Info Note

Uptake and impact of climate-smart agriculture on food security, incomes and assets in East Africa

Findings from Nyando Climate-Smart Villages in Western Kenya

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Key messages

- Increased uptake of climate-smart agriculture (CSA) technologies and innovations across the Climate-Smart Villages (CSVs).
- Adoption of CSA technologies influenced by household socio-economic and institutional factors.
- Improved multiple stress-tolerant crops and improved small ruminant livestock breeds had positive and significant impacts on household livelihood outcomes.
- Participatory learning actions that take into account local knowledge are important for accelerating CSA uptake and enhancing the adaptive capacity of farmers.

Farmers in East Africa are experiencing increasing livelihood challenges attributed to increasing scarcity of agricultural land, steep rises in food prices, deteriorating soil fertility and associated declining crop yields, poor market access and, in some cases unclear land tenure systems (Yamano et al. 2011). Climate change compounds these challenges, with the region witnessing changing climatic conditions characterized by warmer temperatures, changing rainfall patterns and increased frequency and severity of extreme weather conditions (Wheeler and Von Braun 2013). Expected consequences and impacts of these changes include shortened and disrupted growing seasons, reduction in area suitable for agriculture and declining yields in agriculture (Connolly-Boutin and Smit 2016).

Increasing agricultural productivity and meeting food security needs in the face of climate variability and change in East Africa requires a range of technological, institutional and policy interventions. Since 2011, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) in partnership with other stakeholders, has been working with farmers in East Africa through the CSVs Research for Development approach (Agarwal et al. 2018). CSVs are clusters of villages that focus on climate change hotspots across a wide range of agro-ecological zones with different farmer typologies, climate risks and vulnerabilities. Every CSV has a portfolio of CSA activities and innovations, with the overall goal of stimulating actions that enable communities and households to respond to climate extremes and change. This study examines the uptake and impact of CSA technologies and innovations on household livelihood outcomes: food security, incomes and asset accumulation, all of which are among the indicators of resilience.

Study approach

The study uses data collected from the Nyando CSVs in western Kenya (see Recha et al. 2017 for a detailed description). Agriculture is the main source of livelihood, providing food and income in Nyando. The farming system is largely subsistence rain-fed mixed crop-livestock. Climate-related risks include frequent droughts, increasingly unpredictable rainfall patterns, flooding in the lower areas, agricultural water shortages and heat stress, all of which are indications of a changing climate (Kinyangi et al. 2015). The portfolio of CSA technologies and innovations in Nyando include multiple stress tolerant crop varieties (e.g. sorghum, pigeon peas), improved small ruminant livestock (goats and sheep), soil and water conservation, agroforestry, on-farm crop diversification, smart-farms and collective action through community based organisations (CBOs) for learning.

Using quasi experimental approaches, the study combines monitoring and evaluation data and a cross-section survey. The cross-section survey collected data from 433 randomly selected households within and outside of the CSVs. In order to create a counterfactual, we identified villages with similar characteristics to the CSVs in terms of the observable biophysical and socio-economic characteristics. Key informant interviews were also conducted to triangulate information from the survey. The study combined Propensity Score Matching (PSM) and Endogenous Switching Regression (Heckman and Navarro-Lozano 2004) to evaluate the impact of CSA technologies on household income (per adult equivalent), assets (asset index) and food and nutrition security (household dietary diversity score).

Trends in uptake of CSA

Adoption of CSA technologies and innovations increased across the CSVs, including improved agronomic and livestock management practices. Adoption of CSA is influenced by household socio-economic and institutional factors. Social capital (group membership), participation in agriculture as the primary occupation, farmer expectation of occurrence of climate extremes, early receipt of weather forecasts and household wealth were associated with higher likelihood of adoption of CSA technologies and practices. Culture, gender, experiences and micro-climate were also important in influencing farmer's choices of CSA technologies and practices.

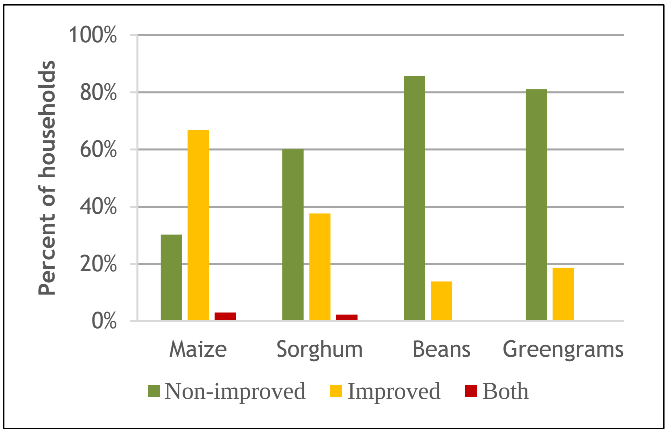

Figure 1. Uptake of improved seeds by crop

Households in the CSVs have organized themselves into collective action groups, through which they have pooled resources together into an innovation fund, where farmers can borrow for agricultural investments and other household needs. The groups have also invested in bringing agricultural inputs of high quality at affordable prices within closer reach of the farmers, and thus increasing use of improved inputs—improved seeds (Figure 1) and fertilizers.

Because of capacity building within the CSVs, uptake of improved climate resilient crop varieties has been on an upward trajectory (Figure 2), with the number of farmers introducing improved crop varieties gradually increasing from 2011. This is consistent with the technology diffusion theory which indicates that, initially only a few farmers may adopt a technology. However, as more farmers observe the experiences of their neighbors, they are motivated to adopt. Even early adopters are likely to intensify adoption once they experience the benefits.

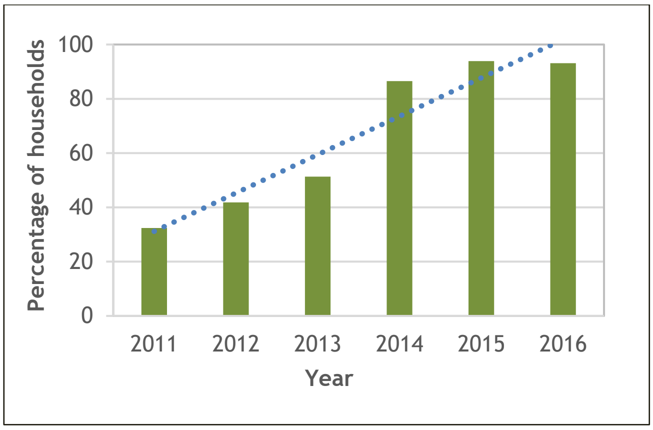

Figure 2. Uptake of improved crop varieties in Nyando

Adoption of more resilient small ruminant livestock breeds, particularly Galla goats and Red Maasai Sheep has also been on the rise since their introduction in the CSVs (Figure 3) between 2012 (when 70 breeding units of Galla goats were introduced) and mid-2013 when (30 breeding units of Red Maasai sheep were introduced). As of 2011, about 60% of households in the CSVs had not introduced any improved or resilient livestock breeds. It is projected that gradually the Galla goat and Red Maasai sheep crosses will replace the indigenous breeds in Nyando CSVs.

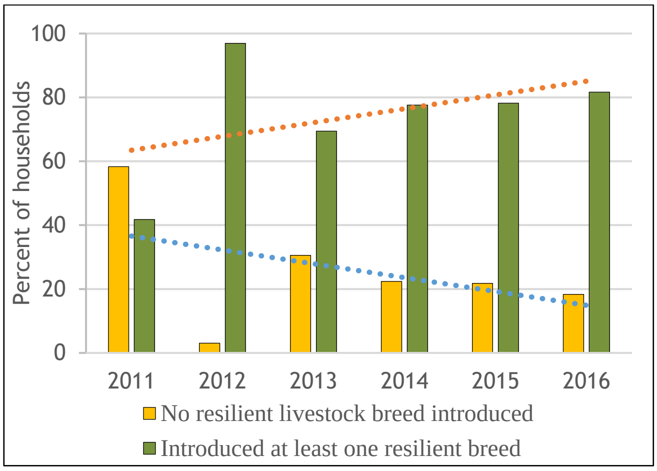

Figure 3. Trends of uptake of improved livestock breeds

Other changes reported include uptake of agroforestry, especially fruit trees; diversification into beekeeping by some households; early planting, crop rotation and intercropping; and soil and water management practices.

Impact of CSA on food security

While food security remains a challenge in Nyando, an increasing number of households in the CSVs reported a decline in the number of hunger months experienced annually (Figure 4). The proportion of households experiencing no hunger at all throughout the year has gradually increased between 2011 and 2016. In the same period, the proportion of households experiencing 5 or more hunger months in a year has consistently dropped.

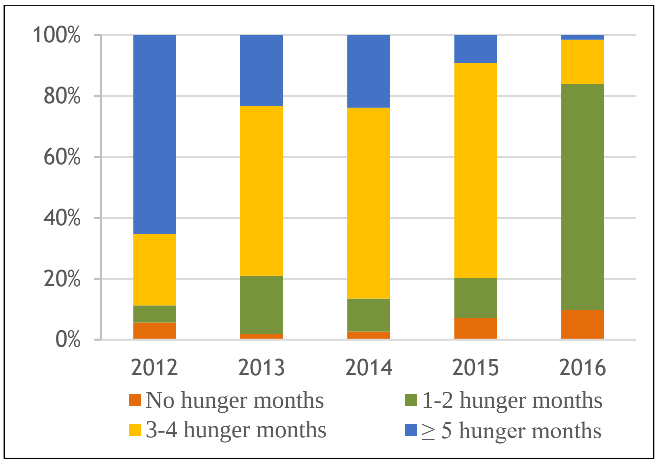

Figure 4. Household food security

Adoption of drought-tolerant crops and improved small ruminant livestock breeds had positive and significant impacts on household dietary diversity (Table 1). Adoption of drought-tolerant crops improved the household dietary diversity score by about 2—adopters consume about 2 food groups above their non-adopting counterparts. The impact of adoption of improved small ruminant livestock breeds was even higher, with adopters having about 3 scores above their non-adopter counterparts. The impacts were significant in CSVs and non-CSVs, and among the poor and non-poor households. The impacts were not statistically different across the sub-samples.

Table 1. Impact of CSA on household dietary diversity

	Without adoption	With adoption	Net change	Observa-tions (N)
Adoption of improved multiple stress-tolerant crops				
All adopters	5.700	7.326	1.626***	202
CSVs	6.001	7.434	1.433***	134
Non-CSVs	5.109	7.113	2.004***	68
Poor	5.821	7.304	1.483***	141
Non-poor	5.424	7.377	1.953***	61
Adoption of improved and better adapted livestock				
All adopters	4.700	7.594	2.9***	91
CSVs	4.887	7.564	2.7***	72
Non-CSVs	3.993	7.707	3.7***	19
Poor	4.675	7.494	2.8***	69
Non-poor	4.782	7.905	3.1***	22

The impact of drought-tolerant crops on dietary diversity is not surprising. It allows the households to produce diverse food crops on-farm. This improves access to more food groups, either because the farmers are able to produce their own diverse food crops or purchase them from other farmers in the neighborhood. The same applies in the case of improved small ruminant livestock breeds. Such breeds improve access to livestock products, either for household consumption or for sale to purchase other food requirements of the households.

Impact of CSA on assets

Adoption of multiple stress-tolerant crops and improved small ruminant livestock breeds had positive and significant impacts on asset accumulation (Table 2). The results show that adoption of multiple stress-tolerant crops increased asset index by about 21 points, while adoption of improved livestock breeds increased asset index by about 22 points. Although impacts were not statistically different across the sub-samples, all the adopters across those sub-samples enjoyed significant adoption impacts. This probably indicates that adoption of drought-tolerant crops and improved livestock breeds leads to surplus output which households can sell to purchase household assets.

Table 2. Impact of CSA on household asset holding

	Without adoption	With adoption	Net change	Observa-tions (N)
Adoption of improved multiple stress-tolerant crops				
All adopters	4.943	25.533	20.59***	205
CSVs	5.296	26.390	21.09***	135
Non-CSVs	4.323	23.951	19.63***	70
Poor	4.797	25.229	20.43***	173
Non-poor	5.818	27.113	21.3***	32
Adoption of improved and better adapted livestock				
All adopters	5.360	27.577	22.2***	91
CSVs	5.836	27.303	21.5***	72
Non-CSVs	3.885	28.617	24.7***	19
Poor	4.978	25.687	20.7***	69
Non-poor	6.746	34.364	27.6***	22

Impact of CSA on incomes

For income, only multiple stress-tolerant crop varieties had significant and positive impact on household income (Table 3). Adoption of drought-tolerant crops increased household income per adult equivalent by about KES 14,000 (approximately USD 140). Notably, adoption of improved livestock had no impact on household income per adult equivalent.

The impact of integrated soil and water conservation practices were marginal and largely insignificant, implying it takes a longer time period to realize their benefits.

Table 3. Impact of CSA on household income

	Without adoption	With adoption	Net change	Observations (N)
Adoption of improved multiple stress-tolerant crops				
All adopters	26.056	40.497	14.44***	203
CSVs	26.769	39.379	12.61**	133
Non-CSVs	24.711	42.702	17.99***	70
Poor	25.926	37.086	11.16**	140
Non-poor	26.318	49.217	22.9***	63

Conclusion

Uptake of CSA technologies and innovations has increased across the CSVs, including improved crop and livestock management practices. Adoption of CSA practices depends on household socio-economic and institutional factors. Group membership, participation in agriculture as the primary occupation, farmer location, gender, farmer expectation of occurrence of climate extremes, early receipt of weather forecast, and household wealth were all associated with higher likelihood of adoption of CSA technologies and practices.

Culture, gender, experiences and micro-climate were also important in influencing farmer's choices of CSA technologies and practices, underscoring the importance of participatory action learning approaches used in the CSVs taking into account local knowledge. The results, therefore, indicate that CSA technologies are successful in helping households cope with climate risks and enhances adaptation to climate change and resilience of smallholder farmers.

A key question is how to promote wider uptake of these CSA technologies, including linkages with the private sector and feeding into policy processes across scales. In addition, there is need to strengthen other support services—climate information, agro-advisories and access to finance and to strengthen existing farmer experimentation networks including mobilizing farmers to continue working in groups. Lastly, there is need to ensure that resource poor vulnerable farmers, women and youth are at the center of efforts to build adaptive capacity.

Further reading

- Heckman J, Navarro-Lozano S. 2004. Using Matching, Instrumental Variables, and Control Functions to Estimate Economic Choice Models. *Review of Economics and statistics* 86(1): 30-57.
- Kinyangi J, Recha J, Kimeli P, Atakos V. 2015. Climate-Smart Villages and the Hope of Food Secure Households. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Recha J, Kimeli P, Atakos V, Radeny M, Mungai C. 2017. Stories of Success: Climate-Smart Villages in East Africa. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

The Info Note is part of a series of studies carried out in the CCAFS Climate-Smart Villages in East Africa to understand adoption and impact of CSA technologies.

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