
RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security


# CCAFS Endline Synthesis Report: Nyando, Kenya (KE0101)

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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**About CCAFS**
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# 1. Introduction

## 1.1 Background

The problems of the smallholder farmers in East Africa include declining availability of arable land due to the rapidly rising population, deteriorating soil fertility and the associated declining crop yields, steep rise in food prices, poor market access, and in some cases, unclear land tenure system (Nelson et al. 2010, Yamano et al. 2011). As a consequence, poverty and food insecurity indicators are worsening (Thornton et al. 2011).

Climate change is compounding the problems of farm households. Globally, temperatures are rising, rainfall patterns are changing, and weather extremes are becoming more frequent and severe (Wheeler and Von Braun 2013). Although consequences are expected to vary by location, they include shortened and disrupted growing seasons, a reduction in area suitable for agriculture and declining agricultural yields (Connolly-Boutin and Smit 2016). For regions such as Sub-Saharan Africa (SSA), where about 70% of households depend on rain-fed agriculture and farming is predominantly subsistence, adverse impact of climate change on household food security is a credible threat. Over time, households have used such coping strategies as migration, income diversification and the use of improved technologies (Babatunde and Qaim 2010, Burney and Naylor 2012, Karamba et al. 2011). The households often rely on indigenous knowledge, experience and trial and error to choose their coping strategies. In order to assist smallholder farmers cope better with climate change, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), initiated the Climate-Smart Villages (CSVs) Research for Development (R4D) approach to test a portfolio of climate-smart technological and institutional options for dealing with climate change in agriculture across selected regions, including East Africa (see https://ccafs.cgiar.org/climate-smart-villages).

## 1.2 The Concept of Climate-Smart Villages

Climate-Smart Villages (CSVs) are clusters of villages in climate change hotspots where researchers, local partners, and farmers collaborate to test a portfolio of climate-smart interventions, identify and implement locally appropriate ones. The aim is to stimulate action to enable the communities and households to respond to climate variability to reduce hunger, ensure food security, and enhance household incomes (Kinyangi et al. 2015).

Piloting of the CSVs concept in East Africa started in 2012 across six (6) sites: Lushoto (Tanzania), Wote and Nyando (Kenya), Hoima and Rakai (Uganda), and Borana (Ethiopia). Every CSV has a wide range of activities (see Recha et al. 2017 for a detailed description). Mostly, farmers within the CSVs work in groups initially formed for pooling financial resources through Rotating Savings and Credit Association (ROSCA) schemes, pooling farm labour, and other social reasons. The groups have become platforms for innovative partnerships for new knowledge and skills and for building the capacity of the local farmers to change farming practices and adopt new resilient crops and livestock. They also provide systems for fast and efficient delivery of extension services, farm inputs and other agricultural services.

## 1.3 About the endline survey

CCAFS has been working across five regions: East Africa and West Africa, Latin America, South Asia and South-East Asia. When CCAFS began in 2011, baseline surveys were carried out in each of the research sites (CSVs) across 17 countries within the five regions. These surveys were conducted using standardized tools to provide benchmarks against which progress would be measured and comprised of three components: a household survey, a village study and an organizational survey. As the CCAFS Research Program comes to an end by the end of 2021, it is important to evaluate how it has performed on the various outcome and output indicators and as part of a global synthesis from the CCAFS five regions. Midline and endline surveys have been commissioned in selected sites to track and evaluate progress in uptake of climate-smart agriculture (CSA) technologies and innovations, including changes in the various livelihood indicators over time. This study examines these changes, specifically focusing on the Nyando CSVs in East Africa (see https://ccafs.cgiar.org/regions/east-africa). This endline survey covers households that were surveyed during the baseline. The survey also covered the villages where interventions have been implemented, including the organizations that work for livelihood and income improvements, and resilience building. The project has also collected a series of M&E data based on the project results framework to track progress and a comprehensive midline evaluation (see Radeny et al. 2018).

## 1.4 Nyando Climate-Smart Village

Nyando river basin lies on the leeward side of the Mau escarpment in Western Kenya. It experiences an annual rainfall amount of 1400 mm, distributed in two seasons, between March and May (long rains) and between September and November (short rains) (Verchot et al. 2007, Tobella 2009). The mean annual temperature is $25^0$C. The region has witnessed episodes of drought, floods and increasingly unpredictable rainfall patterns, all pointing to changing climate (Kinyangi et al. 2015). Analysis of 50-year historical data for the region shows that the onset of rain has drifted by about one month and the length of the main growing season has shortened. Yet agriculture remains the main source of food and income for majority of the households. Thus, shocks associated with climate change are likely to impact on livelihoods of the residents, who already experience high rates of poverty.

The CSVs model in Nyando covers seven (7) villages and focuses on improving local knowledge of climate risks and variability in rainfall, dry spells and disease and pest conditions to inform farming decisions. Through action research approaches, CCAFS in partnership with other research and development institutions and County government extension agents has been facilitating communities in Nyando to test a portfolio of climate change adaptation, mitigation and risk management interventions.

The communities in Nyando have organised themselves into three community-based groups: Friends of Katuk Odeyo (FOKO) and North-East Community Development Programme (NECODEP) in Nyakach Sub-County of Kisumu County; and Kapsokale in Soin- Sigowet Sub-County of Kericho County. The three organizations are made up of 50 Self- Help Groups from

106 villages, covering 2500 households, with women accounting for 80% of the membership of the self-help groups. Other partners include Kenya Meteorological Department (KMD); Kenya Agricultural and Livestock Research Organization (KALRO); Departments of Agriculture, Livestock and Fisheries in Kericho and Kisumu Counties; Maseno University; Magos Farm Enterprises; Rafiki Microfinance Bank; ThinQubator Aquaculture; Vi Agroforestry; World Neighbors; and ILRI.

## 1.5 Climate-smart agriculture technologies and innovations in Nyando

The portfolio of CSA piloted in Nyando is diverse, and the specific interventions include:

*Improved livestock breeds*: Working with ILRI, Vi Agroforestry, Kisumu and Kericho County Departments of Agriculture, Livestock and Fisheries, and CBOs, farmers have been trained on improved livestock breeding and management focusing on small ruminants (sheep, goats) and poultry. Small ruminants and poultry give women more control over returns from livestock and are less labour intensive. Farmers are trained on improved husbandry practices for Galla goats and Red Maasai sheep. The bucks and rams of Galla goats and Red Maasai sheep were introduced into the communities in 2012 and part of 2013 to upgrade the indigenous (small east African) breeds. Galla goats are better adapted to drylands and mature almost six months earlier than the local breeds. Red Maasai sheep are bred for meat and are popular for fast growth and maturity, resistance to internal parasites, tolerance to trypanosomes, drought and heat stress. Crossbreeds of the Galla goats and the Red Maasai sheep mature faster and attract higher market prices compared with their local counterparts.

In addition, some of the farmers are diversifying into improved beekeeping as a livelihood option, using improved beehives coupled with the training of farmers to increase productivity. The intervention is organised around groups affiliated with the CBOs.

*Crop diversification:* To address the risk of rampant crop failure, farm households in Nyando are increasingly diversifying their crops. Preference is given to crops with multiple uses, especially those that serve both food and feed requirements. While maize and sorghum still dominate the farms, other drought-tolerant varieties have been introduced to the farmers coupled with complementary improved agronomic practices. Most households are also diversifying into new crops such as pigeon pea and green grams alongside the traditional legumes (mainly beans and cowpeas). Pigeon pea has the advantage of withstanding drought and water-logging, while the leaves can be harvested and used to feed the small ruminants. Other crops that have been introduced include cassava which is resistant to mosaic virus; sweet potatoes, which are adapted to low moisture; tissue culture bananas which are resistant to bacterial wilt; and mangoes and pawpaw trees, whose fruits are harvested for home consumption as well as for the market.

*Mitigation interventions*: The partnership facilitates communities and households to adopt agro-forestry, land and water management to reduce greenhouse gas emissions. Tree

nurseries, managed by individual farmers or groups, are supported. Further, farmers have been trained in other sustainable farming and land management practices such as contour farming and terracing that reduce erosion and compositing. Finally, communities are facilitated to invest in water storage infrastructure (water harvesting pans).

*Smart farms as adaptation learning hubs*: The smart farms are climate-smart technology learning sites. The farms are managed by farmer groups and undertake various climate-smart activities such as greenhouse farming (particularly for seed bulking of fodder and production of horticultural crops), water harvesting, fish farming, beekeeping and production of multi-stress tolerant crops. These farms serve as demonstration sites for groups, especially women groups, to engage in CSA.

*Institutional innovations*: As indicated earlier, the communities in Nyando have organised themselves into three CBOs: FOKO, NECODEP and Kapsokale. Through the CBOs, farmers receive training via field days, exchange visits, and trade fairs. The CBOs have also set up local agrovet shops to enhance access to high-quality inputs at affordable prices. The CBOs, in partnership with KMD and Maseno University, facilitated access to climate information up to 2015, estimated to have been used by about 70% of farmers to make on-farm decisions. Since 2016, farmers have been getting agro-advisories through a partnership with Magos Farm Enterprises and agricultural extension agents. The three CBOs pooled their financial resources between 2011 and 2015 to raise loanable funds of USD 95,000, up from USD 14,000, constituting the Nyando innovation fund. About 90% of the farmers have borrowed from the fund. The borrowed funds have been used to invest in farming and other income-generating activities and small-scale trade such as basket weaving and grocery shops.

# 2. Methodological approach

The endline survey used a blend of qualitative and quantitative approaches in three modules: household, village and organizational surveys. The household module covered the households surveyed during the baseline, and the village module entailed discussion with male and female focus groups in the various villages of project implementation, while the organizational survey took the form of elite interviews with selected experts from organizations working in the Nyando Basin for livelihood and income improvement. Other relevant bits of information were obtained from secondary sources.

The household survey was administered to 140 households, 20 from each of the 7 villages as per the baseline. The questionnaire covered changes in outcome and output indicators and closely mirrored what was used at baseline to enable comparison. This questionnaire was administered through Computer Assisted Personal Interviews (CAPI) for speed, accuracy and ease of monitoring. The actual survey was preceded by two days of enumerator training, pre-test and debrief. This helped to determine whether the right respondents had been chosen; instruments picked up variations; instruments were appropriate in the contexts within which respondents lived; respondents understood the questions; administrative data

were reliable; recall period was appropriate; surveys were of an appropriate length, and respondents would be found at particular times and places.

Village surveys were organised as outlined in the Village Endline Implementation Manual. They involved preparatory stage (for following the protocol, contacting village authorities and sampling and inviting group participants), training of local teams (team leader and the interpreters), focus group discussions along with specific themes in parallel men and women sessions (restricted to sampled and invited participants) and later as mixed groups. Open community meetings envisaged in the manual were cancelled because of strict Covid-19 protocols imposed on Western Kenya at the time of the survey due to an upsurge of infections. Satellite imagery was used to monitor or detect the land-use change and land-cover change (LULCC) because of their large geographic and high temporal coverage. These satellite images from baseline (2010/11) and endline periods (2020/21) informed the village level discussions. The discussions were based on a tool prepared jointly with CCAFS, and the analysis was conducted along with pre-defined themes as reflected in this synthesis report.

Organizational surveys were preceded by a mapping of the organizations working in Nyando Basin as earlier indicated, taking into account the organizational landscape as recorded at baseline and as informed by the village focus group discussions. The interviews followed guidelines for interviewers and a pre-prepared interview tool. This report provides a synthesis of the changes at the household, village and organizational levels.

# 3. Demographic changes

## 3.1 Household size

Results show an increase in the percentage of households with 7 or more members from 28% to 40% and households with 2 members from 8% to 10% (Table 1). On the other hand, there was a reduction in the proportion of households with only one member, and those with 5 members from 7% and 19%, respectively, to 1.4% and 15%, respectively. The proportion of households with 3 and 6 members recorded no change between the baseline and endline. Overall, however, the proportion of households with more members increased and this, from the key informant interviews, may have been due to Covid-19 pandemic which led to many urban dwellers losing their livelihoods and moving back to the rural areas.

**Table 1. Changes in household size**

| Household size | Baseline (%) | Endline (%) |
|---|---|---|
| 1 | 7 | 1.4 |
| 2 | 8 | 10 |
| 3 | 8 | 8 |
| 4 | 14 | 8 |
| 5 | 19 | 15 |
| 6 | 17 | 17 |
| 6+ | 28 | 39.6 |

## 3.2 Household age categories (percentage of people under 5 or over 60 years)

At the endline, 45% of the households had at least one member being under 5 years, while 35% of the households had at least one of their members being above 60 years old. For comparison with baseline, we examine the proportion of households with member (s) under 5 or over 60 years (Table 2). Notably, the proportion of households with the majority of their members being within the productive age (i.e., where less than 40% of members are under 5 and/or over 60 years) has increased between the baseline and the endline, from 78% to 83%. This is not entirely surprising because fewer of their members are expected to be under 5 years as the households grow older, and at the same time, potential effect of natural attrition on household members who were above 60 years as at the time of the baseline.

**Table 2. Proportion of household members under 5 or over 60 yrs**

| Proportion of households with members under 5 and/or over 60 yrs | Baseline | Endline |
|---|---|---|
| <20% | 37.4 | 57.2 |
| 20 - <40% | 40.3 | 26.1 |
| 40 - <60% | 13 | 13 |
| 60 - <80% | 2.2 | 1.4 |
| 80%+ | 7.2 | 2.2 |

## 3.3 Highest level of education attained by any household member

Between the survey years, substantial milestones were achieved with the proportion of households having primary education or no formal education as the highest level of education achieved within the household, reducing from 77% and 4%, respectively to 21.7% and 1.4%, respectively (Figure 1). On the other hand, the proportions of households with secondary education as the highest level of education in the household rose from 49% to 51.4%, while post-secondary level increased from 9% to 25.4%.

It is apparent that more households are investing in education, most likely indicating access to more resources to meet the cost of education or more awareness of the importance of formal education. These results also mirror the positive outcome of the successive government policies on education, starting with free primary education (2003-2013) to government subsidized secondary education (2013-2022). The acquisition of more education is important for agricultural development as households become more aware of the available technologies and improved agronomic practices. It is also important for food and nutritional security, not just because the households can produce more food and/or earn more income off-farm but also because they become nutritionally aware and capable of selecting what goes into the diet.

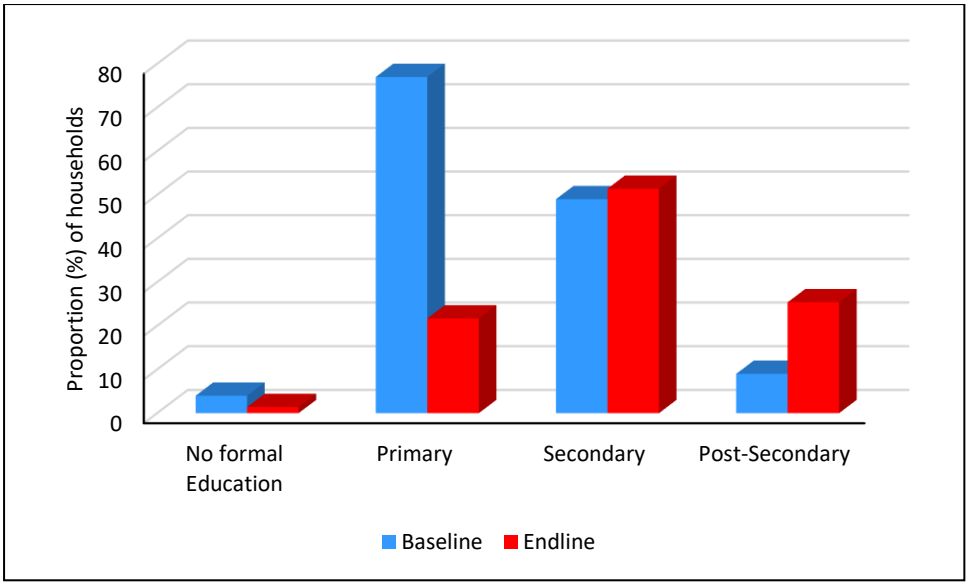


**Figure 1. Highest education level of any household member**

## 3.4 Ratio of female-headed households

The proportion of female-headed households dropped marginally from 37% at baseline to 32% at the endline. The male-headed households increased from 63% to 68.1% in the same period (Figure 2). This could probably be attributable to the relocation of husbands from the urban areas to rural areas, due to Covid-19, and assuming an active role in agriculture.

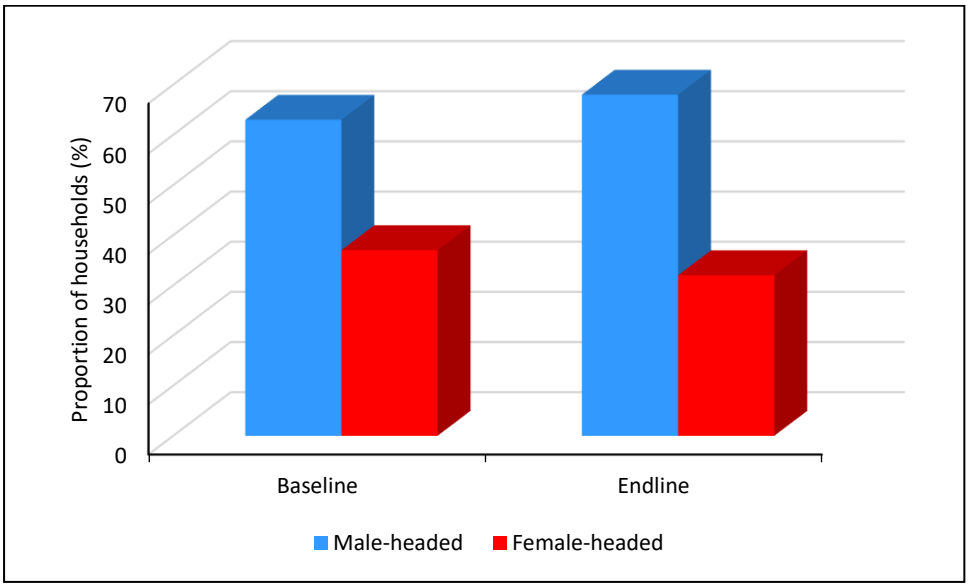


**Figure 2. Proportion of female-headed households across time**

# 4. Changes in farming practices and drivers of changes in resources

## 4.1 Proportion of households introducing three or more changes

Table 3 presents the proportions of households introducing 3 or more changes to their farming practices between the baseline and the endline. Results show a substantial reduction in the proportions of households introducing 3 or more changes to crop, agro-forestry, and livestock-related practices from 83%, 91% and 45%, respectively, to 15.2%, 62.3% and 8.7%, respectively. On the other hand, the proportions of households introducing 3 or more changes to water and soil management-related practices increased from 0% and 17%, respectively, to 7.2% and 22.5%, respectively.

**Table 3. Percentage of households introducing 3 or more changes to the farming system**

| Changes | Baseline (%) | Endline (%) |
|---|---|---|
| Crop | 83 | 15.2 |
| Water | 0 | 7.2 |
| Soil | 17 | 22.5 |
| Tree/Agroforestry | 91 | 62.3 |
| Livestock | 45 | 8.7 |

This could mean that majority of the households in the CSVs have already achieved their optimal adaptation in terms of crop choices, agro-forestry and livestock choices. Very few are, therefore, expected to make adjustments in these areas. However, increasing proportions are moving into soil and water conservation, most probably because the land is getting exhausted and/or degraded over time and land intensification is taking place due to increasing population pressure and therefore efforts to maintain or increase land productivity.

## 4.2 Adaptation index

An adaptability/innovation index was defined as:

- Low - 0 or 1 change over the 10 years
- Intermediate - 2 to 10 changes over the 10 years
- High - 11 or more changes over the 10 years

Figure 3 shows that within the last decade, the proportion of households in the low category increased from 0 to 27%; those in the intermediate category increased from 39% to 54%, while those in the high category declined from 61% to 19%. This change demonstrates a switch by the farming households from high adaptation to intermediate and low adaptation which could be explained by the behavioural changes in the farming system, as noted above, and more by learning over time. That is, initially, households experiment with multiple

technologies and innovations. With time, however, they are able to determine and settle on a few that serve their objectives better.

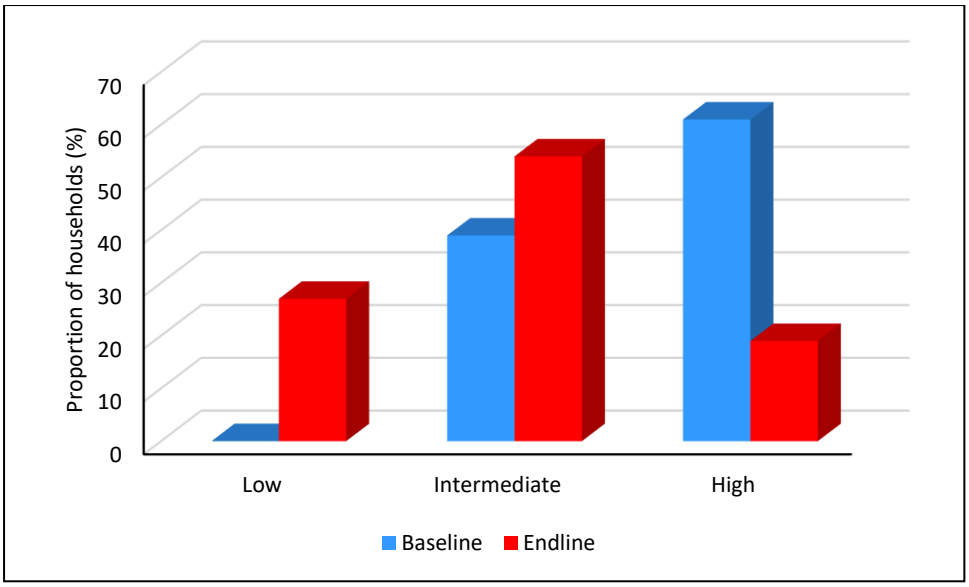


**Figure 3. Changes in adaptation index**

## 4.3 Mitigation index

Households are increasingly recognising the threats of climate change and are taking up mitigation measures such as tree planting and soil and water management. The trees planted serve multiple purposes, providing fruits, fuelwood, erosion control, shade and overall landscape aesthetics. Figure 4 shows that households engaging in mitigation measures declined between the baseline and the endline. Because the households are using the trees as the main mitigation measure, it is possible that most households have attained the number of trees that they desired and very few are planting new trees, either to add the number or replace the old ones.

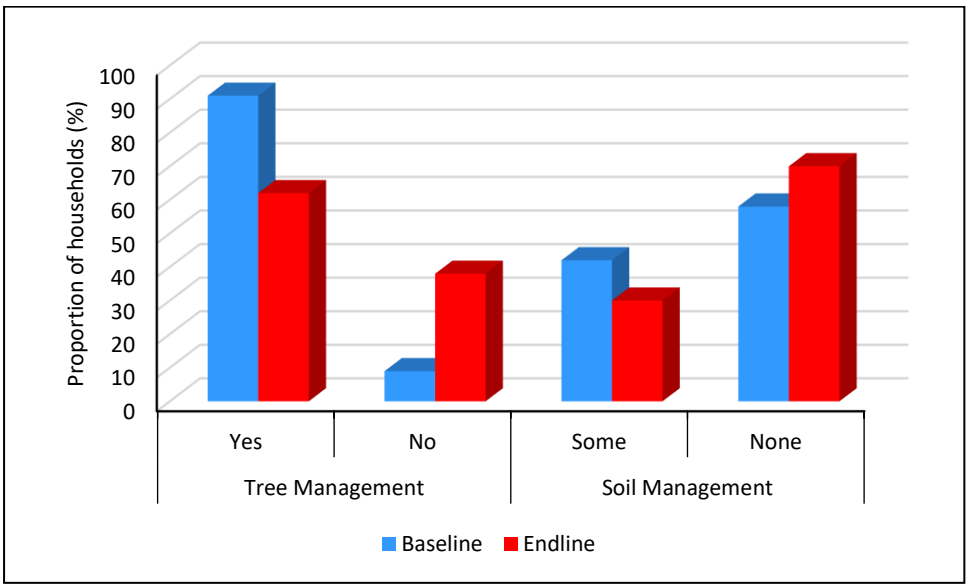


**Figure 4. Households involved in mitigation measures**

## 4.4 Drivers of changes to agriculture and land management

Table 4 presents the drivers of change in crop and land management. Results show that climate change was a leading driver of change at both baseline and endline, as reported by more than 80% of households. The main climate change aspects driving the change are reduced amounts of rainfall, increased frequency of droughts and late start and/or early end of rains. Market was a key driver at baseline (86%), although this dropped to only 45% of the households at endline. Overall, however, some changes have been made because of new opportunities to sell and the associated better prices, which drive the farm households to opt for higher-yielding varieties. Land, labour, and pests were also reported as key drivers of change in crop and land management by 34%, 17% and 25%, respectively, at endline dropping from 55%, 71% and 71%, respectively, reported at baseline. Although only 38 (number) households associated the changes made with land, 32% of these indicated that their land sizes had shrunk. In contrast, another 32% indicated that their arable land sizes had increased (possibly due to rehabilitation of the once degraded land since the same proportion also indicated that their land had become more productive). Another 5% of respondents in this category indicated that they had effected the changes because their land had become less productive. The role of projects in driving change, however, increased from 7% reported at baseline to 14.2% at endline.

**Table 4. Households reporting drivers of change in crop and land management**

| Reason for change | Baseline (%) | Endline (%) |
|---|---|---|
| Markets | 86 | 45.1 |
| Climate | 80 | 81.4 |
| Land | 55 | 33.6 |
| Labor | 71 | 16.8 |
| Pests/diseases | 71 | 24.8 |
| Projects | 7 | 14.2 |

## 4.5 Drivers of change in livestock production

The drivers of change in livestock production are presented in Table 5. Results show that the proportion of households reporting markets as key drivers of change in livestock production declined from 79% at baseline to 52%, those reporting labor declined from 78% to 21%, with those reporting projects declining from 30% to 12% at endline. CCAFS and ILRI promoted upgrading of the indigenous small ruminants by introducing improved small ruminants (Galla goats and Red Maasai sheep) from late 2012. Through training and capacity building on improved management, healthcare, and breeding techniques, the community-based organizations (FOKO, NECODEP and Kapsokale) were empowered and have largely sustained the initiative using their own resources. Therefore, this initiative is most likely seen as a farmer-led adaptation.

In contrast, the proportions of households reporting climate and pests/ diseases as key drivers of change in livestock production increased from 50% and 19%, respectively, at baseline to 87% and 28%, respectively, at endline.

Rainfall was the single most important factor associated with changes in livestock production as reported by 63% of the respondents who indicated that either frequency of droughts had increased, rainfall amounts had dropped, and rains started late and/or ended early. Of the respondents who had made changes because of market, the livestock breeds introduced were associated with higher productivity, new opportunities to sell and better prices.

**Table 5. Households reporting drivers of change in livestock production**

| Reason for change | Baseline (%) | Endline (%) |
|---|---|---|
| Markets | 79 | 51.5 |
| Climate | 50 | 86.6 |
| Labor | 78 | 20.6 |
| Pests/diseases | 19 | 27.8 |
| Projects | 30 | 12.4 |

## 4.6 Changes in use of inputs and credit

Use of certified seed, pesticides/herbicides, and veterinary medicine declined between the baseline and the endline (Figure 5). The use of fertilizers, however, remained the same across the period while access to credit increased. The decline in the use of certified seed is attributed to the introduction of a community seed bank in 2019. The seed bank selects and stocks high quality, high-yielding and resilient seed varieties. This also partly explains the decline in the use of pesticides because the selected varieties are also pest and disease tolerant. The decline in use of veterinary medicine is attributed to the introduction of improved livestock breeds that are more tolerant to pests and diseases, coupled with improved livestock management that ensures better nutrition and health of livestock, thereby reducing the need for frequent veterinary services. Increased access to credit is attributed to the innovation fund managed by the farmer groups (as indicated in Section 2).

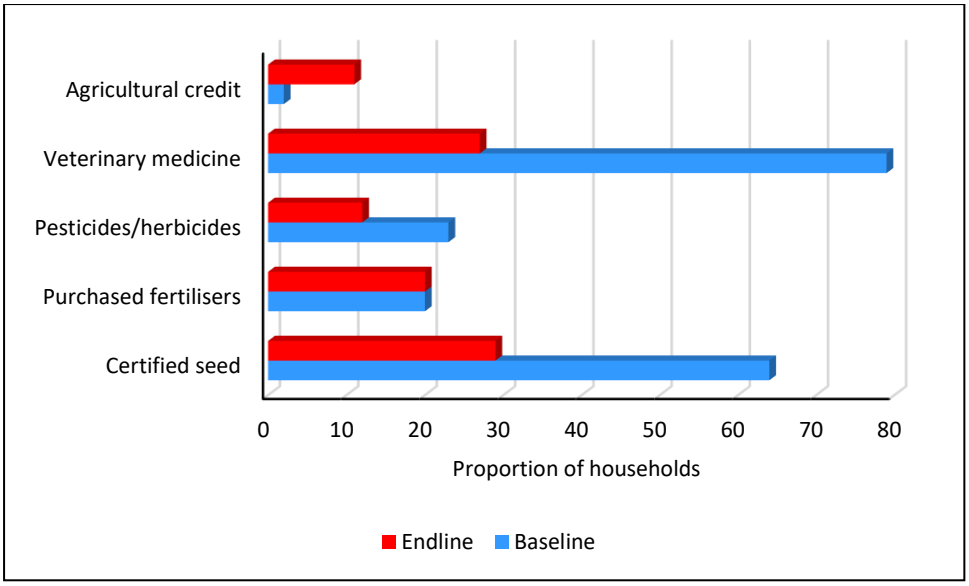


**Figure 5. Changes in use of inputs and credit**

## 4.7 Changes in the drivers of change in the community

The focus group discussions revealed that a number of factors had driven changes in the community. Climate change, especially rainfall which had reduced in amount coupled with frequent occurrence of droughts. In some cases, the rainy season started late and/or ended early. Deforestation was a major driver at baseline as most households depended on forests for fuelwood and charcoal, leading to depletion of the natural forests. However, with the support of development projects in the area, the communities started on-farm planting of trees for the provision of fruits, fuelwood and building materials. As a result, by endline, forest cover in the area had tremendously increased.

Soil degradation continues to influence livelihood systems in the Nyando basin accelerated by rapid population growth and expansion of farms to less marginal areas, keeping large herds of livestock and the occasional excess rainfall and flooding. This compels the communities to adjust their livelihood activities. It is also on this basis that development projects have introduced and/or promoted soil and water conservation, and improved crop variety and livestock breed interventions in the area.

Some of the infrastructural facilities which were poor at baseline have since been improved. New schools have been built, increasing access to education. New health facilities have come up, improving access to health care. Roads have been improved, and markets have expanded and/or increased, increasing market opportunities and promoting market-oriented production. The villages have been connected to electricity, improving security and opening up new business opportunities. Quarries have expanded and new ones have been opened. Besides providing building materials and job opportunities, quarries accelerate erosion and destroy the aesthetic value of the landscape.

**Table 6. Drivers of change in the community**

| Driver of change | Baseline | Endline |
|---|---|---|
| Climate/Rainfall | X | X |
| Deforestation | X | |
| Reforestation | | X |
| Soil degradation/erosion | X | X |
| Population growth | X | X |
| Rehabilitation of water sources | | X |
| Improved varieties/breeds | | X |
| Livestock keeping | X | X |
| Infrastructural development | X | X |
| Mining (sand and murram harvesting) | X | X |

# 5. Livelihood diversification

## 5.1 Changes in sources of income

Table 7 shows the sources of cash income for the households. The main sources of cash income at baseline were employment on someone else's farm (45%), business (45%), remittances/gifts (45%), and other paid employment (14%). Less than 10% of households reported payment of environmental services, payments from projects, formal and informal loans/credit, rental of land, and rental of machinery as main sources of cash income. At endline, the major sources of cash income included business (57%), remittances/gifts (31%), loans/credit from banks/formal institutions (30%), employment on someone else's farm (28%) and loans/credit from informal sources (15%). The results imply that credit has become more available and accessible to households.

**Table 7. Sources of cash income for the households**

| Sources of cash income | Baseline (%) | Endline (%) |
|---|---|---|
| Employment on someone else's farm | 45 | 28.3 |
| Business | 45 | 57.2 |
| Remittances/gifts | 45 | 31.2 |
| Other paid employment | 14 | 13.8 |
| Payments for environmental services | 6 | 0.7 |
| Other payments from projects/government | 5 | 2.9 |
| Loan/credit from bank/formal institution | 6 | 30.4 |
| Loan/credit from informal source | 4 | 14.5 |
| Renting out farm machinery | 7 | 0.7 |
| Renting out land | 7 | 8.0 |
| No other source of cash | 9 | 0 |

It is evident that livelihoods are becoming more diversified as all households had income sources beyond the farm as opposed to during baseline when 9% of the households totally depended on the farm. Notably, business opportunities have remarkably increased which could indicate that incomes have improved, and the market base can support business. Increased access to credit could possibly further stimulate the businesses because of the availability of investible funds to either start or expand businesses. It is also important to note the decline on remittance/gifts from relatives and friends commonly associated with thin economic activities within a particular community or geographical location dependent on income transfers.

## 5.2 Product diversification index

A production diversification index for the households was created by getting the sum of all products produced or harvested on-farm:

- Low diversification (1-4 products)
- Intermediate diversification (5-8 products)
- High diversification (9 or more products)

Figure 6 shows the results of production diversification of on-farm. More than half of the households (had an intermediate production diversification index, increasing from 52% at baseline to 54.7% at endline. The proportion of households with high production diversification index, however, declined from 33% at baseline to 20% at endline. About one-quarter of the households had low production diversification at endline compared to 16% at baseline. The households have transitioned from high diversification to intermediate and low diversification. Most probably, this is attributed to learning by the households, which has helped them move from trial and error (which leads to high diversification) to conclusive decisions on what works best, leading to the dropping of the less suitable products.

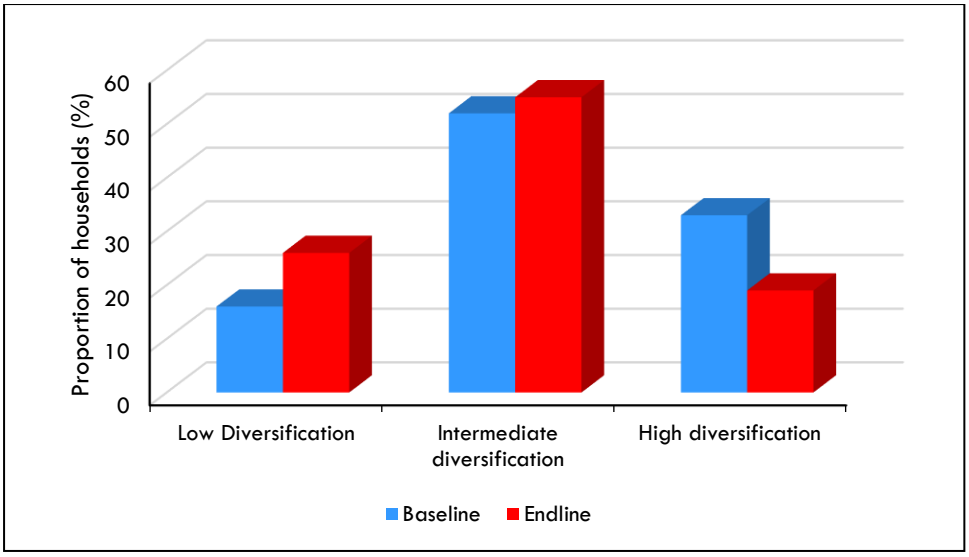


**Figure 6. Product diversification index**

## 5.3 Commercialization diversification index

The commercialization or sale of products index was created by adding the products produced on-farm and sold, and grouped into four categories:

- No Commercialization (No products sold);
- Low Commercialization (1-2 products sold);
- Intermediate Commercialization (3-5 products sold); and
- High Commercialization (6 or more products sold).

More than half of all households surveyed at endline showed either intermediate (49.3%) or high commercialization (11.6%) indices compared to 33% and 9%, respectively, at baseline (Figure 7). On the other hand, 10.1% of the households showed no evidence of commercialization, selling none of their agricultural produce at endline compared to 26% at baseline. This is consistent with increased business as the main source of income reported in the earlier sections of the report.

The farmers are becoming more market-oriented than subsistence, indicating increased production beyond subsistence or a switch from farming for livelihood to farming as an agribusiness. This could be attributed to the introduction of high-yielding crop varieties coupled with improved agronomic practices. Results from the focus group discussions indicate that the local markets have expanded, and farmers are also linked to other markets, making production for the market more attractive.

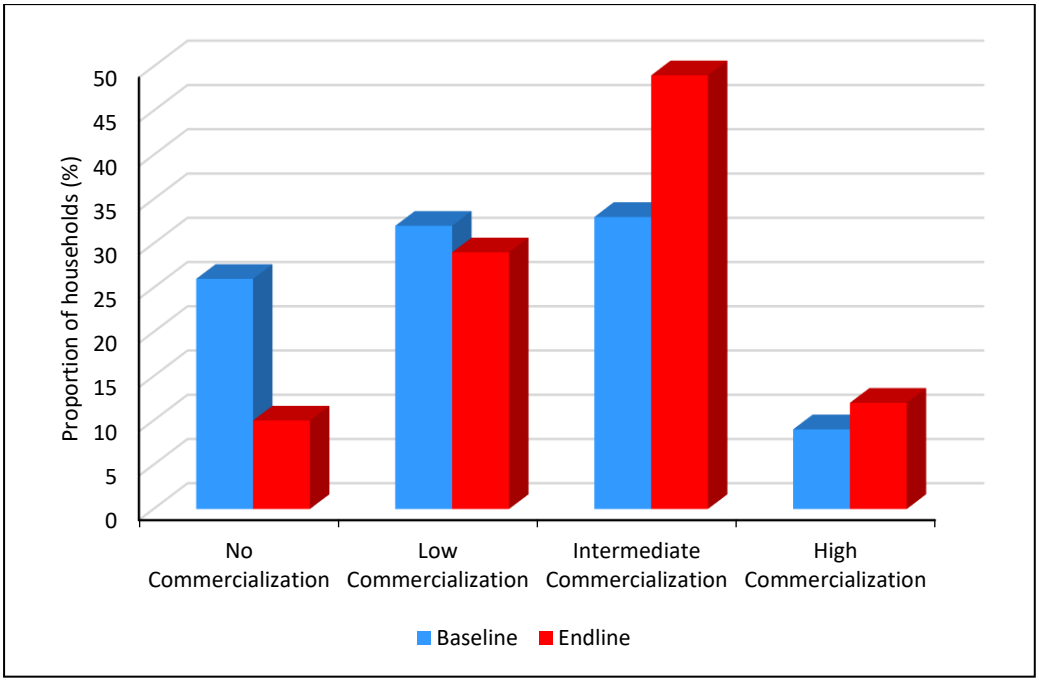


**Figure 7. Commercialization index**

# 6. Food security

## 6.1 Food security index

The food security index created was based on the period (number of months) that the majority of the households experienced food shortage (hunger months). At baseline, no households experienced hunger for five or more months. This changed at the endline when 15% of the households experienced hunger for more than 6 months while 22% of the households experienced hunger for 5 to 6 months. Further, the households experiencing hunger for 3 to 4 months increased from 17% at baseline to 43% at endline. Moreover, while 81% of the households experienced only 1 to 2 months of hunger at the base, this had dropped to only 20% at the endline. Notably, no household was completely food secure at endline, unlike at baseline when 1% of the households were.

The rise in the proportion of households experiencing more months of hunger at endline, according to key informants, was attributable to the prolonged dry spell of 2021, which led to total crop failure for most of the households in the Nyando Basin and partly due to the effects of Covid-19 which led to increased household sizes as people who had lost their livelihoods in urban areas moved back to their rural homes. Even where the kins did not move back to the rural homes, the farm households still had to support them by sending part of the farm produce for their upkeep. An evaluation study conducted in 2017 revealed that the introduction of CSA technologies and innovations had indeed improved food and nutrition security in the Nyando Basin (see Radeny et al. 2018).

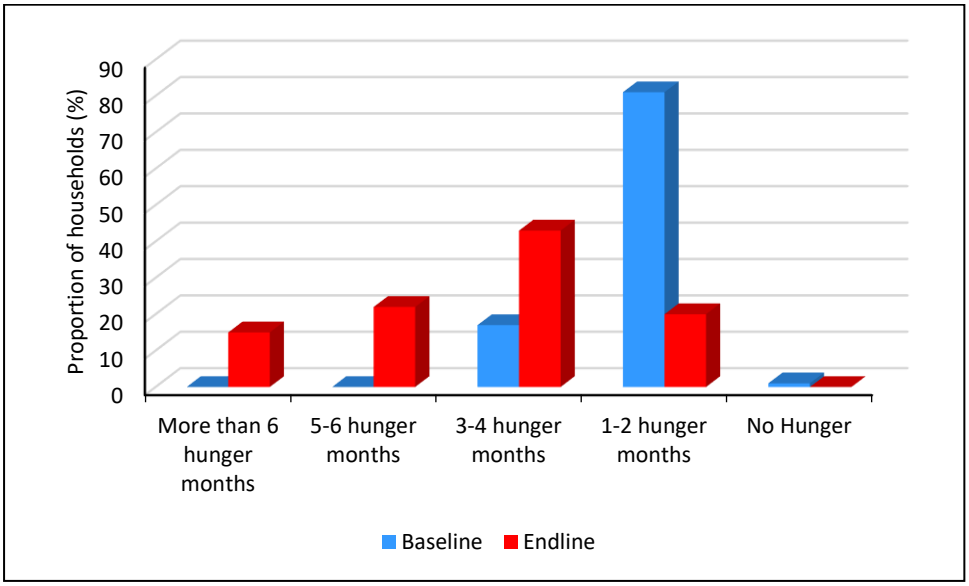


**Figure 8. Hunger months experienced by households**

## 6.2 Number of organizations working on food security in the community

The focus group discussions with male and female participants identified a number of organizations working in Nyando to improve food security, mainly through improving agricultural productivity. These included One Acre Fund, World Vision, SNV Netherland Development Organization, Friends of the Old (FOTO), Practical Action, Ministry of Agriculture (MoA), Kenya Agricultural and Livestock Research Organization (KALRO) and community-based organizations (CBOs) (see Table 8 for details).

**Table 8. Organizations working on food security in Nyando**

| Organization | Main areas of activity |
|---|---|
| **One Acre Fund** | Offers financing and training to small-scale farmers, provide high quality agricultural inputs on credit and trains on modern farming techniques. Also promotes strategies for adaptation to and mitigation of climate change. |
| **World Vision** | Increasing food production for nutrition and market, improving household income, community capacity building on resilience to environmental shocks e.g. floods and drought and sustainable use of water and other natural resources in conflict free environment. |
| **SNV** | Capacity building in the vegetable value chain, regenerative agricultural seed system, commercialization of traditional vegetable and strengthening the vegetable seed system. |
| **FOTO** | Friends of the Old (FOTO) works on reducing or eliminating water borne diseases in lower Nyakach, welfare of the elderly and assisting vulnerable girls achieve basic education and improving food security. |
| **Practical Action** | Increasing the participation of youth in agribusiness, promoting agro-ecology practices for increased farm productivity and influencing policy environment for youth in agribusiness. |
| **MAGOS** | Works on improving access to farm inputs, improving access to markets by linking farmers with buyers and improving yields-through proper use of inputs. |
| **HANDS** | Mainly works to improve nutrition of ECD children and the community. |
| **STIPA** | Enhancing inclusivity, sustainable development and ownership of projects. It ensures access to quality, accessible and affordable healthcare for vulnerable groups. |
| **Alliance Bioversity** | Helps farmers to adapt to climate change through crop diversification, increasing access to appropriate seed through seed banks, enhancing value addition and building capacity of farmers in variety selection, business and financial management. |
| **MoA – Nyakach Subcounty** | Increasing agricultural productivity, promoting agricultural marketing and environmental conservation. |
| **MoA – Soin/Sigowet Subcounty** | Increasing agricultural productivity, capacity building of farmers on best technologies available, improving farmer incomes through farmer groups and value addition. Also works on reducing soil erosion and maintaining soil fertility and improving nutrition among households through improved knowledge on food utilisation. |
| **KALRO Genebank** | Enhancing conservation of traditional crops, promoting climate resilient varieties and ensuring a secure supply for farmer preferred varieties. |

| Organization | Main areas of activity |
|---|---|
| **KALRO Kibos** | Increasing agricultural productivity, conserving soil and environment and ensuring increased farmer incomes through value addition. |
| **FOKO** | A CBO which mainly works on improving food security, environmental conservation, promoting social capital and linking community with other partners. |
| **NECODEP** | A CBO and focuses on building capacity of farmers, soil erosion control, promotion of tree planting and environmental management e.g., desilting dams. |
| **Kapsokale** | A CBO with a focus on farmer training, linkage with other specialised organizations, availing improved seeds within easy reach of farmers and offers grants for business. |

Other areas that could enhance food security but have not been effectively covered by the previous and current organizations operating in Nyando include agricultural mechanisation, post-harvest management, value-addition, irrigation, and improving market linkages.

# 7. Collective action on natural resource management

The community has diverse natural resources: agricultural land, rivers and springs, wetlands, water pans and dams, quarries, forests and trees and gullies. Management of these resources has remained the same since baseline, dominated by individual ownership and use. Agricultural land, for example, is owned by the individual farmers who use them for their own production of crops and livestock. However, some community members allocate land for use by community groups for experimentation and demonstration and, in some cases, group production for commercial purposes. Community groups have also been important for building innovation funds, bulking of seed and mobilizing members for training on agricultural technologies. Indeed, these group efforts have been credited for the improved adoption of climate-smart technologies in Nyando.

Rivers and springs have been managed as open access resources and have suffered degradation due to climate change and siltation, mainly brought about erosion arising from overstocking and the associated watering of livestock at the rivers. Individual households whose plots are close to the rivers have also cultivated up to the riverbanks, degrading such banks. The communities, however, have a vision of restoring the degraded riverbanks and even the wetlands by planting suitable tree species and compelling the community members to preserve the riparian areas.

Water pans and dams are under different management regimes. There are those under community management and use, while others are on private land for family use, although other community members can access with permission. Most of the water pans and dams have, however, been mismanaged and getting silted up. In fact, they are becoming a threat to the adjacent farmlands, especially during heavy rains when they break their banks to

flood the farms. This has led to the development of more gullies in the community and expansion of the pre-existing ones.

Previously, forests were communally used, which led to the degradation of the community forests to the extent that they could no longer serve the community needs for forest products. This, with the help of community groups and development organizations in the area, has led to tremendous progress in establishment of on-farm trees. Currently, although on-farm forests and woodlots are individually owned and managed, there are tree nurseries managed by community groups from which farmers can get seedlings conveniently at an affordable price. Some individual farmers have also taken up tree nurseries as a business. Predominantly, fruit trees are grown for their multiple uses, such as providing fruits, breaking winds, reducing soil erosion and providing wood fuel.

Organizations that have worked with farmers on natural resource management included CCAFS, KALRO, World Vision, MoA, One Acre Fund, ILRI, Bioversity, Caritas, STIPA, and CBOs (Koyombe Pan, FOKO, NECODEP, Obinju Self Help Group, Tagangurwet, and Chemildagey). Some of the activities undertaken by these organizations include training and demonstration on control of soil erosion through terracing, stone lining and planting of trees and fodder grasses like Vetiver and Nappier.

Natural resources management initiatives have led to some positive outcomes:

- Increased agro-forestry and planting of trees on-farm among the villages for fruits, timber and fuelwood, and for control of erosion.
- Construction of water pans to store run-off water and curtail erosion besides providing water for irrigation.
- Improved soil and water management.
- Rehabilitation of wetlands and other water sources, and some gullies.

# 8. Organizational membership

Table 9 presents the proportions of households belonging to various groups. Results show an overall increase in group participation among the households between the baseline and endline. Only the vegetable production groups recorded a decline in membership participation. Participation in savings and credit groups registered the highest increase in membership participation, from 33% of the households at baseline to 84% at the endline. This is most probably attributable to the innovation fund from which members can borrow to boost their agricultural activities or cushion them in times of difficulty.

**Table 9. Group membership and participation**

| Group type | Baseline (%) | Endline (%) |
|---|---|---|
| Savings and/or credit group | 33 | 84.3 |
| Productivity enhancement group | 7 | 9.8 |
| Vegetable production group | 6 | 3.9 |
| Tree nursery/tree planting group | 5 | 7.8 |
| Water catchment management group | 1 | 1.0 |
| Soil improvement activities group | 2 | 6.9 |
| Crop introduction/substitution group | 1 | 3.9 |
| Marketing agricultural products group | 1 | 5.9 |
| Seed production group | 1 | 5.9 |
| Other group (soil, land, or water management) | 1 | 4.9 |

# 9. Asset ownership

## 9.1 Households with assets by level

Household assets covered five asset categories:

- Energy: electricity, generator, solar panel, biogas digester, car battery;
- Information: radio, cell phone, computer, internet access;
- Production: tractor, mechanical plough, thresher, and mill;
- Transport: bicycle, motorbike, car or truck; and
- Luxury: fridge, air conditioning, fan, improved stove, bank account.

In addition, an asset index or indicator was created by adding all the assets owned by the household, resulting in three levels of asset ownership: basic level (no assets); intermediate level (1-3 assets); high level (4 or more assets). It is important to note that the asset indicator is not conclusive as it was not intended to include all possible types of assets. For example, livestock assets, which are critical, especially for resource-poor households, were also not included. The results show that the proportions of households with high asset levels (4 or more assets) increased from 26% at baseline to 53% at endline, while the proportion of households with intermediate assets levels (1 to 3 assets)) declined from 63% to 47% at the endline (Figure 9). Similarly, the proportions of households with no assets dropped from 11% to 0% over the same period.

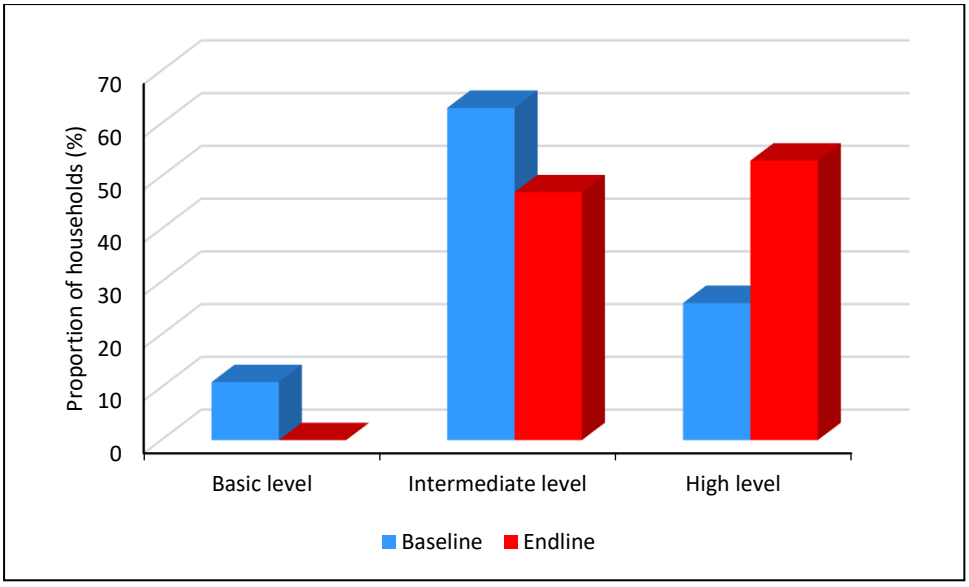


**Figure 9. Asset ownership by level**

## 9.2 Household asset ownership by category

Figure 10 shows the ownership of transport assets by the households. Results show that the proportion of households owning motorcycles and car/truck increased from 4% and 1%, respectively, at baseline to 18% and 3.6%, respectively, at endline. On the other hand, the proportion of households owning a bicycle dropped from 31% at baseline to 24% at endline. The decline in ownership of bicycles coupled with the rise in motorcycle ownership implies a shift in the modes of transport from manual manpower-driven modes to motorised modes of transportation.

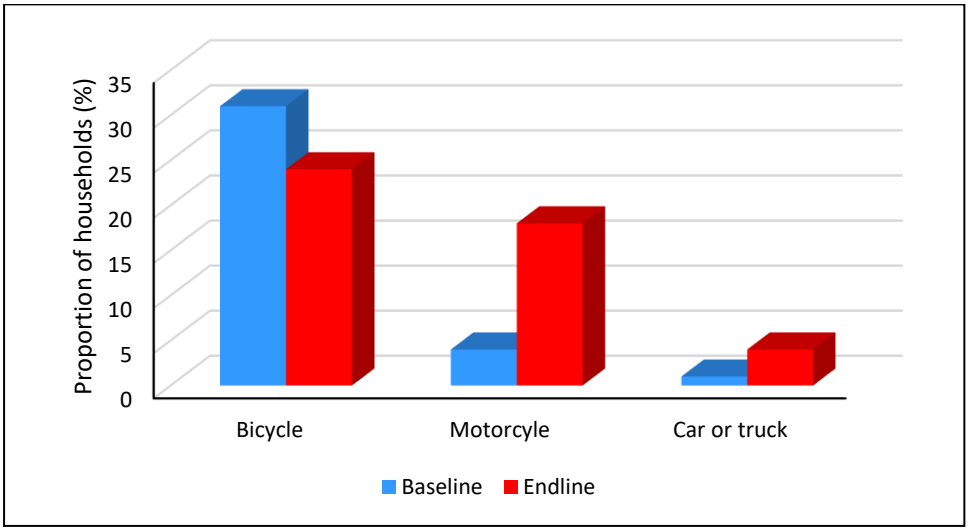


**Figure 10. Ownership of transport assets**

Table 10 presents ownership of production assets and which shows a significant increase in ownership of assets (water pump, mechanical ploughs and mills) compared to baseline. At baseline, none of the households owned a mechanical plough or a mill. Only 1% of households owned a water pump/treadle pump at baseline.

**Table 10. Ownership of production assets**

| Production assets | Baseline (%) | Endline (%) |
|---|---|---|
| Mechanical plough | 0 | 43.8 |
| Mill | 0 | 12.5 |
| Water pump/treadle pump | 1 | 62.5 |

Similarly, the proportion of households owning energy assets increased. Ownership of solar panels, for example, increased from 4% at baseline to 57% at endline (Table 11), while the proportions of households owning battery and LPG gas increased from 9% and 0%, respectively, at baseline to 16% and 9%, respectively at endline.

**Table 11. Ownership of energy assets**

| Energy assets | Baseline (%) | Endline (%) |
|---|---|---|
| Solar panel | 4 | 57.1 |
| Generator | 2 | 3.1 |
| Battery (large - e.g., car battery) | 9 | 16.2 |
| Liquid pressurized gas | 0 | 8.9 |

Figure 11 shows the proportions of households owning different communication and information assets. The results indicate that the proportion of households owning a radio increased from 82% at baseline to 88.4% at endline, while the proportion owning a television increased 14% to 34.5%. Similarly, the proportion of households owning cell phones, computers, and have access to the internet increased from 60% at baseline to 94% for cell phones at endline and from 1% to 12.3% for internet access. This is an illustration that the households have had improved incomes, resulting in increased asset holding. It is also important to note that these assets in this category are important for receiving agricultural information (production and/or marketing information).

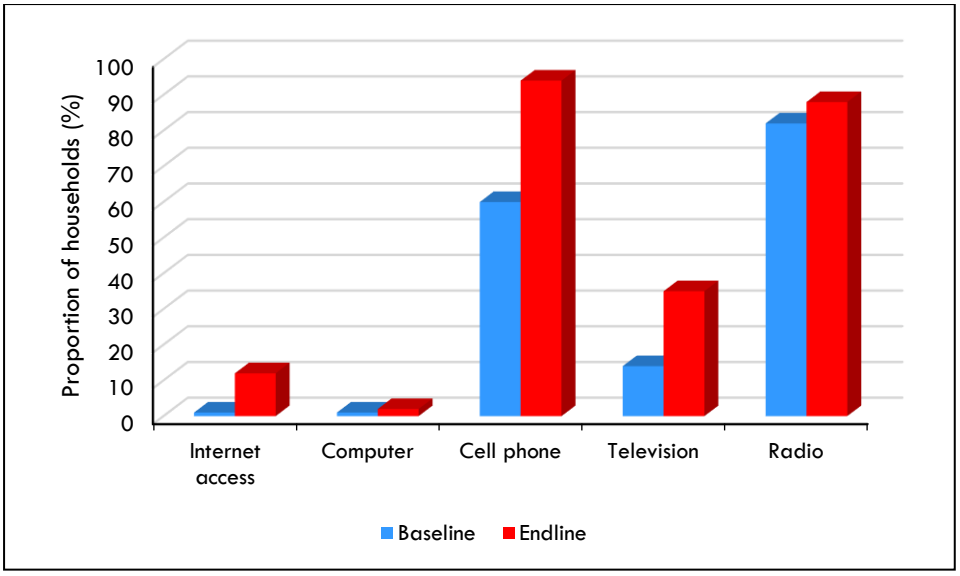


**Figure 11. Ownership of information and communication assets**

The ownership of luxury assets is presented in Table 12, indicating marginal changes in ownership of air conditioning and electrical fan assets. The proportion of households owning a refrigerator also increased from 1% at baseline to 4.3% at endline. Consistent with the observed increase in access to financial services, the proportion of households owning a bank account also increased from 4% to 26%.

**Table 12. Ownership of luxury assets**

| Luxury assets | Baseline (%) | Endline (%) |
|---|---|---|
| Refrigerator | 1 | 4.3 |
| Air conditioning | 0 | 1.4 |
| Electrical fan | 0 | 0.7 |
| Bank account | 4 | 26.1 |

# 10. Information access

## 10.1 Networks of information

Households received information on different aspects of farming: types of seed, rainfall/weather, planting time, fertilizer and crop varieties, soil type, marketing, and crop and livestock management. At baseline, the various sources of information for both men and women are summarised in Table 13. Notably, both men and women received information on seed types and fertilizer and crop varieties. Information on weather, planting time and soil types was only received by men, while information on marketing and crops and livestock management was only received by women.

Access to information greatly improved, with both men and women having access to the same types of information and from similar sources. Traditional methods of weather forecasting were, however, getting abandoned by the communities in favour of the modern approaches. Important types of information identified included the start of rains, pests and diseases, fertilizers and agrochemicals, market, seed varieties and livestock management. Mobile phones are increasingly becoming the main source of agricultural information. Other important sources of information include radio and/or television, public meetings (usually organised by local administration) and extension agents, either by the government or the organizations working in the area. Table 14 summarises the various types of information received, including their sources and how the communities use the information.

**Table 13. Network of information as identified at baseline (0=not identified, 1=identified)**

| Source of information | Men | | | | | | | Women | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seed type | Weather | Planting time | Fertilizer & crop varieties | Soil type | Marketing | Crop & livestock management | Seed type | Weather | Planting time | Fertilizer & crop varieties | Soil type | Marketing | Crop & livestock management |
| Family | 1 | 1 | 1 | 1 | 1 | - | - | 0 | - | - | 0 | - | 0 | 0 |
| Friends | 0 | 0 | 0 | 0 | 0 | - | - | 1 | - | - | 1 | - | 1 | 1 |
| Neighbours | 1 | 0 | 0 | 0 | 0 | - | - | 0 | - | - | 0 | - | 0 | 0 |
| Old women | 0 | 0 | 0 | 0 | 0 | - | - | 0 | - | - | 0 | - | 0 | 0 |
| Organizations | 1 | 0 | 0 | 0 | 0 | - | - | 1 | - | - | 1 | - | 1 | 1 |
| Radio | 1 | 1 | 0 | 0 | 0 | - | - | 1 | - | - | 1 | - | 1 | 1 |
| TV | 0 | 0 | 0 | 0 | 0 | - | - | 1 | - | - | 1 | - | 0 | 0 |
| Newspapers | 0 | 1 | 0 | 0 | 0 | - | - | 0 | - | - | 0 | - | 0 | 0 |
| Personal observation | 1 | 1 | 0 | 0 | 0 | - | - | 0 | - | - | 0 | - | 0 | 0 |
| Meetings | 1 | 0 | 0 | 0 | 0 | - | - | 0 | - | - | 0 | - | 0 | 1 |

**Table 14. Main information networks at endline**

| Type of information | Source | Use |
|---|---|---|
| Start of rains | MoA, mobile applications, radio, TV | Land preparation and planting |
| Pests and diseases | Agro-dealers, NGOs, radio, TV, public meetings, neighbours | Choice of appropriate crop varieties, choice of disease and pest control measures |
| Seed varieties | Radio, TV, Agro-dealers, NGOs, trainings/seminars | Choice of suitable crop varieties |
| Extreme weather events (e.g., floods and droughts) | NGOs, radio, public meetings and mobile phone alerts | Making decisions on appropriate coping strategies |
| Soil conditions | NGOs | Choice of amendment measures e.g., type of chemical fertilizers to use and appropriate crop variety |
| Market | Radio, TV, mobile phone applications and personal inquiries | Making marketing decisions - when and where to sell produce and prices |

## 10.2 Households receiving weather-related information

The proportion of households receiving various types of weather-related information are presented in Figure 12. The proportion of households receiving information on the start of the rains declined marginally from 87% at baseline to 85% at endline. In general, there is a substantial decrease in the proportions of households receiving forecasts on extreme weather, forecast of pest and disease outbreaks, 2–3 months weather forecasts and 2–day weather forecasts. Perhaps this demonstrates that the start of rains is the single most crucial element of weather forecast to the farmer, and most service providers are inclined to provide it.

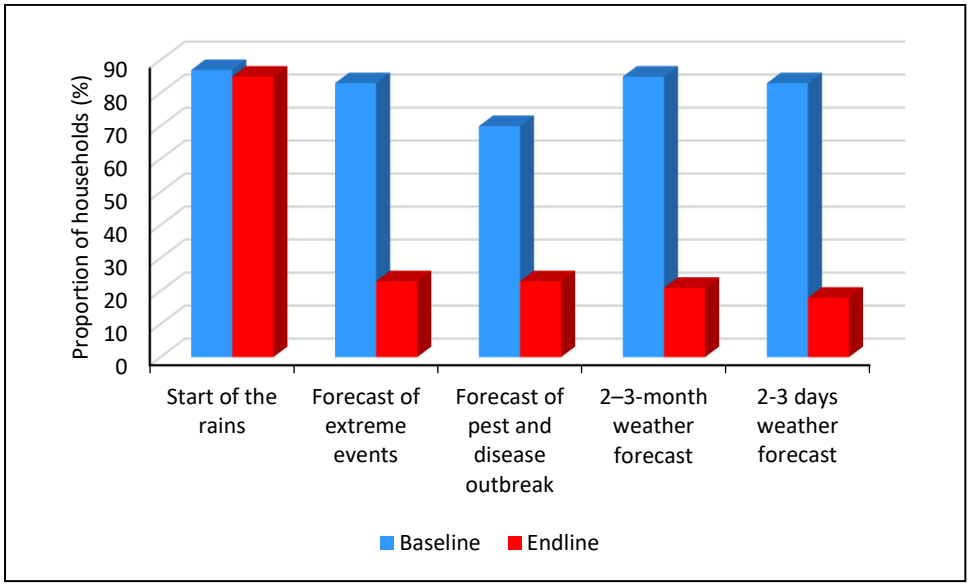


**Figure 12. Proportion of households receiving weather-related information**

## 10.3 Members of household receiving weather information

In most households, the receipt of weather information is becoming gender-neutral, unlike at baseline when weather information was mainly received by women in most households (Figure 13).

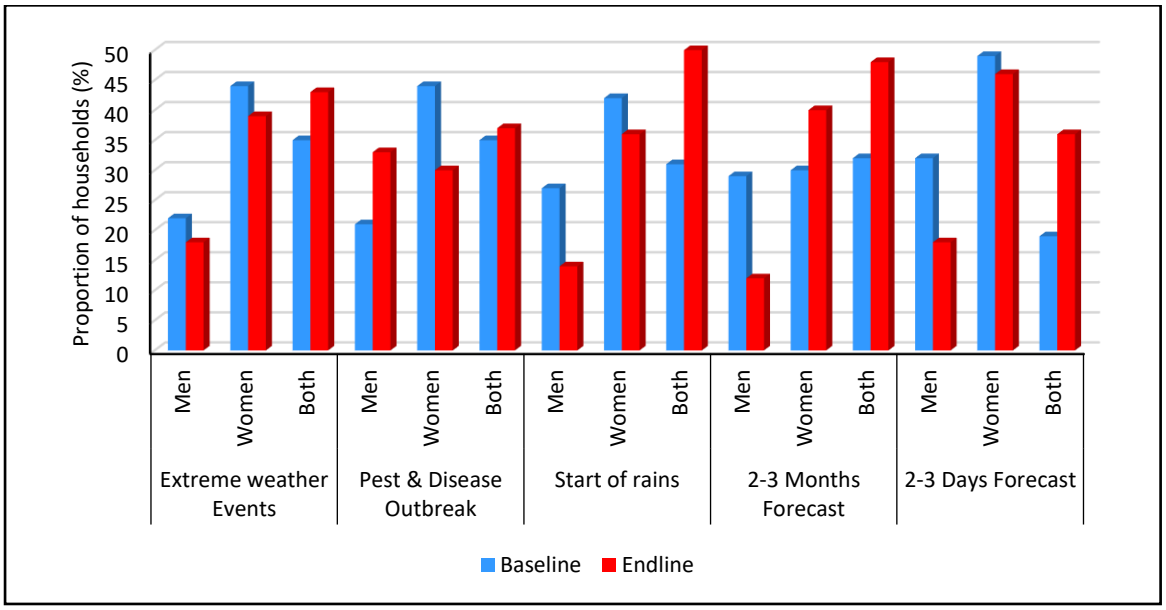


**Figure 13. Household members receiving weather-related information**

The proportion of households where receipt of extreme weather events was a preserve of men declined from 22% at baseline to 18% at endline. The households in which only women members received extreme weather events information declined from 44% to 40% in the same period, while those in which the information was received by both men and women increased from 35% to 43%. A similar trend is replicated for other weather-related information such as outbreaks of pests and diseases, start of rains, and long-term and short-term forecasts. This change is important for agricultural development because agricultural decisions transcend the gender of household members. Thus, all members receiving the information is likely to hasten the decisions.

# 11. Organizational priorities

As indicated earlier, several organizations are working in the Nyando CSV, focusing on improving food security and sustainable natural resource management. These include One Acre Fund, World Vision, SNV, FOTO, Practical Action, MAGOS, HANDS, STIPA, Alliance-Bioversity, Ministry of Agriculture (MoA) for Nyakach and Soin/Sigowet, KALRO-Gene Bank, KALRO-Kibos, and the CBOs (FOKO, NECODEP and Kapsokale). The focus areas of each of these organizations are described in detail in the Organizational Endline Report.

For food security, most efforts focus on increasing food availability by providing improved seed and training farmers on appropriate agronomic practices and complementary technologies. A few organizations were also involved in the direct supply of food to vulnerable members of the community and training community members on how to use different food types to improve

nutritional outcomes. For natural resource management, the organizations had activities related to improvement and sustainable use of the resources and climate change adaptation and mitigation measures. There was an increase in number of NRM activities relative to baseline, and the CBOs in the area had been empowered and were, in turn, empowering the community. There was, however, still a need for more collaborations between local CBOs and other organizations working in the area to join hands and build capacity for the sustainability of the activities being implemented. The predominant activities under Natural resource management were environmental protection and rehabilitation through tree planting, sustainable farming, soil and water conservation, water management and renewable energy use.

While the organizations in Nyando did not seem to work closely with each other, it was clear that all of them worked closely with the Ministry of Agriculture (MoA) and with community-based organizations such as FOKO, NECODEP and Kapsokale. The MoA, therefore, provides a framework through which the activities of the organizations could be coordinated for synergy and optimal outcomes.

Although significant milestones have been made in food security and natural resource management in the Nyando CSV, the organizations contended that more could still be done. Water scarcity, however, was identified as the most limiting factor in implementing climate-smart agriculture practices by the farmers. Hence, the implementing organizations suggested intensification of the following technologies: water conservation measures such as protection of water catchment areas, water harvesting technologies such as excavation of water pans, promoting water use efficiency technologies such as drip irrigation systems and building dams that can be used for irrigation during dry seasons. None of the organizations, nevertheless, was planning to change its focus priorities to meet these needs or other emerging community priorities because they were project-based and had pre-determined targets to deliver and time frame to operate. They also relied on donor support and would find it difficult to change their priorities midstream. It is for the same reasons that a large number of organizations that operated in the area at baseline had exited the scene.

# 12. Conclusion

This synthesis report assessed the changes that have occurred at household and community levels (village and organizational) between the baseline (2011) and endline (2021) and how these combine to contribute to climate change adaptation and mitigation. A couple of conclusions can be drawn from the comparative analysis of the baseline and endline indicators:

- Changes in the demographics, with an increase in household sizes and the number of dependants. The education levels of the household members have also improved.
- Business and remittances are increasingly becoming the main sources of household cash income compared to farm labour at baseline.
- Increased access to credit from formal and informal credit sources.
- Membership to savings and credit groups has tremendously increased, possibly indicating credit constraints among the smallholder farmers. Thus, many farmers are turning to these groups to improve their access to agricultural credit.
- Changes of sources of agricultural information from the more traditional ways to more modern mobile application-based, and media and social networks approaches.
- Proportion of households receiving weather information has declined, and in most households, the information is now received by both men and women.
- Number of households with an intermediate level of adaptation has increased, although new investments in climate change mitigation have declined.
- Changes in livestock and crop production and land management practices in Nyando are largely driven by climate change and the need to cope with or mitigate it.
- Majority of households have low to intermediate production diversification, indicating that farmers are no longer experimenting. Instead, they have made conclusions on crops best suited for them, which signifies the likelihood of the decisions' sustainability.
- Marginal increases in levels of commercialization, indicate a shift from purely subsistence production – an indication of a rise in surplus production.
- Although food and nutrition security have improved, the communities are not yet food secure as demonstrated by the increased number of food insecure months at endline, resulting prolonged dry spell in the survey year and the effects of Covid-19 pandemic.
- Increase in household wealth, measured by asset ownership, specifically for the production, energy, information, and luxury assets.
- Many organizations and CBOs in Nyando are working on food security, focusing on increasing food availability through increased production and productivity. Access to and utilisation of food, though important for food security, are less explored. There are opportunities for improving synergies among the different organizations for optimal results.

Overall, there is satisfactory progress towards sustainable natural resource management to contribute to food and nutrition security under climate change and ecosystem changes. Although attribution is not conclusive, this provides a case for scaling up climate-smart technologies and innovations for improving livelihoods and incomes of vulnerable communities, and for climate change adaptation and mitigation.

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