protocols in three out of the four trials[4]. The MAMJ season 2022 is characterized by crop failure in all trials apart from beans in Laikipia Tigithi trial on mulching. For the OND season 2022, some results are available but data from harvest are not yet available.

However, some results are already available. First, for the trial at *Meru University on Sciences and Technology* (MUST) on the use of *Tithonia diversifolia* as a biofertilizer, it can be mentioned that there was no significant difference in the germination rate of maize among treatments. The chlorophyl content of the leaves (SPAD) has been measured at 5 and 7 weeks after top-dressing (for the concerned treatments). As shown by the figure 9 below, the SPAD readings differed markedly. At 5 weeks after topdressing (5WATD), the chlorophyll content was highest in the Tithonia alone treatment. This was followed closely by the 25% DAP (TSP) plus 75% Tithonia treatment, whereas the DAP (TSP) + Urea showed the lowest chlorophyl content at 5 and at 7 weeks after top-dressing. Also, the SPAD readings seemed to decrease significantly as the crop aged especially in the Tithonia alone treatment. Over two weeks, the percentage decrease in chlorophyll content was ordered as follows; (DAP (TSP) + Urea) : 45,2% > (50% DAP(TSP) + Urea) + (50 % Tithonia) : 39,2% > Tithonia : 37,9% > (75 % DAP(TSP) + Urea) + (25 % - Tithonia) : 28,1% > (25 %DAP(TSP) + Urea) + (75 % Tithonia) : 27,6%. The chlorophyl content difference among treatments showing the highest and the lowest chlorophyl content increased from 4,21 units at 5 weeks to 10,3 units at 7 weeks.

[4] Only the Tigithi trial site in Laikipia has been maintained with no modifications from the OND 2021 season to the OND 2022 season

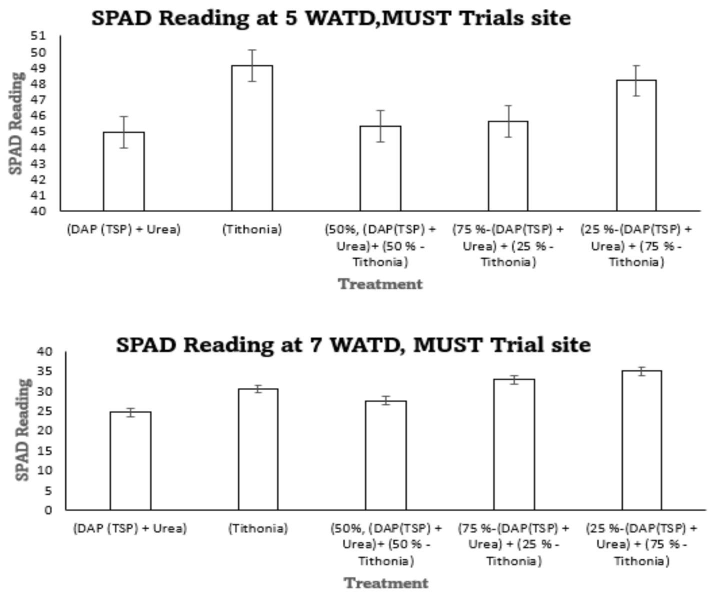


Figure 9. *SPAD readings at 5 and 7 weeks after top-dressing at MUST trial site for the OND 2022 season*

No clear pattern is coming out of this analysis about the potential influence of tithonia on the chlorophyl content evolution.
Further analysis will shed light on if the differences in chlorophyl content between treatments have had a significant impact on the fresh weight of the stovers and the yield.

In the Laikipia Tigithi trial site on mulching strategies, only the beans have reached maturity for the MAMJ 2022 season, enabling the analysis of bean yield results over the three past seasons[5]. The results are presented in the Figure 10 below :

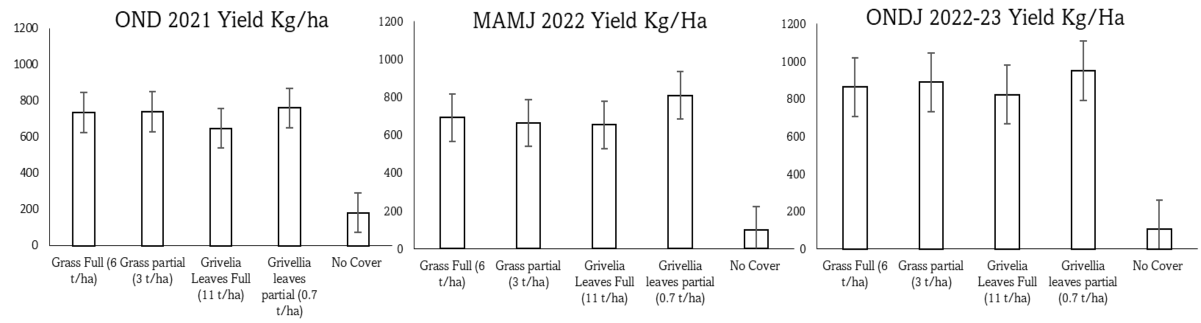


Figure 10. *Bean yield over the three last seasons in the Laikipia Tigithi trial site*

NB : Rainfall data for the seasons have been : 155mm for OND 2021, 175mm for MAMJ 2022 and 201mm for OND 2023

[5] Maize planted in the OND 2022 season has not yet been harvested, but reached maturity

There was significant difference between the mulched plots and non-mulched plots for all seasons. However, there was no significant differences between the mulched plots in any season. Nevertheless, the treatment with Grevillea partial mulch showed consistently higher yields that the other treatments.

As a complement, data on soil moisture content is worse mentioning here. Moisture content has been measured for the MAMJ 2022 season on 4th of June 2022, when the bean was almost reaching maturity. As shown in Figure 11 below, all the mulching strategies demonstrated significant effects on soil moisture content in the bean plots compared to the non-mulched treatment. The Grevillea full-mulch and Grass full mulch at 6 t/ha showed higher moisture content than the other treatments, but the difference among mulched treatments is not significant.

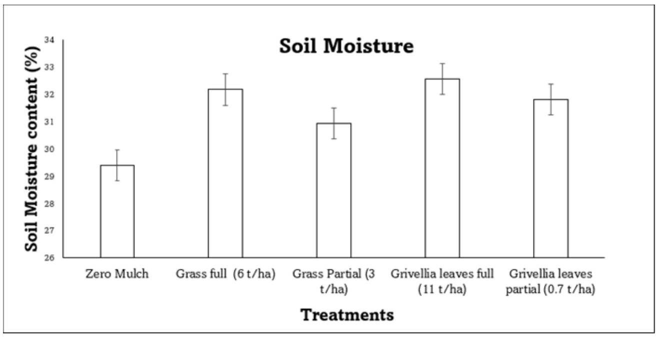


Figure 11. *Soil moisture content measured in bean plots, June 4th 2022 – Laikipia Tigithi trial site*

Though the full mulch treatments show higher soil moisture content, the treatments showing higher yields are partially mulched treatments, though not significantly, calling for deeper analysis of the data.

Hence, the results from this trial clearly indicate a strong positive contribution of mulching, whatever the material and the mulch disposition.

DISCUSSION AND CONCLUSION

Meru and Laikipia counties are experiencing severe drought. In most affected areas, farmers don't have water for their home consumption. Though water-efficient practices were used, like vertical gardening, mulching or minimum tillage, in some groups the demonstration plots and the nurseries have not performed. Even the most efficient practices can't enable plant growth without a minimum of water. This calls for coordinated stakeholders intervention to provide rural communities with sustainable sources of water.

Paradoxically, water stress conditions exacerbate the relevance and efficiency of agroecological practices, accelerating their adoption.

However, the adoption of certain practices like conservation agriculture is hampered by constraints emanating from other value-chains of the farm. Therefore a global farm approach is essential to maximize the chances of adoption. For example, for farmers who can't apply crop residues retention because they need to feed their cattle, two main strategies can be considered: i/ offering other feed source options, by planting fodder crops (Lucerne, Brachiaria, Pennisetum, Mucuna…) and/or ii/ identifying other materials for mulching or covering of the field. *Grevillea robusta* leaves have shown good results as a mulching material at the Laikipia trial site 1. Nevertheless, *Grevillea robusta* takes a few years to be usable and is not found everywhere. Same for *Tithonia Diversifolia* as a fertilizing crop. Therefore, promotion of the use of these crops entails to be proactive and anticipate the demand for them by creating nurseries.

Furthermore, restoration of soil fertility takes time. For the most vulnerable families, being farsighted is not a priority when subsistence is at stake. Hence, diversification of farming systems and income streams is crucial. Vegetable farming and small animal husbandry appear as beneficial enterprises to sustain small-scale farms as they are short-term productions and relatively not intensive in capital. But to make them meaningfully profitable requires professionalizing the farmers by building their skills and thinking with them on how to integrate these enterprises in their global farming system. Sometimes, it might imply producing other types of crops (Mucuna, sunflower, soybean, …) that are traditionally not grown in the area.

Embracing agroecological practices such as compost or other biofertilizers processing and mulching in small-scale farm enterprises appears to be easier for farmers than it is for bigger plots devoted to cereals and pulses. Such plots require significant amounts of compost, mulching, etc. thus demanding more time (and capital) during their preparation.
Therefore, farmers' aversion to risk must be taken into consideration. Farmers often start changing their practices on a piece of their land to verify their benefits before extending to their whole farmland. Therefore demonstration-plots and model farms are perceived as relevant tools to cascade the adoption of agroecological practices.

Another restraint to the adoption of alternative food crops for maize in dry areas where maize does not perform anymore, such as sorghum, finger millet, cowpea, etc, is the attachment for maize for food and the conception of food security as being the ability to produce enough maize that is needed for the family for an entire year.

Here, two complementary strategies can be adopted : i/ sensitizing and training rural communities on the cooking of alternative crops to make them more attractive and/or ii/ through economic calculations, show families that it is possible to achieve food security without producing maize or producing less maize, but focusing on producing a market crop that will generate the cash needed to buy maize at its harvest when the price is low. Yet, changing attitudes about food and the systems is bound to take time and it will require the involvement of multiple stakeholders, principally on the government side. A recent initiative by the Kenyan government to millers on the need to produce blended maize and wheat flour was meant to promote the adoption of other crops that have higher nutritional value. This included sorghum, millet, cassava, dried traditional vegetables among others. Even though the initiative was suspended due to a lack of enough supplies of alternative cereals in the market, it has aided somewhat in encouraging more farmers to adopt such other neglected crops.

Agroecology, and especially organic inputs, are also often considered less productive than conventional farming. This advocates for taking into account the economic implications of their processing and use, in terms of costs, time involved and income. Indeed, in the present intervention, all technologies that are tested or demonstrated on trials or demonstration plots are evaluated and compared through the gross margin they generate. In the context of tremendous increase in input prices, many farmers can’t afford agrochemicals. Others are willing to consider the trade-off; accept getting less production if it can preserve or even increase their gross margin. In our current interventions in Meru and Laikipia, field officers have been trained in technical-economic advice. This comprehensive approach of advisory relies heavily on data and record keeping from the farmers to enable the calculation of gross margins and on the support on cashflow management. Indeed, from evidence, cashflow shortages are often hampering the adoption of innovative practices in farming and in faming systems or strategies as a whole.

The preceding methodologies, approach and strategies are the pillars of proximity advisory, whose central objective is to empower farmers in their decision-making capacity and support them, at their pace, in the development of perennial practices, projects and/or services.

Many development interventions provide farmer groups with equipment or funds but don’t encompass creating the conditions to make the impact of this intervention long-term. As such, project appropriation by the leader of the group, misuse of funds or collapse of the projects has often been observed in rural Kenya. This intervention considers strong support of groups in terms of group governance, leadership and functioning. Engaging and supporting the groups from the beginning in the design of their development plan up to the sustainability plan of their projects ensures the relevance of the intervention and the sentiment of ownership of it by the targeted groups.

Going beyond technology models and packages (climate smart agriculture, regenerative agriculture, …), advisory, as opposed to extension in its strict sense, being one of the "tools" of a farmer-centred intervention, is addressing farmers real needs, proposing to them a diversity of options for their enterprise development, based on the farmers' objectives, skills, constraints, and its environment. The farmers are considered in advisory as key decision-makers. The field officer then supports step by step the farmers in the adoption of the selected strategies or practices.

As opposed to extension in its very sense, advisory put an emphasis on raising farmers critical thinking. Many CGA members have been trained on "good agricultural practices" though they are not often taught about the rationale of many of the practices and recommendations. For instance, they know how to grow maize but they don't know why the recommended spacing is important nor why most of nitrogen input should happen at top-dressing stage. Increasing farmers agronomic knowledge is essential to convince them of the negative impact of some practices and the relevance of agroecological practices. This approach of ensuring that farmers understand the rationale behind the proposed practices intends to empower them to be able, through close accompaniment from the field officer, to select the practices that are the most relevant in their particular context and also to adapt the recommended practice to this context (type of soil, slope, …). The field officer then supports farmers in the adaptation of the practices and their implementation.

For a field officer, adopting the posture of an advisor, requires to develop some specific technical and interpersonal skills, such as collective thinking facilitation, listening and analysis skills, global farm and technical-economic analysis, adaptability, patience, humility, ability to question oneself and one's knowledge, etc. Specific trainings should then be provided for field officers.

Proximity advisory of farmer groups is nevertheless often neglected by development stakeholders because it is seen as expensive (in capital and human resources) and small-scale.

This is from a project-oriented development perspective. From farmers perspective, proximity advisory provides a platform for farmers empowerment to become the main stakeholder of their development : needs-tailored intervention, global farm technical-economic advice and co-finding of solutions to challenges farmers face in the implementation of new strategies or practices. Advisory seeks long-term impact.

Proximity advisory is then complementary to extension services and interventions that focus more on procuring equipment for farmers.

To compensate for the relatively small-scale prime focus of the interventions, hence, to foster up-scaling of its impacts, farmer advisors play a key role. First, since they are farmers. Secondly, they can produce products that are needed by members. Eg bio-inputs. Indeed, producing biopesticides or biofertilizers is labour-intensive – compost turning, collection and mixing of biopesticide materials, etc - and not all farmers are able to dedicate the time required.

Too often, development programs centralize their support on forefront rural leaders. These leaders are able to provide services to farmers but i/ these services are standard and might not fulfil farmers' needs; ii/ the opportunity of making money out of the service provided can make the leader focus more on the number of farmers reached than the quality of the service provided. On the contrary, this intervention bets on a bottom-up approach, where farmer advisors are selected by their fellow farmers. This ensures trust between the stakeholders. Besides, the groups and farmer advisors are supported by the field officer in choosing the services the farmer advisor will offer them and then in building the sustainability model for the service delivery. This sustainability model aims at setting the rules that will enable the service provision to run contribution from the group members and the farmer advisor, sharing of the benefit or loss, cost of the service for the group members and other farmers, etc.

Another characteristic of the intervention is the forefront role given to farmers in its piloting, through farmer leaders. These leaders contribute to the design of the intervention through the determination of its objectives and activities, the selection of the farmer groups and the evaluation of the actions undertaken.

For the trials' implementation, farmer leaders from the two counties have been invited to suggest topics of interest for research; they contribute during observation of the treatments and data collection and analysis. They ensure that the proposed treatments or strategies tested are or could be useful, usable and used by many farmers.

Implementation of the trials, even though their objective is not academic research, requires abiding by some principles and rules (as mentioned in the methodology part) and minimizing the biases. To answer quickly the need for trials, CGA and Fert have started implementing trials even though they were lacking expertise. On the way, they have been supported and empowered through partnerships with *Meru University of Science and Technology*, *African Plant Nutrition Institute* and *Arvalis Technical Institute*. They have learnt from their mistakes. One of the lessons is that the choice of the trial plot and its host is critical : the site must be secured, as homogeneous as possible in terms of type of soil, land use, slope, and the host must be available to monitor the crop on the trial and contribute to data collection and hosting of visitors. Also, soils with good fertility tend to show less significant results when it comes to trials about soil fertility or plant nutrition improvement strategies.

Farmer-led research is then complementary to academic research and there is a stake in linking more research institutions to farmers and farmers' innovation initiatives. On one hand, academic research will be more related to farmer needs – therefore more useful - and on the other hand, farmers innovations and trials will be enriched thanks to scientific knowledge and access to adequate data analysis equipment.

The ongoing trial on the use of *Tithonia diversifolia* as a biofertilizer has brought about new research questions surrounding the use of *Tithonia diversifolia* : i/ when is the best moment to incorporate it in the soil to maximize the availability of nutrients when the crop needs them the most? ; ii/ what is the optimum quantity of *Tithonia D.* to ensure yield thus managing cost? And ; iii/ what is the best (combination of) form of *Tithonia D.* to use? ("solid" at planting and/or liquid at top-dressing). This calls for more trials on the topic.

In a nutshell, the analysis of this ongoing intervention concludes that there is an urgent need for a shift in designing and implementing agricultural development interventions towards farmer-centred approaches – global farm and proximity advisory on one hand and farmer-led research on the other hand - that ensure the ownership of the intervention by the farmers, ensuring that what is implemented will be useful, usable and used by them. Nevertheless, the challenge of the adaptation to climate change for the farming communities in Meru and Laikipia counties in Kenya is colossal, requiring more integrated and collaborative interventions from public and private stakeholders.

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