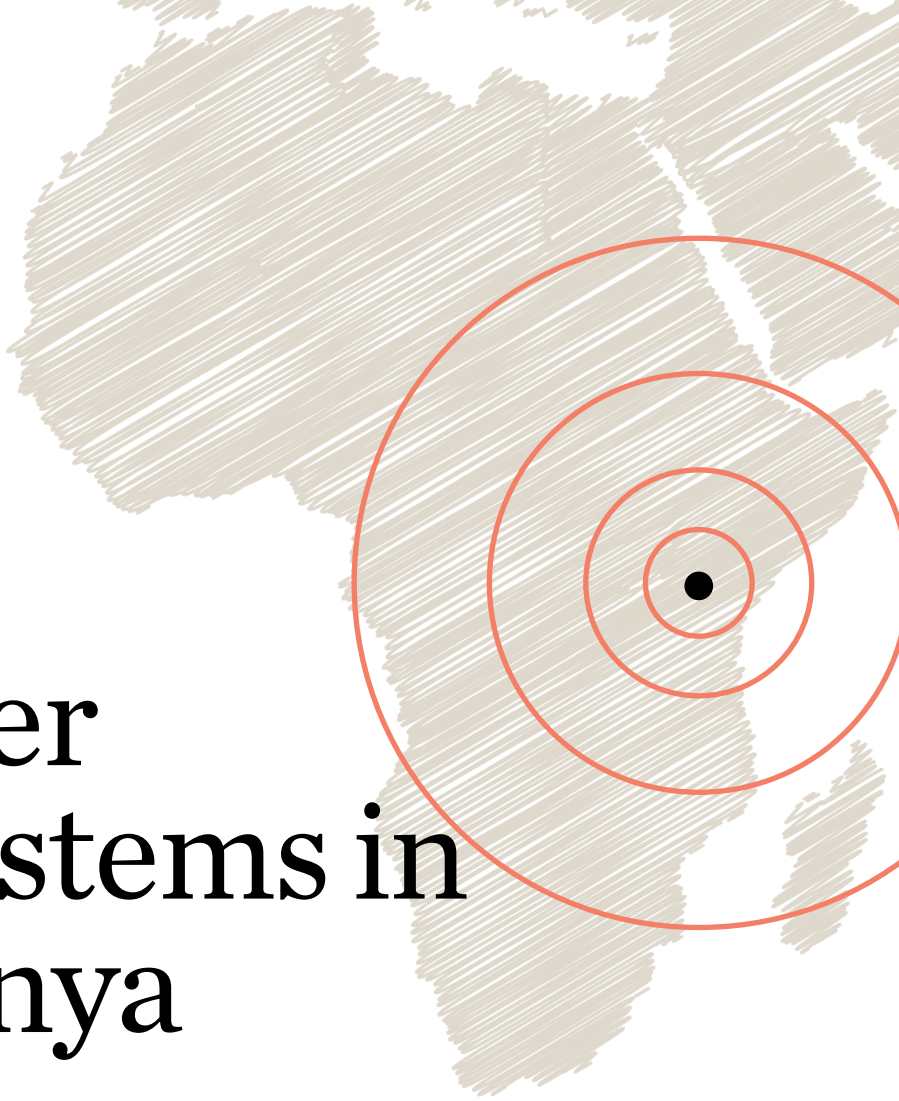

Smallholder farming systems in coastal Kenya

Key trends and innovations for resilience

Chemuku Wekesa, Paul Ongugo, Leila Ndalilo, Arafa Amur, Sylvia Mwalewa and Krystyna Swiderska

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Smallholder farmers in coastal Kenya are already significantly affected by climate change, particularly in semi-arid and dryland areas. They have developed a number of innovations to enhance resilience and productivity, e.g.: crop diversification using resilient local varieties, new planting techniques and wild tree domestication. This report explores key trends in climate, livelihoods, food security, crop diversity and social capital in five Mijikenda communities, as well as traditional knowledge-based innovations to address climatic and socio-economic challenges. It presents findings from the SIFOR project (Smallholder Innovation for Resilience).

Contents

Summary

This report presents the findings of a study conducted in the Mijikenda community in the Kenyan coast as part of the SIFOR project (Smallholder Innovation for Resilience). The study, conducted in 2013–14, explored key trends in livelihoods and migration, food security, crop diversity, climate, social capital and biocultural heritage, since 2003 and 1982 (based on farmer recall). It also explored traditional knowledge-based (or 'biocultural') innovations developed by farmers in response to climatic and socio-economic challenges. The study sought to provide baseline data for monitoring and evaluation, and to address the project's first objective on identifying and disseminating a) traditional knowledge-based innovations that enhance productivity, and b) conditions which foster vibrant and resilient TK-based innovation systems.

The study covered the Giriama, Chonyi, Rabai, Digo and Duruma sub-tribes (i.e. communities) in Kilifi and Kwale counties. Although their cultural practices are similar, they occupy different agro-ecological zones (wet, semi-arid and dryland) which enabled comparison across the sites. First, a qualitative study was conducted in 2013 in 31 villages (155 households), exploring key trends and biocultural innovations. A more in-depth quantitative survey was conducted in 2014, exploring the same key indicators, and covering a total of 375 households, selected through stratified random sampling. This report presents the findings of the quantitative baseline study, and a summary of the qualitative findings on innovations.[1]

Crop production, small businesses and labour in urban areas were rated as the most important livelihood activities in 2012, but the importance of crop production to livelihoods has been declining since 2003. This trend was largely attributed to climatic changes, but also to migration to urban areas to seek employment. There are still more men than women in farming (overall), but women play a key role in selecting seeds of landraces for self-saving, which provides nearly a third of all seeds. Net income rose in most communities since 2003 due to income diversification (e.g. tourism), except in Duruma where it decreased due to increased spending on food as a result of low crop and livestock productivity and prolonged drought periods.

The main climatic changes identified by farmers were an increase in extreme events (reported by 95 percent of households), temperatures and drought (90 percent), sunshine strength (89 percent) and crop and animal diseases (82 percent), and reduced rainfall (78 percent). In all the communities, rainfall has become more erratic and unpredictable, resulting in longer dry spells and droughts and a considerable decline in crop productivity. Other climate change impacts include disappearance of some native plant species and reduced forest area.

There has been a significant decline in crop diversity, particularly since 1997, with the proportion of households growing landraces down to about 50 percent for cassava and 70 percent for maize, compared to 100 percent in 1982. The loss of traditional crop varieties declined after a peak in 2004, as farmers started reverting back to traditional varieties because they are more resilient to drought and pests than modern varieties and don't require high levels of inputs for production.

Traditional knowledge and crop varieties play an important role in the communities' adaptation strategies and innovation responses for food security in the face of climate change. In Chonyi all farmers have started planting large areas of drought tolerant crops such as cassava, and most plant early maturing varieties; while in Digo, irrigation farming and afforestation are the main adaptation strategies. In the semi-arid Giriama community, planting resilient traditional varieties is the main strategy to ensure productivity, along with development of bio-pesticides. Duruma, which is the driest community with perennial water problems, has developed an innovative method of excavating water pans within homesteads to provide clean water for cattle and reduce disease. Communities also offer prayers and sacrifices in the hope of averting natural disasters. Overall, more households reported adopting traditional farming technologies as an adaptation strategy than modern farming technologies.

[1] The full report of the SIFOR-Kenya qualitative baseline study is available here: http://pubs.iied.org/G03830/

The five communities have come up with several bio-cultural innovations to respond to climatic changes and enhance food security and livelihoods – mainly technological innovations, but also market and institutional innovations. The most widely adopted innovation was planting hybrid, improved and local varieties of cassava and maize together to reduce the risk of crop failure (reported by 43 percent of households) – hybrids are fast maturing and high yielding but cannot tolerate drought, pests and diseases, while local varieties are slow maturing and lower yielding but can tolerate these stresses. This was followed by domestication of wild medicinal and food plants from Kaya forests to increase incomes and reduce pressure on forests (35 percent). Farmers have discovered that planting young pruned cassava tops reduces maturation time by a third and increases yields 4–5 fold. Other innovations include combining modern and traditional tilling practices, using animal manure to enhance soil fertility and water holding capacity, using agro-forestry to fix nitrogen, and development of effective herbal remedies to treat crop and animal diseases. Market innovations include the formation of community marketing groups, diversifications of income sources and village banking. The formation of a Rabai cultural village adjacent to a Kaya forest has enhanced community networking and information exchange, while conserving resilient local crops and boosting income from tourism.

The study explored the social factors (conditions) that support bio-cultural innovation (people/individuals, institutions, networking and community level factors), and the role of cultural values in innovation (notably solidarity, reciprocity, equilibrium and collectiveness). Traditional institutions such as the Kaya elders' council play a key role in promoting traditional knowledge-based innovation in the five communities. Community organizations such as herbal, women and farmers' groups enable exchange of knowledge, skills and planting materials for innovation. Cultural values play an important role in binding the community, promoting sharing of ideas at community level through various traditional ceremonies and festivals, and ensuring traditional knowledge transmission and biodiversity conservation for innovation. The most innovative communities were those with strong cultural values – Rabai, and with the greatest climatic challenges – Duruma was most active in crop improvement. Linking external/scientific and traditional knowledge is also important for developing effective innovations to improve productivity and income.

Despite their importance, traditional knowledge, cultural values and innovation are being weakened by a range of factors, including modern culture, religion and education, out-migration of youth and recent climate change impacts. The study recommends that:

- Policies that safeguard traditional knowledge and local innovations should be implemented, including Kenya's new law on traditional knowledge, and the FAO Treaty provisions on the protection of farmers' rights over traditional knowledge and genetic resources.
- Capacity building should be undertaken to help local communities add economic value to traditional products, and strengthen incentives for sustaining biodiversity and traditional knowledge.
- Traditional institutions and resource governance systems should be strengthened to stem the loss of traditional knowledge and associated genetic resources.
- Exchange of traditional knowledge, innovations and technologies among the Mijikenda communities should be supported to spread successful innovations and appropriate solutions to common challenges.
- Research and extension services should recognize the value of local landraces and farmers' traditional knowledge for climate resilience, and support biodiversity-rich climate smart agriculture.
- Participatory Plant Breeding should be supported to tailor crop breeding to the needs of Mijikenda farmers, develop new varieties that are both more resilient and higher yielding, and conserve resilient local landraces for climate adaptation and future plant breeding.

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Introduction and methodology

Giriama community performing a traditional dance during the Mekatilili Wa Menza Cultural festival at Mekatilili cultural center. Photo credit: Arafa Amur.

1

As global temperatures continue to rise, and extreme events such as drought and flooding become more frequent and intense, smallholder farmers are becoming increasingly vulnerable to hunger and food insecurity, particularly in areas with already harsh conditions (FAO, 2013). Climate change is expected to have considerable adverse effects on crop production in Africa (IPCC, 2014b). However, smallholder and indigenous farmers in marginal areas often sustain resilient local varieties and traditional production strategies for survival in harsh environments. These have important yet largely untapped potential for addressing today's climatic challenges. By managing ecosystem services that support livelihoods, vulnerable communities can maintain local 'safety nets' for coping with disruptive shocks and trends (IUFRO, 2014). Good ecosystem management is often achieved through cultural values and norms based on traditional knowledge (TK). As recognized by the Paris Agreement on climate change, adaptation action should be based on both traditional knowledge and science.

1.1 The SIFOR Baseline Study

In coastal Kenya, the Mijikenda community has developed several environmentally-friendly, low-cost traditional knowledge-based innovations for agriculture, livelihoods and collective natural resource management. Many of these TK-based innovations were developed as ways to cope with extreme weather and climate variability. However, they have never been documented and disseminated. The SIFOR project (Smallholder Innovation for Resilience) explored TK-based or 'biocultural' innovations in Kenya, India, China and Peru, as part of a comprehensive baseline study. This five year project funded by the European Union, aims to strengthen traditional knowledge-based innovation systems for food security in the face of climate change. It works with indigenous and traditional farming communities in remote and risk-prone environments that still sustain significant agrobiodiversity and traditional knowledge.

The baseline study involved qualitative and quantitative surveys, conducted in 2013 and 2014. Five Mijikenda communities were asked about trends in livelihoods, food security, farming systems, agrobiodiversity, social capital and climatic changes, and biocultural innovations that enhance productivity and resilience. The study documented their innovations, including resilient crop varieties, traditional farming practices, agrobiodiversity conservation practices, and climate related coping strategies. It aimed to provide baseline data for monitoring and evaluation of SIFOR project, and to address the project's first objective on identifying TK-based innovations that enhance productivity and the conditions that foster vibrant and resilient innovation systems. It explored innovations for adaptation to both climatic and socio-economic changes, including technological, market and institutional innovations. It also explored the role of social factors, cultural values, and access to wild gene pools and sacred sites in supporting biocultural innovation.

Innovation can be defined simply as 'a new way of doing things'. The SIFOR project focused on 'bio-cultural' innovations – i.e. innovations derived not only from traditional knowledge, but also from associated biodiversity and bio-cultural heritage as a whole (see Box 1).

BOX 1. KEY CONCEPTS AND TERMS

Biocultural Innovations: The project defined 'biocultural innovations' as new practices or technologies which arise from the interaction between the components of biocultural heritage (traditional knowledge, biodiversity, landscapes, cultural and spiritual values and customary laws); or between traditional knowledge and science.

Conservation: For the purposes of this study, 'conservation' was defined as: the careful preservation and protection of natural resources, environment, biodiversity and, in this case, indigenous knowledge systems through community-developed TK-based innovations/ technologies and practices that are thereafter passed to the next generation.

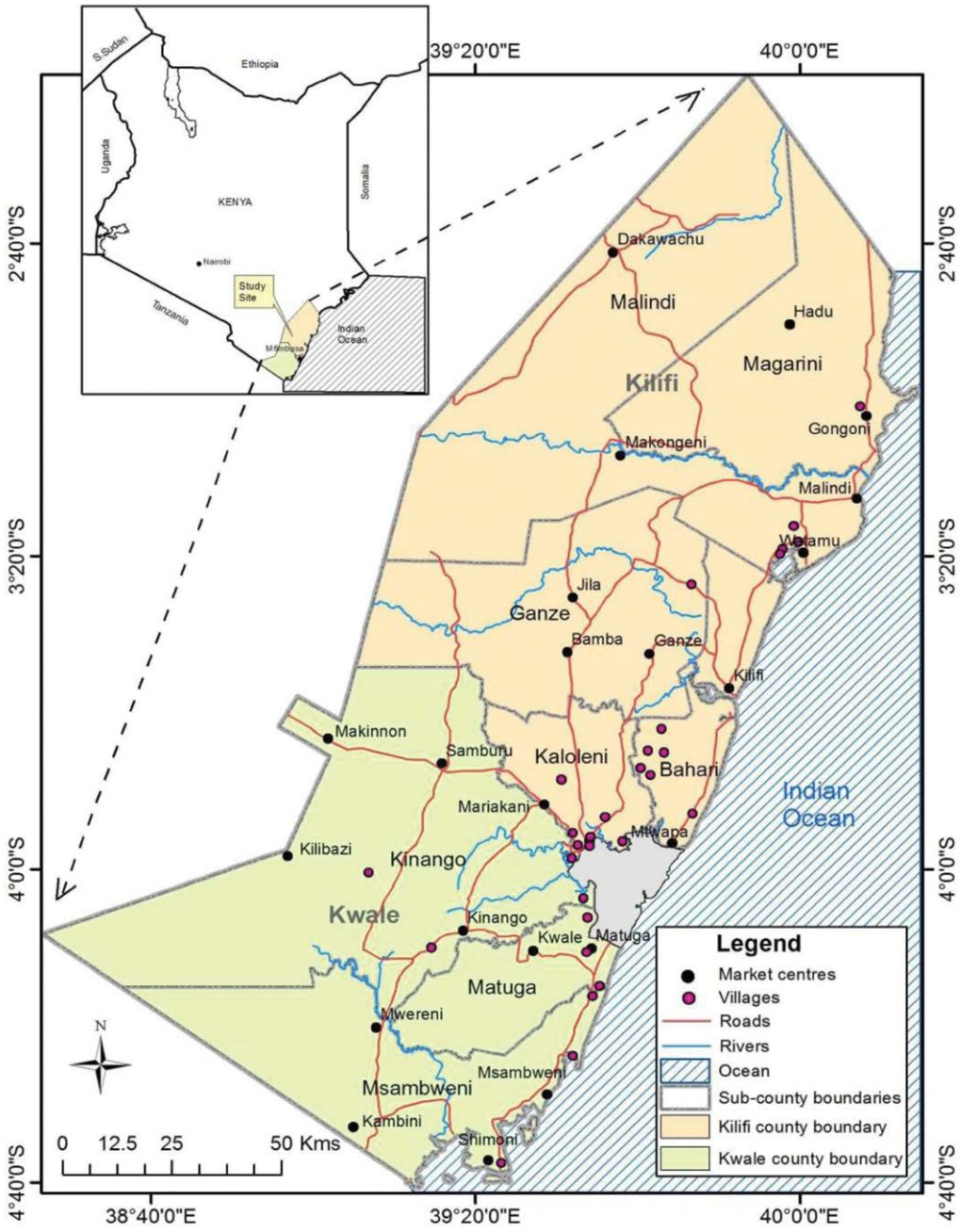
Food Security: Food security is achieved when all people in the community at all times have physical, social, and economic access to sufficient, safe and nutritious food that meet dietary needs and food preferences for active health (FAO, 2002).

Plant Genetic Resources: Plant genetic resources are any genetic material of plant origin with actual or potential value for food and agriculture (FAO, 2009). They include all agricultural crops and wild relatives, which often have valuable traits. Landraces have a substantial genetic variation. Plant breeders should strive to reduce the trend of genetic impoverishment, i.e. loss of crop diversity, because this is reducing the genetic basis for plant breeding and therefore resilience to future changes in climate (Jiri et al., 2015).

1.2 Study sites and communities

The study was undertaken in Kilifi and Kwale, two Kenyan counties mainly inhabited by sub-tribes of the Mijikenda community (Figure 1). The communities chosen were Giriama, Chonyi and Rabai in Kilifi County, and Digo and Duruma in Kwale County (South of Mombasa towards Kenya-Tanzania border). They were originally selected for the project because of their diverse agro-ecosystems, rich traditional knowledge and agrobiodiversity (indigenous vegetables and Kaya forests), and because of their involvement in a previous action-research project.[2] These communities are spread along the Kenyan coast in wet, semi-arid and dryland agro-ecosystems, both near the coast and, in the case of the Duruma community, more inland. Chonyi was selected as a control community in which no project activities were initiated to enable future evaluation of the impacts of the project in the communities with interventions.

Figure 1: Kwale and Kilifi counties



[2] Protecting community right over traditional knowledge: Implications of customary laws and practices (2005–2009) See: http://pubs.iied.org/14591IIED/

Natural resource use and management practices in the five communities are guided to some extent by customary rules, centred on the sacred *Kaya* forests culture, although the degree of influence and acceptance varies. The variations in agro-ecosystems and cultural beliefs and practices amongst the study communities provided a basis comparison.

About 71% of people living in Kwale and Kilifi Counties live below poverty line (Republic of Kenya, 2013a; Republic of Kenya, 2013b). In Kilifi County, the average annual rainfall ranges from 1,300 mm in the coastal belt to 300 mm in the hinterland, while the mean annual temperature is 21 – 30°C and 30 – 34°C in these areas respectively (Republic of Kenya, 2013a). Kwale County has an average annual rainfall of about 1200 mm in the coastal belt and 400 mm in the hinterland, and an average temperature of around 24°C in the coastal belt and 26 °C in the hinterland (Republic of Kenya, 2013b).

Communities in Kilifi County

The **Rabai community** occupies a hilly area that has moderate rainfall, and thus they practice mixed farming, i.e. both livestock keeping and crop farming. Infrastructure development is relatively good. Most households have electricity, piped water and access to regional as well as local markets. A tarmac road, as well as the main Nairobi – Mombasa Highway, serves this community.

The **Giriama community** occupies semi-arid and arid zones of the coastal lowlands. In the semi-arid areas, mixed farming is the main economic activity while in the arid zones livestock keeping is the main activity. Infrastructural development is still low with very few households having access to electricity.

The **Chonyi community** (control) occupies a wet fertile ridge (*Ngama*) that is continuous with the lower Shimba Hills in Kenya and the Amani forests of Tanzania. People here are mostly crop farmers. Other economic activities include small scale businesses and tourism along the coastal beaches. The major towns in the area are Shariani and Kikambala. *Kaya Chonyi* is the main *Kaya* for the community living around the forest and it has been used over time by elders to offer prayers and sacrifices and has been conserved mainly through cultural beliefs.

Communities in Kwale County

The **Digo community** occupies the wet coastal plain, foot plateau, coastal uplands and Nyika plateau. *Kaya Kinondo*, also known as *Kaya Ngalaani*, is a gazetted National Monument under the National Museums Act. It is in Msambweni sub-county (on the southern Kenyan coast) and is the main *Kaya* for the Digo community. *Kaya Kinondo* has survived pressures from population growth, poverty and tourism because of the Digo people's strong cultural beliefs, which use the *Kayas* to communicate with ancestral spirits through worship and sacrificial offerings. The main forms of livelihoods in the area are farming, fishing, small business and employment in beach activities (tourism).

The **Duruma community** is in the Kinango sub-county, which is in the semi-arid Nyika plateau and has much lower rainfall than the rest of Kwale County. This community is the driest and is characterized by high poverty levels. Livestock keeping and subsistence farming are the main economic activities. The sub-county faces a myriad of other challenges, including deforestation and charcoal production, high unemployment rates, high rates of dropping out of school and many early marriages, all of which exacerbates poverty.

In each Mijikenda sub-tribe, 7 villages were selected for the study, with the exception of Digo and Duruma communities where 6 and 4 villages were selected respectively. A village was defined as the area under the smallest possible administration system – the village Chairmanship according to Kenyan governance system, where village elders form the first decision making organ. A total of 31 villages were selected based on the following considerations:

a) Diverse socio-economic activities

b) Adherence to traditional culture

c) Linguistic/dialect differences

d) Development level and proximity to urban areas (villages with varying development levels were selected for comparison)

e) Geographic features and unique landscapes

f) Geographic positioning and distribution in the overall area

1.3 Research methods

A mixed methods approach was used involving both qualitative and quantitative surveys to explore the same key indicators. This approach can enhance the breadth and depth of understanding and corroboration, while offsetting the weaknesses inherent in using each approach alone (Creswell and Plano Clark, 2007). The qualitative study was conducted first to identify the range of innovations present, so that these could then be captured in the design of the quantitative survey.

Both surveys explored the following key indicators: livelihoods and migration, crop diversity, social capital and biocultural heritage, climate change, biocultural

innovations and innovation factors. The quantitative survey explored them in more depth, covering also food security and seed systems, through household and community level surveys.[3] The qualitative survey was conducted from January to June 2013. The quantitative survey from November 2013 to February 2014 – however, the data collected was for the previous year (i.e. 2012) to ensure consistency with the other SIFOR case studies and allow comparison between them. Data was also collected for 2008 and 2003, and 1982 (i.e. 30 years ago) for some indicators, based on farmers' recall. Both surveys also involved Participatory Rural Appraisal, notably Focus Group Discussions.

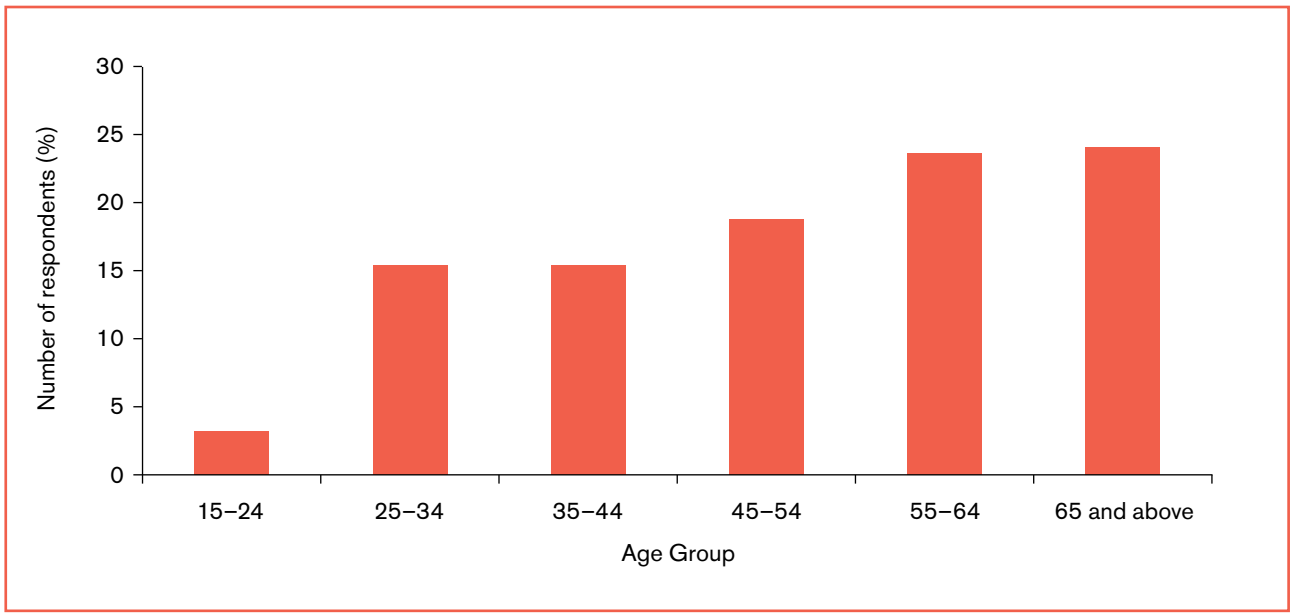
A literature review (of both published and unpublished reports) was also conducted on the Mijikenda community, their farming systems, indigenous traditional knowledge, cultural practices, customary laws and practices, the conservation of sacred *Kaya* forests, extreme weather events, socio-economic profiles, agrobiodiversity conservation and TK-based innovations.

For the qualitative survey, five respondents with rich knowledge of traditional farming practices and agro-biodiversity conservation were selected from each of the 31 villages. In total, 155 respondents were interviewed using an open ended questionnaire that explored the main indicators (for more details see Ongugo et al., 2014).

For the quantitative survey, stratified random sampling was used to select the respondents from different 'wellbeing levels'. These levels were determined by the communities during focus group discussions, based on income. The number of interviewees chosen was proportionate to the population size in each of the villages. Representatives of 375 households were interviewed. Interviewees included herbalists, rainmakers, *Kaya* elders and indigenous farmers. Discussions were held with the village and *Kaya* elders to obtain consent before collecting the data, since they are the main custodian of the indigenous knowledge and make decisions on behalf of their communities. Many of the respondents were elderly, with roughly half aged 55 and over (Figure 2).

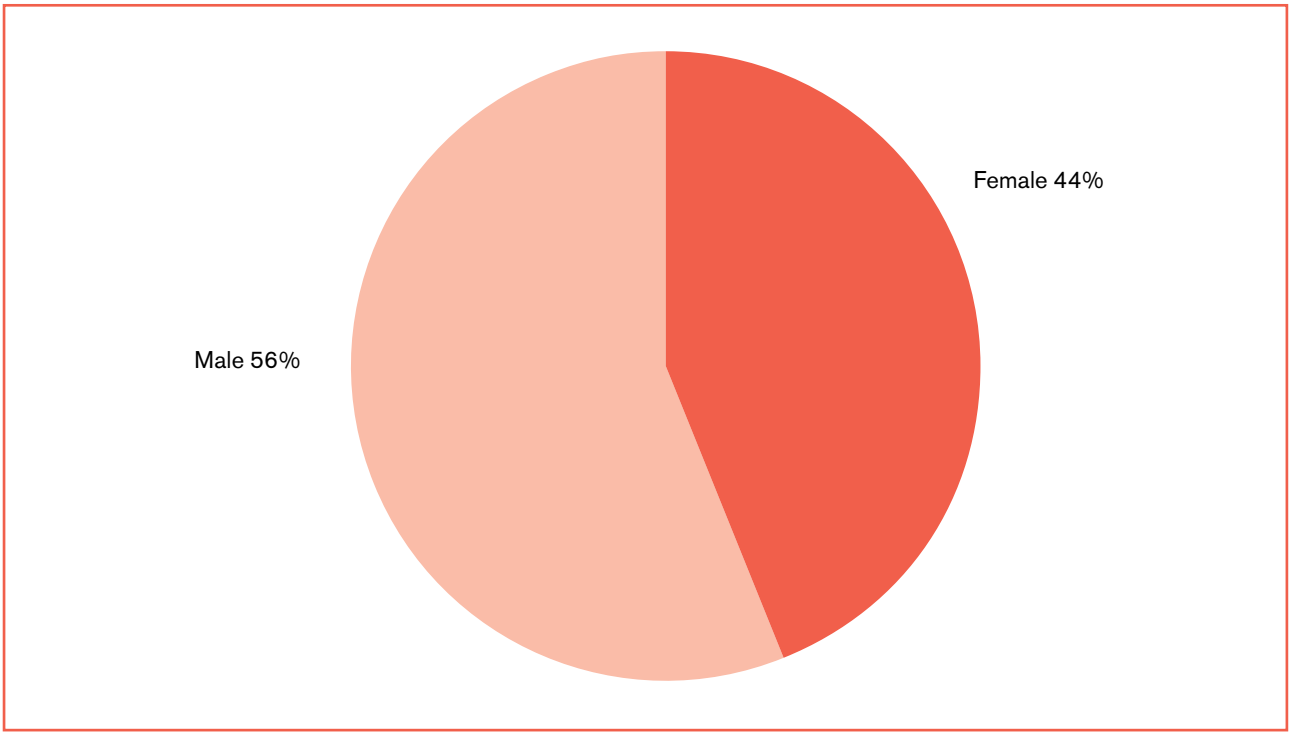
Overall, 44 percent of the people interviewed for the quantitative survey were women (Figure 3). However, women's participation was about 50% lower in the Digo community because it is largely Muslim, and women's participation in decision making is often low. Women were only allowed to participate in the interviews with the consent of their menfolk, or if no men were present.

Figure 2: Age distribution of the interviewees for the quantitative survey



[3] For the quantitative household survey, see: http://pubs.iied.org/G04038/ ; for the community level survey see: http://pubs.iied.org/G04037/

Figure 3: Gender of the interviewees for the quantitative survey



An additional qualitative survey was conducted in September-November 2014 to explore the role of cultural values in innovation – notably solidarity, reciprocity, equilibrium and collectiveness. A total of 46 key informants, including Kaya elders, herbalists and village elders were interviewed, and one focus group discussion was held in each of the five communities. The results are presented in section 9.3.

Sections 2–8 present the findings of the quantitative baseline survey covering all the indicators, while section 9 presents the qualitative findings on biocultural innovations and social and cultural factors that support innovation.

Livelihoods and migration

Value added herbal products developed by Ufanisi conservation group, Giriama with support from SIFOR project. Photo credit: Arafa Amur.

2

2.1 Main livelihood activities and their contribution to income and food security

Small businesses, crop production, and labour in urban areas were the most important livelihood activities recorded across all the communities. However, the importance of crop production has been declining since 2003 (Figure 4). Crop farming formed the main livelihood in 2003, but household involvement in farming activities has since declined by 14 percent. Interviewees indicated this was because of low crop productivity, due in turn to unpredictable rainfall, prolonged dry periods and increased weeds, pests and diseases. The communities have now partially shifted to alternative livelihood sources such as small businesses, particularly motorcycle transport and casual employment to supplement farm income. Labour in urban areas has also become increasingly important in the recent years, almost doubling from 2003 to reach 13 percent in 2012. Other important livelihood activities include employment in village surroundings, livestock production and sales, and petty trade.

The importance of livelihood activities for income generation was compared across sites (Figure 5). Crop production was the most important in Giriama at 33 percent, while in Rabai, Digo and Duruma, small businesses were most important at 25 percent, 26 percent and 19 percent respectively. In Chonyi, employment in surrounding villages was the leading source of income (19 percent). The preference for crop production in Giriama was attributed to the large tracks of arable land and development of several biocultural innovations that minimize crop vulnerability in the face of recent climatic changes.

The reduction in crop and livestock productivity in Rabai, Digo and Duruma communities (due to recent climatic changes) has resulted in the adoption of small businesses, such as motorcycle transport and food vending, as alternative sources of income. However, livestock production continues to be important in Duruma, a dryland area where indigenous breeds are kept using traditional rangeland grazing due to the harsh conditions. In Chonyi, the low agricultural productivity has forced residents to seek employment in the village surroundings (urban areas) to generate much needed income. Moreover, agricultural production is strained by inadequate labour as the existing labour force is engaged in other activities which are considered more lucrative than farming.

Figure 4: Most important livelihood activity, as reported by households

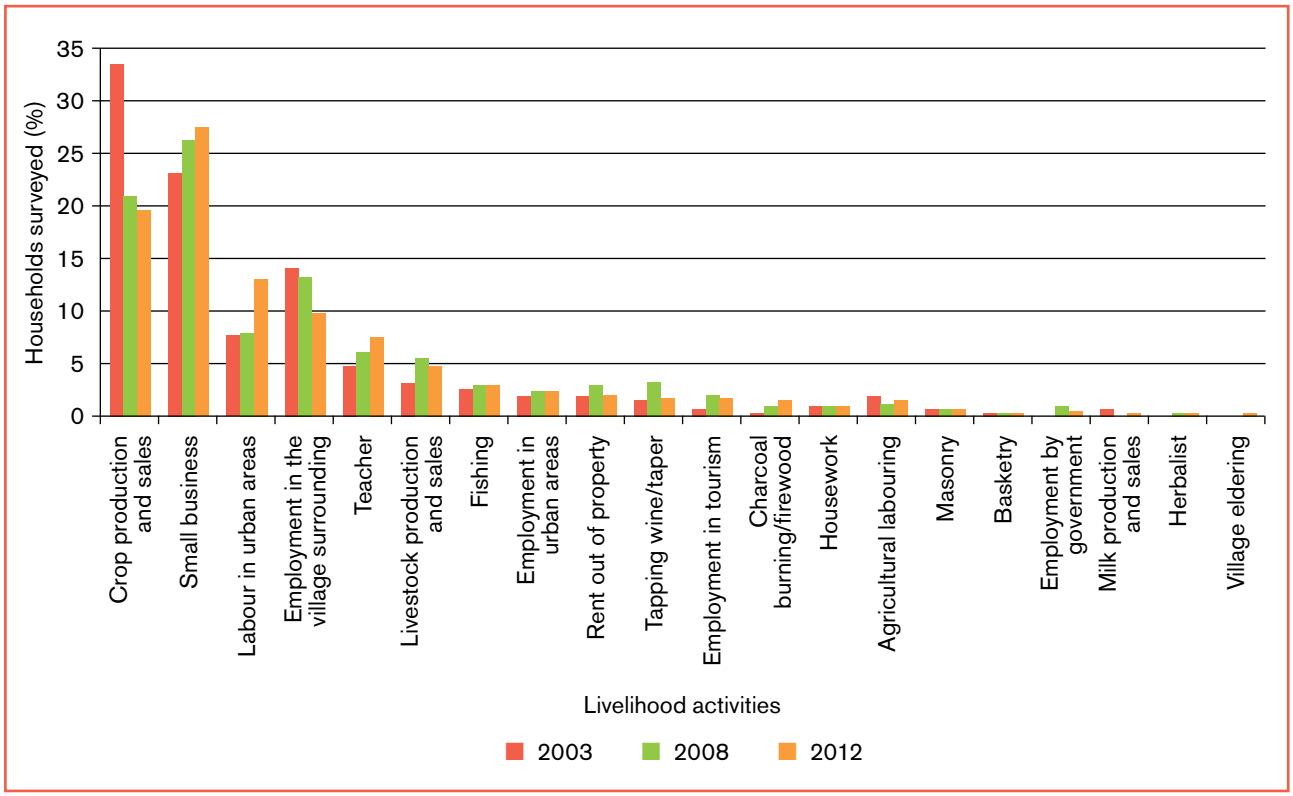
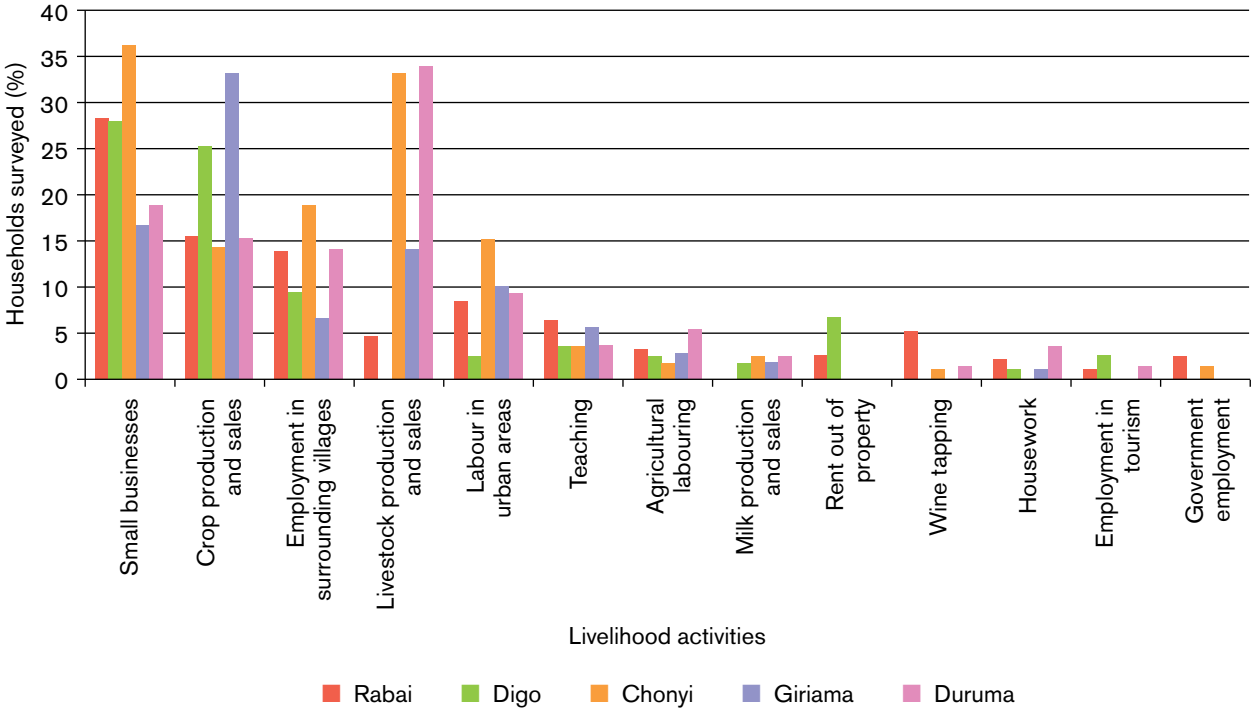


Figure 5: Most important livelihood activity for income generation



Households were also asked which of their livelihood activities was most important for achieving household **food security** (Table 1). In Giriama, Chonyi and Digo communities, crop production and sales was cited as the main contributor to household food security (by 51 percent, 33 percent and 33 percent of households respectively). In Rabai, small businesses were the leading contribution to household food security (24 percent). Livestock production and sales was most important for food security in Duruma at 34 percent, followed by Chonyi, at 33 percent of households surveyed. In Giriama, where arable land is relatively available, crops are produced on a large scale for both food security and income generation. In contrast, in Digo and Duruma, agriculture is relatively small scale, and mainly for food security. In Rabai, small businesses are a major contributor to both income and food security, mainly due to the proximity of Mombasa.

Table 1: Households' most important livelihood activity for ensuring food security

ACTIVITY	PERCENTAGE OF HOUSEHOLDS SURVEYED (%) N=375				
	RABAI	DIGO	CHONYI	GIRIAMA	DURUMA
Crop production and sales	16.3	33.0	33.3	51.1	24.2
Small business	24.4	26.2	1.4	10.3	16.2
Livestock production and sales	4.6	-	33.3	13.9	34.1
Employment in the village surrounding	12.8	7.3	6.5	5.1	13.1
Labour in urban areas	8.1	1.9	3.7	8.8	9.1
Agricultural labouring	2.9	1.0	7.4	7.3	4.0
Milk production and sales	–	1.9	14.4	1.5	1.0
Teaching	7.6	4.4	–	–	4.0
Employment in urban areas	4.7	–	–	–	2.0
Tapping wine/taper	4.1	–	–	–	1.0
Renting out property	2.3	2.9	–	–	–
Housework	1.7	0.5	–	0.7	4.0

2.2 Household income and expenditure

For all five sites combined, average income at household level has been increasing annually, from around Kshs 111,000 in 2003, to nearly Kshs 126,000 in 2008 and over Kshs 148,000 in 2012 (Table 2). The respondents attributed this to diversification of income generating activities.

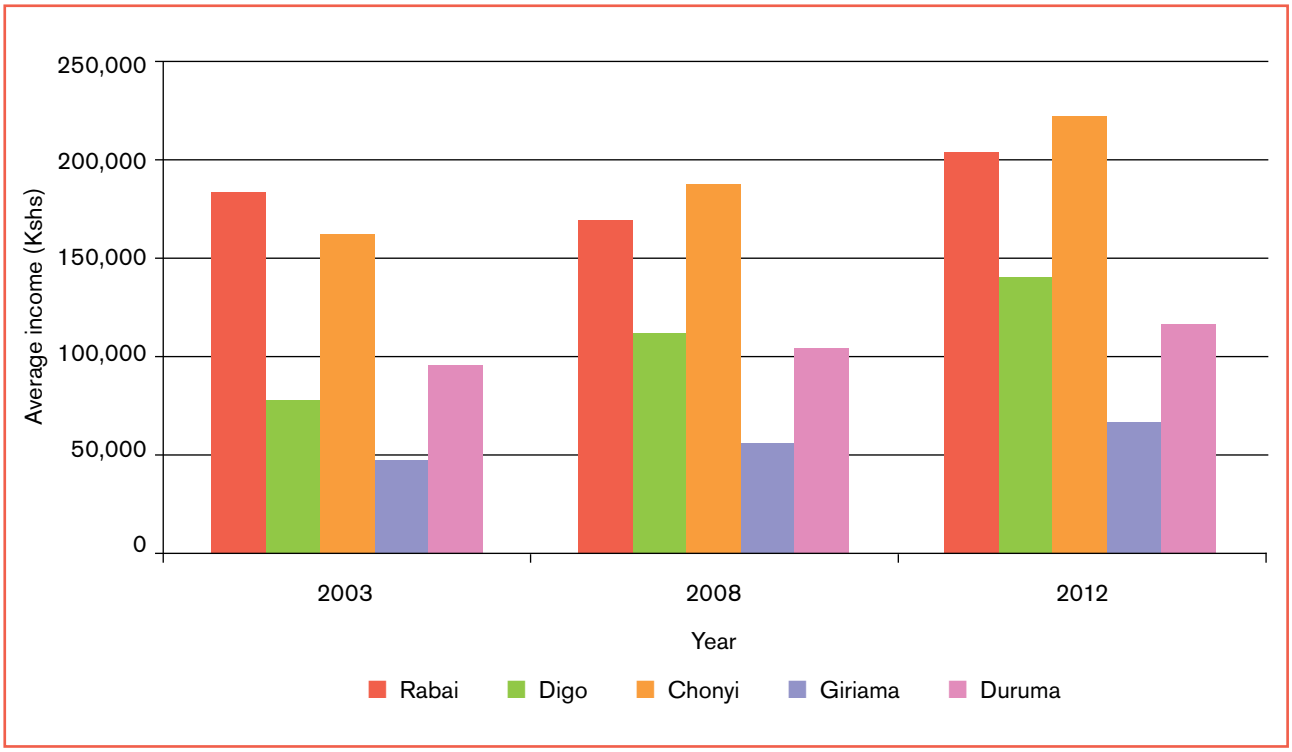
Table 2: Total average income across sites

YEAR	AVERAGE HOUSEHOLD INCOME (1.0 USD = KSHS 102)	
	KSHS	USD
2012	148,251.63	1453.45
2008	125,708.11	1232.43
2003	111,023.27	1088.46

Analysis of annual income generation trends in the individual communities (Figure 6) revealed that Digo had the highest percentage increase between 2003 and 2012 at 48 percent, followed by Giriama (41 percent), Chonyi (40 percent), Duruma (23 percent) and Rabai (11 percent). According to the respondents, the high increase in annual income in Digo was attributed to the growth in the tourism industry in the area. This has provided employment opportunities and additional revenue for the community to initiate small business ventures.

Chonyi had the highest income levels in 2008 and 2012 because the area receives substantial amount of rainfall that facilitates crop farming – agricultural productivity is therefore high. Moreover, Kilifi town, the county headquarters, is close to Chonyi and provides a ready market for agricultural products at better prices. Rabai had the second highest income levels – this can be attributed to the influence of nearby Mombasa town and the main Mombasa-Nairobi highway. The Rabai community is relatively developed hence the income sources have remained relatively steady over recent years.

Figure 6: Total average annual household income for all sites



Annual household spending increased from an average of Kshs 105,528 in 2003 to Kshs 145,552 in 2012 for all sites combined (Table 3). The increase can be attributed to Kenya's rising cost of living in recent years, as well as population increases that have driven up demand for basic services and amenities.

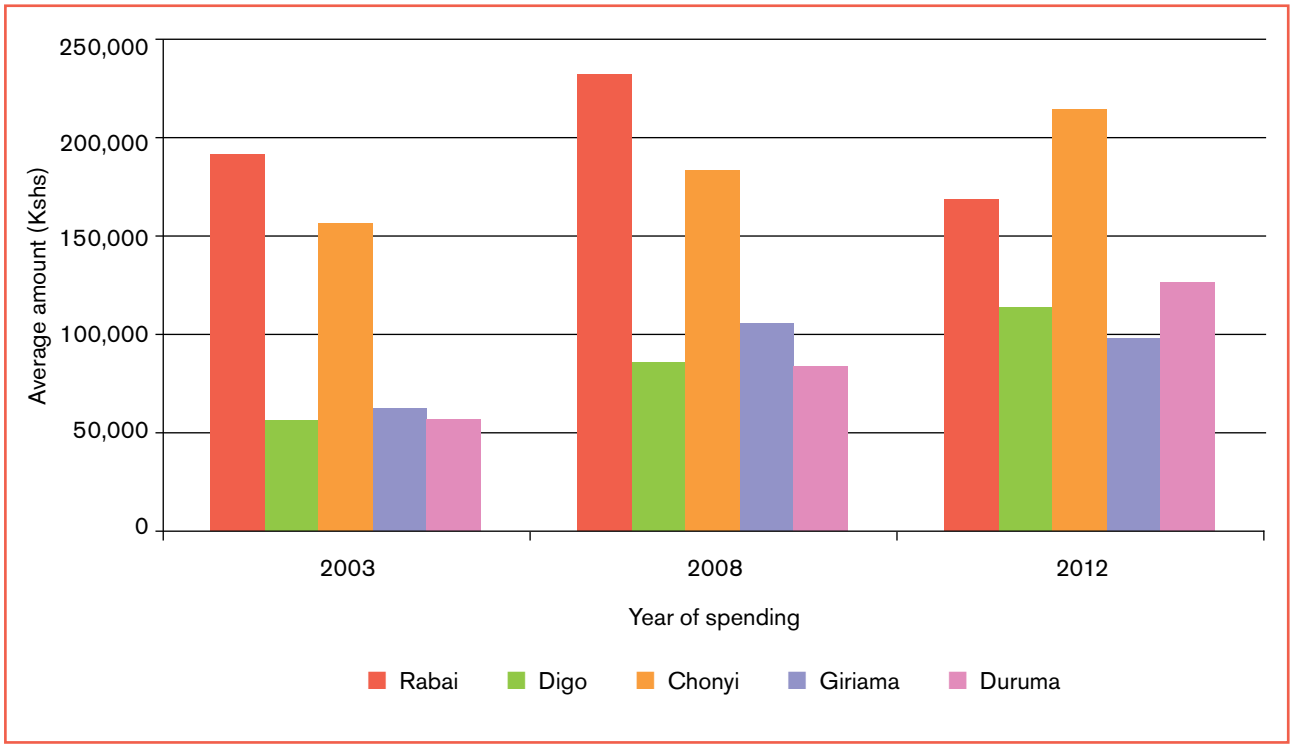
Table 3: Average annual household spending, all sites combined

YEAR	AVERAGE ANNUAL HOUSEHOLD SPENDING (1.0 USD = KSHS 102)	
	KSHS	USD
2003	105,528.40	1034.59
2008	139,578.40	1368.41
2012	145,551.80	1426.98

Analysis of the household expenditures in the target communities reveals varying trends (Figure 7). There was an increase in annual spending in Chonyi, Digo and Duruma. Giriama and Rabai have also increased spending since 2003, but this fell slightly between 2008 and 2012. Chonyi and Rabai had the highest annual spending. This is probably due to their proximity to major urban areas of Kilifi and Mombasa respectively, which raises the cost of living. Giriama had the lowest annual spending, attributed to higher agricultural productivity driven by TK-based agricultural innovations and good availability of arable land, which ensure that most food needs are catered for from the farms.

Because the rise in expenditure was lower in Giriama, this community had the highest rise in net income, from Kshs 15,429 in 2003 to Kshs 31,529 in 2012. However Rabai had the highest net income in 2012. Duruma had the lowest net income attributed to increased expenditure on food due to low crop and livestock productivity as a result of prolonged periods of drought. In Duruma, by 2012 average annual expenditure actually exceeded average annual income by over Kshs 10,000. Long periods of drought have pushed up the price of food in Duruma and hence most households had micro-loans to supplement their income.

Figure 7: Average annual household spending across sites



2.3 Women's and men's changing roles in farming over time

Both women's and men's involvement in farming activities has declined from 2003 to 2012 as communities diversify their sources of income (Table 4). The number of households where a man is the lead farmer declined in Rabai by 50%, in Chonyi by 75% and in Giriama by 25%. Men's declining roles in crop production across these sites could be attributed to out-migration to urban centers to seek employment and engagement in small business enterprises, which are emerging as alternative sources of income. Yet in all these communities, men still play a greater role in crop production and sales than women.

In the semi-arid Giriama community, women barely participate in farming activities since the majority of them are involved in small businesses. Men, on the other hand, participate in both crop and livestock production and sales, and their involvement in livestock production and sales increased between 2003 and 2012. Crop and animal production and sales are major livelihood sources in Giriama, both in terms of income generation and food security.

In Digo community, men did not report farming activities. Most of them are employed in tourist hotels. Women's participation in crop production and sales increased between 2003 and 2007 but declined slightly in 2012 as more women ventured into small businesses. In Duruma community, women's participation in crop production and sales increased slightly in 2012 compared to 2003. Women's participation in livestock production in Duruma has declined over the years (Table 4), and overall livestock production has declined (Figure 10), probably due to pressures of drought and pests and diseases. In the wet community of Chonyi, men's involvement in livestock production declined between 2003 and 2012 as more men travelled to urban areas to seek employment.

The combined involvement of men and women over 60 years old in farming remained relatively constant from 2003 to 2012 despite a slight decrease in three communities (Table 5). This is probably because most women over 60 years do not migrate from the village. Instead, they perform domestic chores. Similarly, the elderly men spend their time at home working in their farms. The data suggests that male temporary out-migration to urban areas has not resulted in an ageing agricultural labour force. This is because the jobs found in nearby urban centers, such as Mombasa, Kilifi and Malindi, are seasonal and as soon as the tourist season is over, the men return to their villages and continue engaging in farming activities.

Table 4: The percentage of households where men and women say they farm

FARMING ACTIVITIES	SITE	PERCENTAGE RESPONSES OUT OF HOUSEHOLDS SURVEYED (%) N=375					
		2003		2007		2012	
		MEN	WOMEN	MEN	WOMEN	MEN	WOMEN
Crop production and sales	Rabai	26.9	11.5	16.0	16.0	13.3	10.0
	Digo	–	4.8	–	5.3	–	5.0
	Chonyi	14.1	9.4	11.0	3.1	3.7	1.8
	Giriama	12.2	0.7	9.0	–	9.5	–
	Duruma	14.6	15.0	13.6	13.6	14.6	17.4
Livestock production and sales	Rabai	–	–	14.3	14.3	14.3	14.3
	Digo	–	–	–	–	–	–
	Chonyi	37.5	10.4	18.2	36.4	22.2	–
	Giriama	14.3	–	11.8	–	21.1	–
	Duruma	–	59.1	–	14.3	–	20.0

Table 5: percentage of households with men and women aged over 60 years in farming

SITE	PERCENTAGE HHS SURVEYED (%)		
	2003	2007	2012
Rabai	32.2	28.3	30.6
Digo	22.5	22.5	22.5
Chonyi	7.2	7.0	7.0
Giriama	34.1	33.8	32.6
Duruma	26.8	25.0	25.0

2.4 Gender disaggregated migration to urban centers

Male temporary movement to urban areas to find work was generally higher than that of females across all the sites (Table 6). Duruma had the highest proportion of men moving to urban areas to seek employment at 21 percent, followed by Chonyi at 18 percent, while Digo had the lowest (2 percent). We attribute the situation in Digo to the vibrant tourism industry as well as other industries, such as Base Titanium and Kwale International Sugar Company, which offer employment. Duruma, being a dryland area with minimal agricultural productivity, had the highest number of men migrating to better farmland as well as to seek work in neighbouring urban centers like Mombasa. In Chonyi, the fast growth of Kilifi town due to devolution is driving out-migration. Many people are moving to Kilifi to seek employment created by Pwani University and the county government. Additionally, the Kaloleni area, which is mainly occupied by the Chonyis, is densely populated and land scarcity is pressuring the Chonyis to move and seek farmland in other areas like Matsangoni and Magarini (inhabited mainly by Giriama community).

Female out-migration was highest in Rabai (8.6 percent) and lowest in Duruma (3.4 percent). Rabai had the highest number of educated people owing to the early introduction of Christianity and modern education in the area. A sizeable number of educated women have found work outside their locality. By contrast, women in Duruma are mainly housewives who undertake domestic chores and stay at home.

Table 6: Residence patterns for men and women from survey households in each of the five study communities

GENDER	SITE	RESIDENCE (%)	
		VILLAGE	OUTSIDE THE VILLAGE/OTHER TOWNS
Male	Rabai	89.9	10.1
	Digo	97.7	2.3
	Chonyi	81.6	18.0
	Giriama	85.0	15.0
	Duruma	78.3	21.7
Female	Rabai	91.4	8.6
	Digo	98.0	2.0
	Chonyi	97.3	2.7
	Giriama	92.9	7.1
	Duruma	96.6	3.4

Food security and farming systems

Training of Rabai Cultural group on propagation of medicinal plants. Photo credit: Arafa Amur.

3

3.1 Food crop self-sufficiency

This study found a considerable decline in food self-sufficiency between 2003 and 2012, due to reduced crop and livestock productivity owing to poor rainfall, prolonged dry periods and high incidences of pests and diseases. Staple food self-sufficiency for all the sites combined declined from 81 percent to 34 percent, vegetable self-sufficiency from 83 percent to 51 percent, and meat self-sufficiency from 53 percent to 26 percent. However, cooking oil self-sufficiency increased from 2 percent in 2003 to 12 percent in 2012. In the Duruma community, this was attributed to an increase in the number of livestock kept since they make cooking fat from cream using a traditional method. About 80 percent of the interviewees rated food self-sufficiency to be very important, and 18 percent rated it as important, while only 2 percent rated it as slightly important.

The study showed that, in 2012, most of the yield for the main food crops was for self-consumption in most of the communities, except for Chonyi where the proportion of yields taken to markets was slightly higher (Figure 8). This is because Chonyi is near to Kilifi town and Pwani University, where food crops fetch high prices and demand is high.

The main food crops (maize, cassava, pulses, bananas, sweet potatoes, vegetables, coconut and mangoes) generally fetched higher prices in Digo and Chonyi than in the other communities. In Digo, food prices are high because demand is high since much land previously under food crops has been taken over by the Kwale International Sugar Company (KISCOL) for sugar cane plantations. Besides, there are a number of tourist hotels in Kwale County that get their food crops from local farms, further pushing up the demand (and prices). Chonyi is near Kilifi town, which is strategically located between Mombasa and Malindi towns along a major highway and thus attracts a large number of buyers, which results in higher prices. However, bananas and cassava fetched even higher prices in Giriama (Figure 9) due to their high demand in the neighbouring Malindi town.

The average price per kilogramme of bananas was Kshs 30.70, cashew nuts Kshs 37.70, cassava Kshs 72.20, coconut Kshs 33.60, maize Kshs 54.70, mango Kshs 34.30, millet Kshs 30, Oranges Kshs 35, sweet potatoes Kshs 50, pulses Kshs 70, spices Kshs 50, vegetables Kshs 36.30 and sugarcane Kshs 40.

Figure 8: Percentage yield for market and self-consumption in 2012

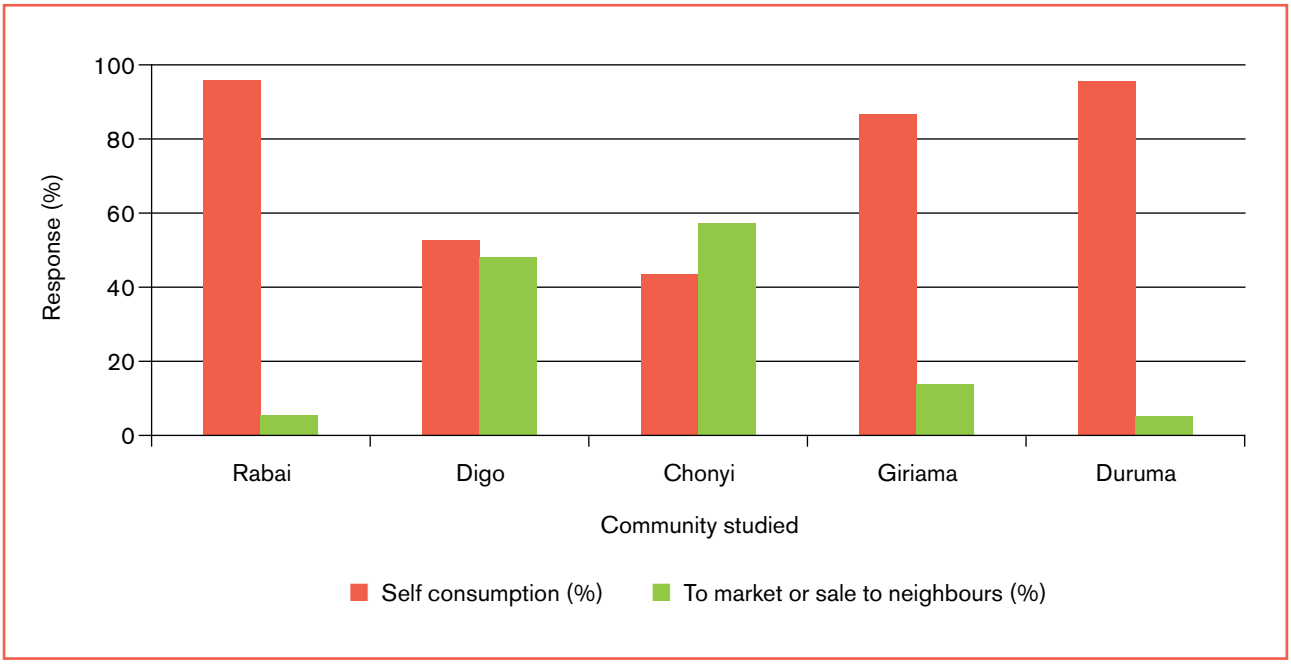
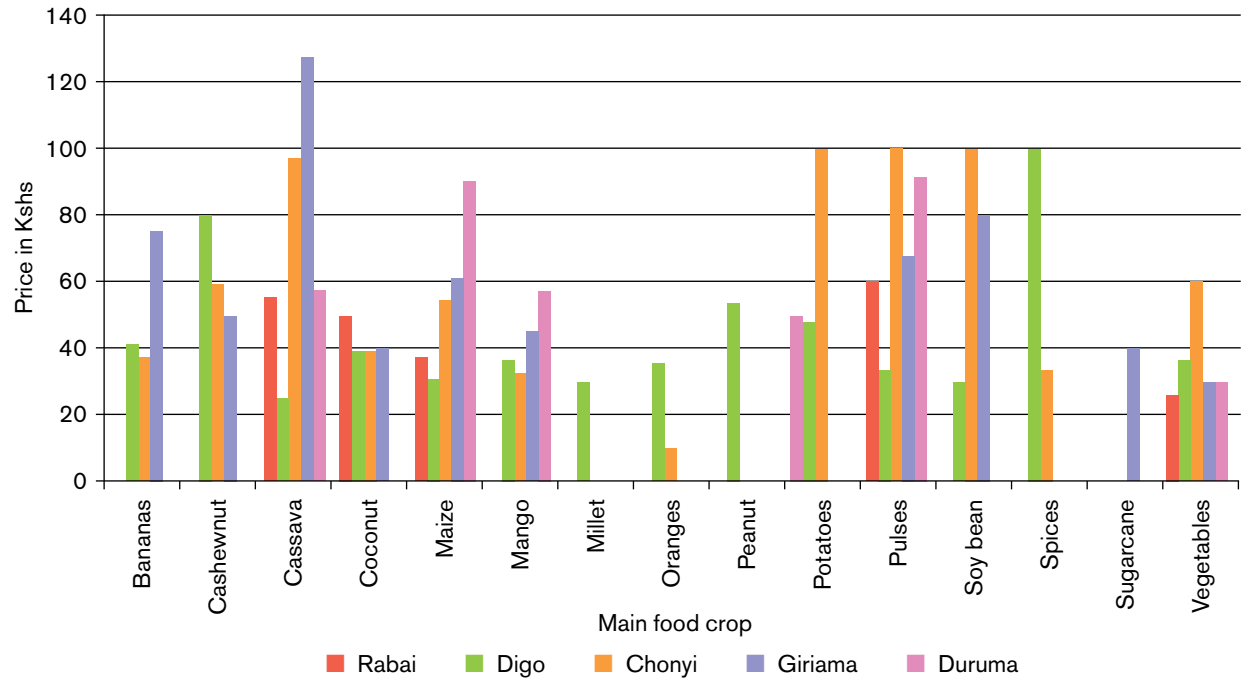


Figure 9: Prices of the main food crops in 2012



3.2 Livestock production and self-consumption

Overall, the number of livestock kept has increased mainly due to poor crop productivity (due to increased pests and diseases and prolonged droughts). However, livestock production in Duruma declined slightly between 2003 and 2012 (Figure 10). Overall, livestock kept are mainly for household consumption, and this has been increasing over the years, particularly since 2008 (Figure 10), while production for market has been declining. Duruma had the lowest percentage of livestock reared for self-consumption since it is located in dry areas with low crop productivity, hence livestock farming for market has become a major source of household income in the area.

Cattle are the most preferred commercial livestock because they fetch the highest price (Figure 11). Pigs, sheep and ducks fetch lower prices due to the low preference for their meat in the markets.

Figure 10: Livestock production overall and for self-consumption

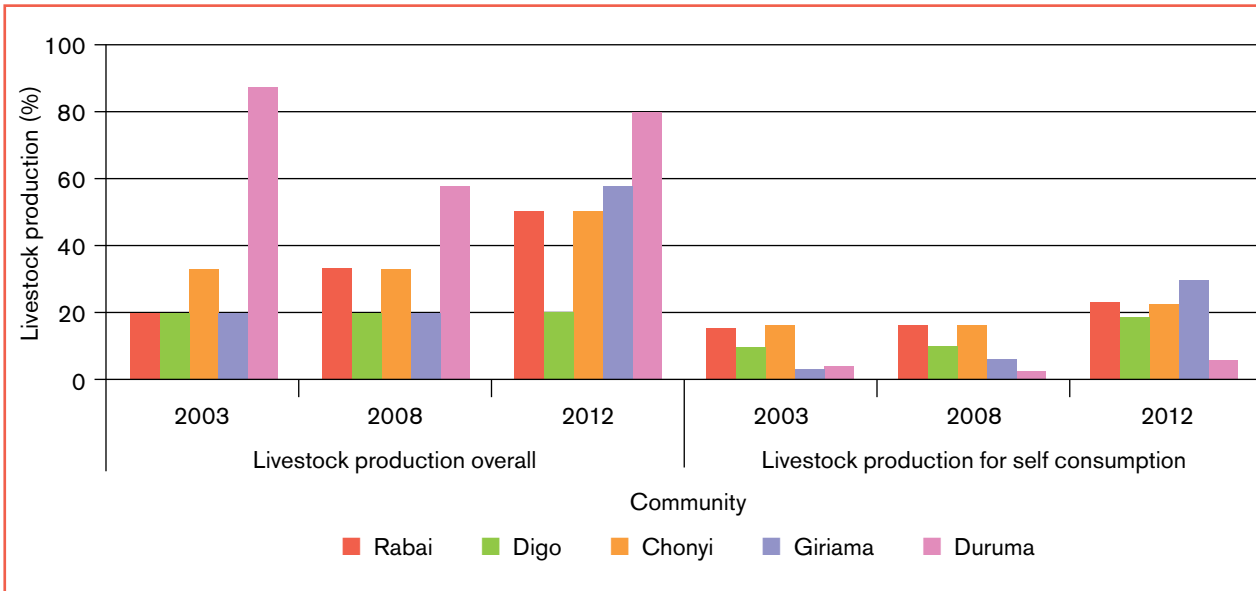
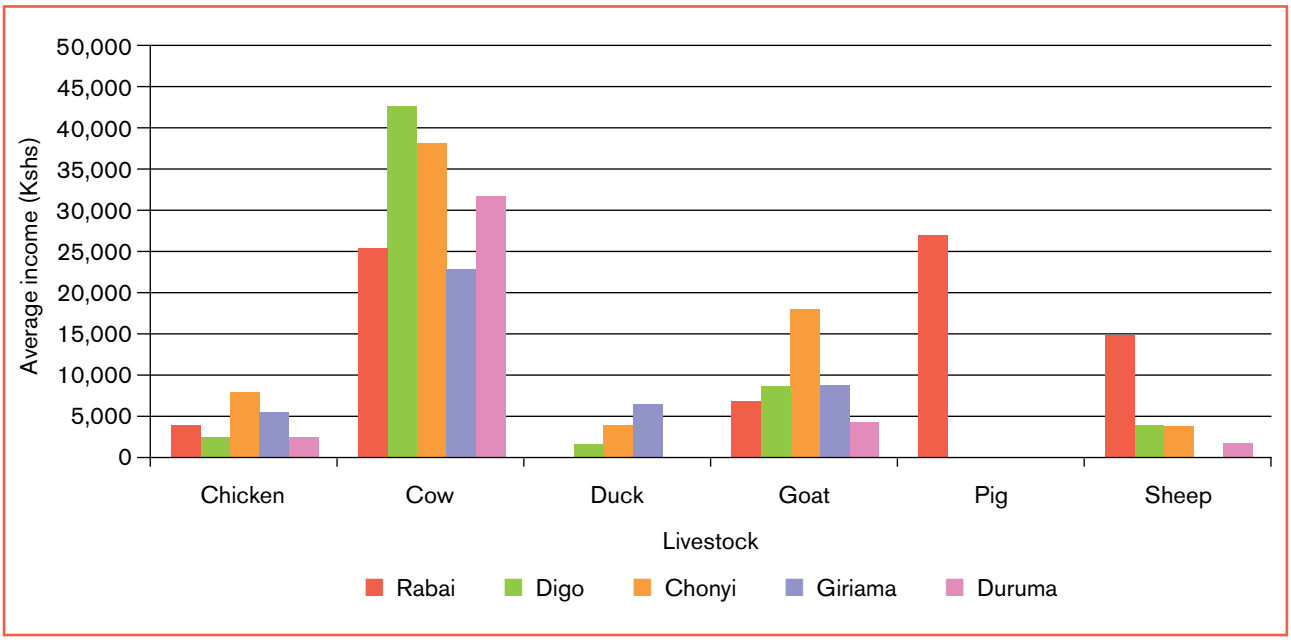


Figure 11: Average net income from livestock farming

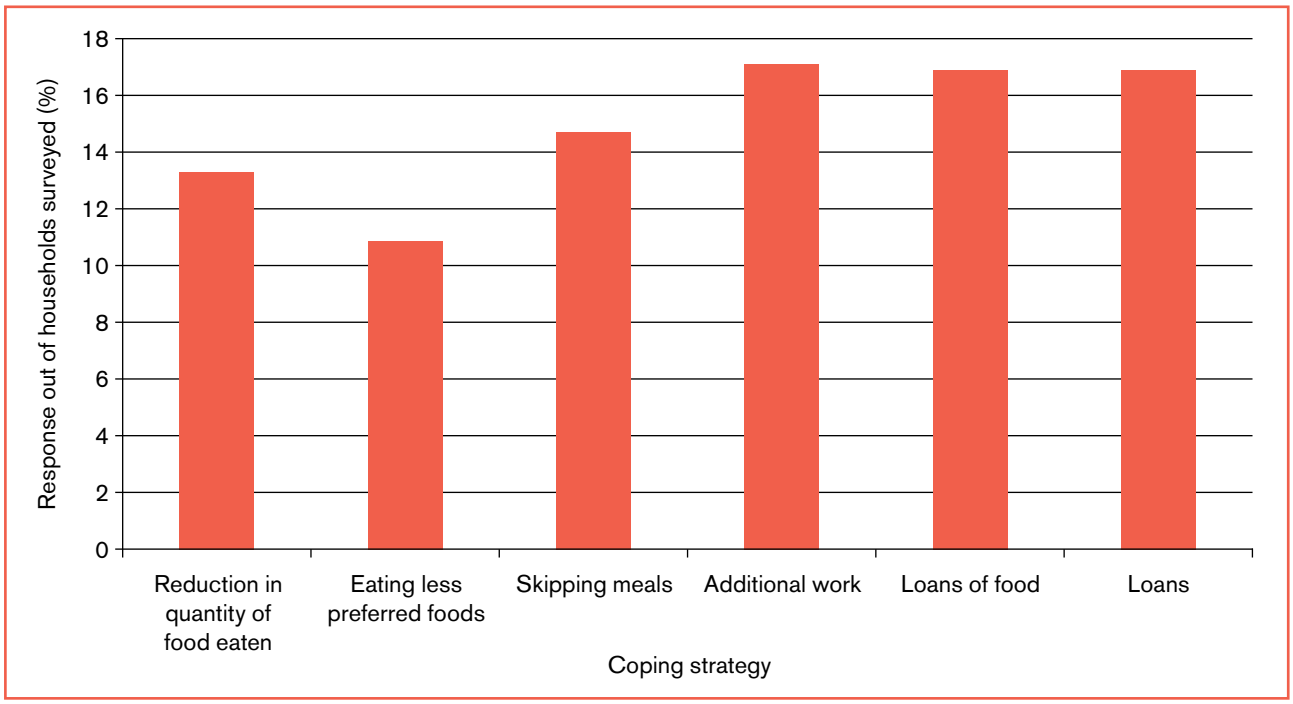


3.3 Main coping strategies for food security

Recent climatic changes have significantly affected food production, prompting the Mijikenda community to develop various coping strategies (Figure 12). The most widely applied strategies during periods of food insufficiency were food loans, financial loans and additional work (reported by 17 percent of interviewed households), followed by skipping meals (14 percent), reduction in quantity of food eaten (13 percent) and eating less preferred foods (11 percent).

Communities seek financial loans and diversified income sources in order to buy food, but these strategies have compromised nutrition, which is a key aspect of food security: most people in these communities eat to survive. Households have also changed their eating habits and more people are now eating less preferred foods, such as beans.

Figure 12: percent of households reporting various coping strategies during food insufficiency



Crop diversity

Traditional dance by Rabai community during New Year celebration. Photo credit: Arafa Amur.

4

4.1 Trends in landraces and varieties lost

This study found that more households are still growing landraces than hybrids for the two staple crops – maize and cassava. However, landrace cultivation has decreased over time, while hybrid cultivation has increased (Figure 13). The proportion of households growing landraces for maize and cassava has fallen substantially from 100 percent in 1982 to about 62 percent in 2012. Farmers are now adopting fast growing and drought tolerant hybrid varieties to complement landraces.

From 1982 to 1992 there was very little crop variety loss due to the strong cultural attachment to traditional varieties and community governance structures (Figure 14). The number of introduced and hybrid varieties at that time was also very low. The next 15 years were characterized by increasing crop variety loss that reached a height in 2004, due to erosion of culture, weakening of community governance systems, and a high number of introduced hybrid and improved varieties, promoted by extension services at the time. The 5 years from 2008–2012 revealed a slowing in the loss of traditional crop varieties. This was probably because hybrid and introduced varieties began to have more pests and diseases, because the frequent

Figure 13: Trends in growing landraces and hybrids

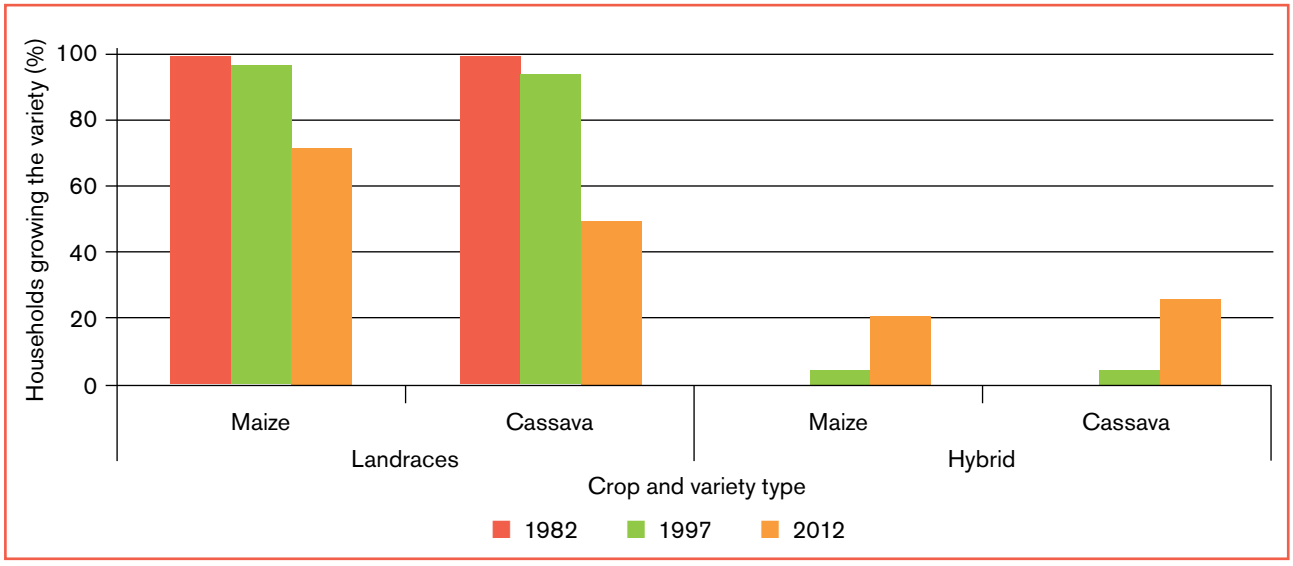
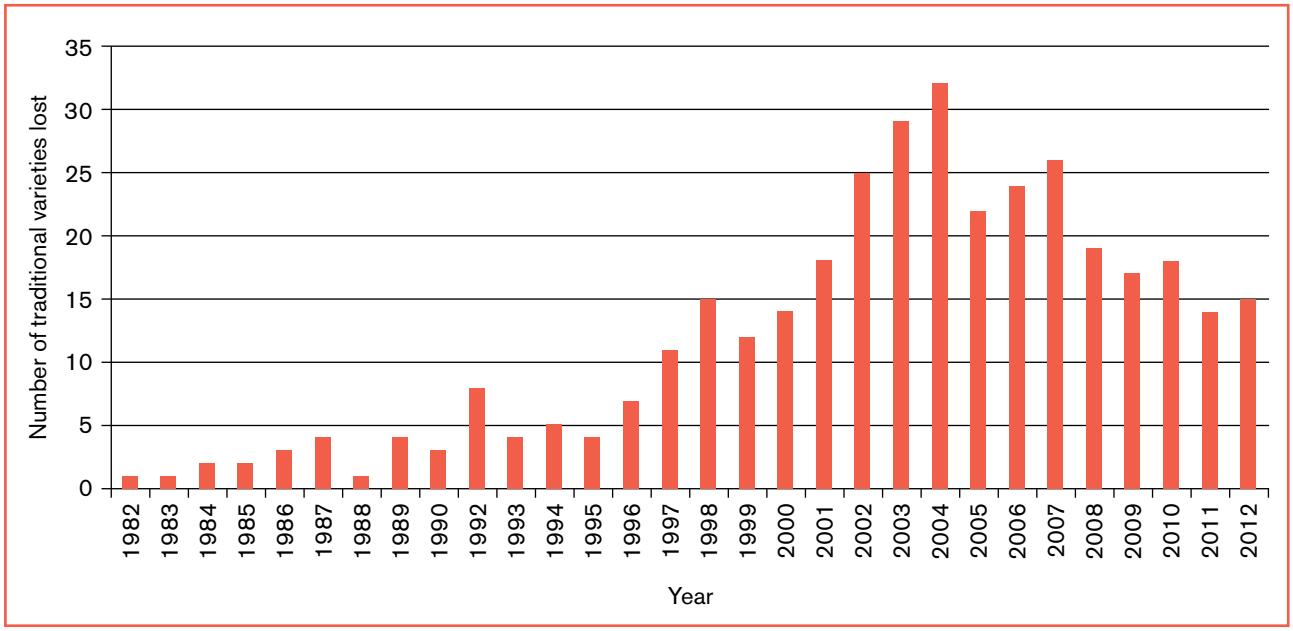


Figure 14: Traditional crop varieties lost between 1982 and 2012



droughts did not suit them, and because they need high levels of inputs for production. Farmers started growing more traditional varieties again, because these are more resistant to pests and diseases and drought.

4.2 Number of crop varieties planted and stored

For common food crops such as maize, cassava and cowpeas, the number of crop varieties planted has increased since 2003 (Table 7). Farmers are planting different varieties (e.g. traditional, introduced and hybrid varieties) to ensure food security even if some varieties fail due to unpredictable weather conditions. The increase in the number of varieties reflects both the introduction of hybrids such as PH1, PH4, DH1 and DH4 by Kenya Agricultural and Livestock Research Organization (KALRO), and a return to more resilient landraces, since these hybrids failed to enhance production after succumbing to prolonged droughts and increased incidences of pests and diseases associated with climate change.

Table 7: Number of crop varieties planted for all sites combined

CROP	NUMBER OF VARIETIES (2003)	NUMBER OF VARIETIES (2012)
Maize	5	9
Cassava	2	5
Cowpeas	3	6
Sweet potatoes	3	3
Bananas	7	7
Coconut	3	3
Green grams	1	2

The Mijikenda community store seeds of some crops for planting for the next season (Table 8). The stored seeds are mainly for traditional and improved varieties with the latter being stored more. They have devised several seed preservation and storage mechanisms to ensure that stored seeds retain their viability until the next cropping season. Diversification of crop varieties for food security was the main reason for conserving different seed varieties to use in the next planting season. The varieties were also stored to provide alternative sources of seeds for replanting in case of crop failure and ensure household food sufficiency. For maize, 5 varieties were self-saved out of the 9 varieties planted in 2012, while for cowpeas, 3 varieties were saved (out of the total of 6 varieties planted).

Table 8: Number of varieties sustained through self-saved seeds

CROP	NUMBER OF VARIETIES (2012)
Maize	5
Cowpeas	3
Green grams	1
Millet	1
Sorghum	1
Rice	1

Drought tolerance was reported as the main reason for conserving different crop varieties by 63 percent of households interviewed (Table 9), followed by ensuring availability of planting material (29 percent). Other reasons include ensuring food availability for most of the year, replanting when the germination rate is low, and to reduce risks associated with pests and diseases.

Table 9: Households' main reason for conserving crop varieties

REASONS FOR CONSERVING DIFFERENT CROP VARIETIES	RESPONSE (%)
To ensure availability of planting material for the next cropping season	29.2
For replanting in the case of low survival percentage	3.3
Drought tolerance to ensure food security	62.5
Ensure availability of food for most part of the year	4.7
Reduce the risk of pests and diseases	0.3

4.3 Crops and varieties introduced between 1982 and 2012

The Digo community had the highest number of new crop varieties introduced in the three decades compared in this study (18 varieties). Tourism in the area offers ready markets for the crops, and favourable weather conditions encouraged the community to introduce fast growing varieties instead of traditional varieties (Table 10).

The Chonyi community introduced 14 varieties, and the Giriama 11. Both these communities are near to Kilifi town, where there is high demand for food and hence provides a market for the agricultural products. Thus these two communities are adopting varieties that grow and mature faster so as to meet that market demand. The strong attachment of the Rabai community to their culture, despite being in a cosmopolitan and a highly fertile area, has resulted in adoption of fewer introduced varieties (nine). However, the Duruma community, being in a dryland area, had the lowest adoption of introduced varieties as they only adopted varieties that could tolerate prolonged dry spells.

Table 10: Crops and varieties introduced in the last 30 years

SITE	CROP	NO. OF VARIETIES INTRODUCED BETWEEN 1982 AND 2012
Rabai	Maize	4
	Cassava	1
	Cowpeas	1
	Sweet potatoes	1
	Kale	1
	Mango	1
Digo	Maize	6
	Cassava	4
	Cowpeas	2
	Mango	2
	Tomato	1
	Banana	1
	Coconut	1
Chonyi	Maize	4
	Cassava	2
	Cowpeas	3
	Mango	1
	Banana	1
	Orange	1
	Cashew nut	1
	Coconut	1
Giriama	Maize	5
	Cassava	4
	Cowpeas	2
	Kale	1
Duruma	Maize	2
	Cassava	3
	Cowpeas	1
	Kale	1

4.4 Main food and cash crops

The number of landraces planted as either cash or food crops has remained relatively constant since 2003, as the rate of loss of traditional varieties slowed, with the exception of maize landraces, which declined in Digo, Chonyi and Giriama. This decline is due to adoption of more productive hybrid maize varieties like Pwani Hybrid 4 (PH4) (Table 11).

Table 11: Number of landraces grown for the main food and cash crops

SITE	FOOD CROPS				CASH CROP			
	CROP	2003	2008	2012	CROP	2003	2008	2012
Rabai	Maize	5	5	5	Coconut	1	1	1
	Cassava	3	3	3	Cassava	3	3	3
Digo	Maize	5	4	3	Maize	0	0	0
	Cassava	3	3	3	Cassava	3	3	3
Chonyi	Maize	5	4	4	Coconut	2	2	2
	Cassava	2	2	2	Oranges	2	2	2
Giriama	Maize	5	5	4	Coconut	2	2	2
	Cassava	3	3	3	Cassava	3	3	3
Duruma	Maize	5	5	5	Green grams	1	1	1
	Cassava	2	2	2	Cowpeas	2	2	2

Seed systems

Herbal grove for Ufanisi conservation group.
Photo credit: Arafa Amur.

5

5.1 Seed sources

Overall, purchased seed is the leading source of seeds employed by 55 percent of households surveyed. Hybrids and improved varieties[4] are mainly sourced through purchases from agro-vet shops and other licensed seed sellers. Self-saved seeds were the next most important source, with 27 percent of households saving seeds, particularly landraces. Chonyi and Rabai had the highest number of farmers saving seeds for next planting season at 90 percent and 79 percent respectively (Table 12). Some farmers experiment by

Table 12: Seed sources for various crop varieties

SITE	VARIETY TYPE	SEED SOURCES (%)											
		SELF-SAVED	SELF-IMPROVED	COMMUNITY IMPROVED	PURCHASES	EXCHANGE WITHIN SAME COMMUNITY	EXCHANGES BETWEEN COMMUNITIES	RELATIVES (MOTHER'S SIDE)	OTHER RELATIVES	GIFTS AND REMITTANCE	LOCAL MARKET	LOCAL EXTENSION STATIONS	NGOS
Rabai	Landrace	78.6	1.6	0.0	12.5	1.6	0.0	3.9	1.6	0.4	0.0	0.0	0.0
	Improved varieties	0.0	0.0	0.0	84.2	0.0	0.0	0.0	5.3	10.5	0.0	0.0	0.0
	Hybrid varieties	8.6	0.0	0.0	82.9	0.0	0.0	0.0	0.0	5.7	0.0	0.0	2.9
Digo	Land race	54.5	0.0	0.0	9.0	8.2	0.3	0.0	19.5	7.9	0.0	0.6	0.0
	Improved varieties	0.0	0.0	0.0	82.4	5.9	0.0	0.0	11.8	0.0	0.0	0.0	0.0
	Hybrid varieties	10.0	0.0	0.0	80.0	5.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0
Chonyi	Landrace	89.9	0.0	0.0	4.8	0.0	0.0	0.0	2.4	0.0	2.7	0.3	0.0
	Improved varieties	6.7	29.6	0.6	54.2	0.0	0.0	1.1	1.1	0.0	6.1	0.0	0.6
	Hybrid varieties	2.9	.4	0.0	81.0	0.0	0.0	0.0	0.0	0.0	8.4	7.3	0.0
Giriama	Landrace	72.6	1.6	0.0	17.3	5.6	0.8	0.8	0.0	0.0	0.0	0.4	0.4
	Improved varieties	27.3	9.1	9.1	36.4	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0
	Hybrid varieties	12.5	0.0	0.0	79.2	4.2	0.0	0.0	0.0	0.0	4.2	0.0	0.0
Duruma	Landrace	37.0	0.0	2.5	59.7	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
	Improved varieties	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Hybrid varieties	0.0	0.0	0.0	92.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7
Mean		26.7	2.82	4.14	55.06	2.03	0.07	0.99	2.78	1.63	1.43	0.96	0.77

[4] 'Improved seeds' were defined as seeds developed from crossing hybrids and landraces and in this case they were mainly coast composite maize varieties developed by KARI (Wekesa et al., 2003).

saving seeds from hybrid crops, but when planted, the performance is poor with almost zero yields. Community improved seeds were the third biggest seed source, reported by 4 percent of households overall, although only two of the five communities (Giriama and particularly Duruma) use this method– for sourcing seeds of landraces and improved varieties (not hybrids) (Table 12). Duruma community is particularly active in seed and crop variety improvement because the harsh climatic conditions here require more resilient crop varieties to guarantee yield.

There is little exchange of seeds among farmers within the same community with only 2 percent of survey respondents alluding to such exchanges. Similarly, very few farmers (0.07 percent) exchanged seeds with farmers from other communities. There are almost no community seed banks/centers that could bring farmers together for such exchanges, and customary laws and practices that used to promote seed sharing and exchange have been weakened. High seed exchange was observed in Digo and this was probably because many farmers had lost their own source of saved landraces seeds when they switched to the hybrids promoted by KALRO (which has strong presence in the area).

5.2 Roles of men and women in selecting seeds

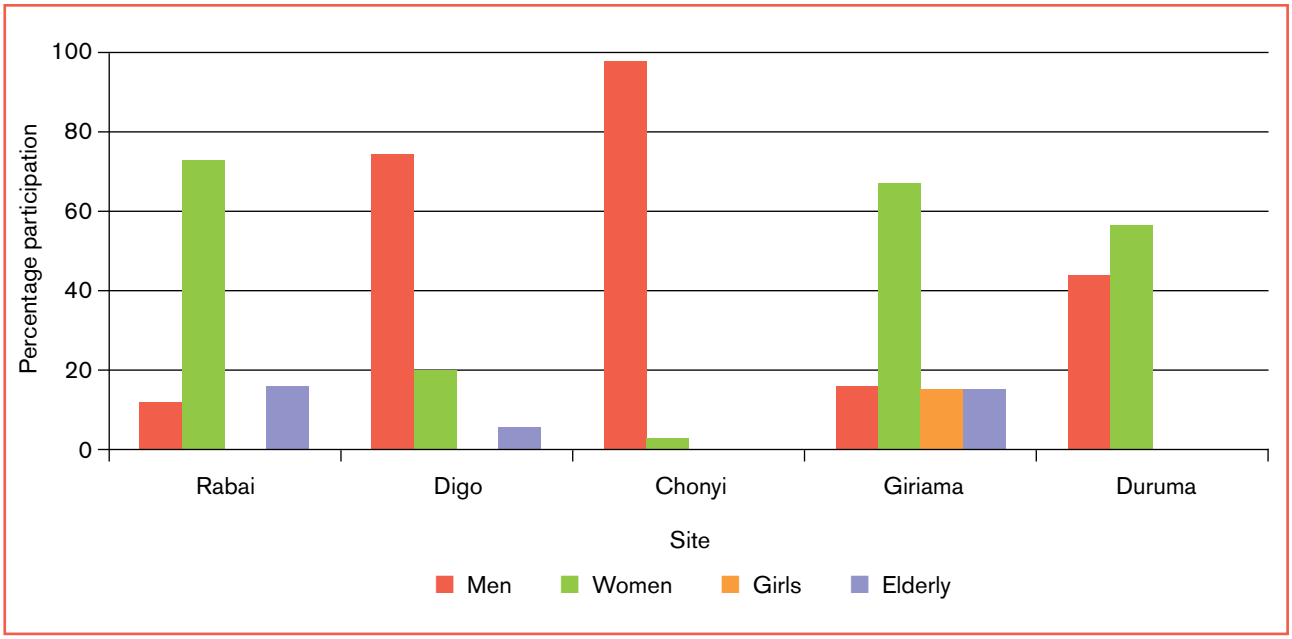
It is mostly women who select seeds for self-saving and planting for household consumption especially when it comes to landraces. On average, women select landrace seeds in 71 percent of households, while for men it was 29 percent. In contrast, men select hybrid seeds in about 77 percent of households, whereas women do so in only 23 percent of households. Similarly, men select improved seed varieties in 66 percent of households on average, compared to 34 percent for women (Table 13). This could be because men purchase hybrid and improved seed varieties from towns where they frequently do business, while women, who in most cases stay at home, select seeds for landraces.

When it comes to selection and storage of seeds for market crops, this was done by men in 49 percent of households overall (Figure 15) (97 percent in Chonyi and 75 percent in Digo). Women's participation in seed selection for market crops was lower (44 percent overall). Girls' involvement in selection of seeds for market crops was 7 percent, while that of elders was 13 percent on average (their participation in farming activities may be limited by health issues).

Table 13: Role of men and women in seed selection for household consumption

SITE	RESPONSE OUT OF HOUSEHOLDS SURVEYED (%)					
	LANDRACES		IMPROVED VARIETIES		HYBRID VARIETIES	
	MEN	WOMEN	MEN	WOMEN	MEN	WOMEN
Rabai	19.5	80.5	55.6	44.4	68.6	31.4
Digo	41.8	58.2	68.7	31.3	75.0	25.0
Chonyi	55.8	44.2	75.0	25.0	85.3	14.7
Giriama	4.6	95.4	80.0	20.0	95.7	4.3
Duruma	25.2	74.8	50.0	50.0	61.5	38.5
Mean	29.38	70.62	65.86	34.14	77.22	22.78

Figure 15: Role of men and women in seed selection for market crops



New and improved seed materials for planting were mainly obtained through borrowing from other farmers (in 35 percent of households on average) or buying (31 percent of households) (Table 14). Buying is the main source for hybrid varieties since saved seed germinates poorly or gives poor yields. Other seed sources included government support programmes (used by about 9 percent of households) and food aid grains (used by about 7 percent of households) – these sources provide seeds to poor rural farmers, but have been decreasing over time.

Table 14: Sources of new seeds

SOURCE	RESPONSE OUT OF HOUSEHOLDS SURVEYED (%)					AVERAGE (%)
	RABAI	DIGO	CHONYI	GIRIAMA	DURUMA	
Buying	41.4	26.5	29.3	43.0	16.3	31.3
Borrowing	46.4	34.7	25.7	34.4	33.3	34.9
Exchange with friends	4.3	2.7	1.6	2.3	2.3	2.64
Food aid grains	5.0	5.4	0.0	12.5	14.0	7.38
Self-saved	0.7	0.7	0.5	5.5	3.1	2.1
Research institutes	0.0	6.1	12.6	1.6	5.4	5.14
Government programmes	1.4	9.5	13.6	0.0	20.2	8.94
NGO`s	0.7	1.4	16.8	0.0	0.8	3.94
Gifts from family and friends	0.0	12.9	0.0	0.8	4.7	3.68

5.3 Strength and weaknesses of varieties selected from previous harvest

Farmers consider several characteristics when selecting seeds from previous harvests: not only high yields, but also ability to tolerate drought and pests and diseases which is often superior in non-hybrid seeds. Ease of seed storage and taste also inform seed selection (Table 15). For crops such as maize, cassava and pulses, the seeds selected from previous harvests were mainly landraces, although a few improved varieties were also selected. The results show that the majority of households rated landrace varieties selected from the previous harvest as having the greatest benefits not only in terms of drought and pest resistance, but also for all other criteria, with the exception of seed size which is higher in hybrids.

Table 16 presents the reported weakness of various saved seeds. The main weaknesses of landraces were reported to be small-sized seeds. Despite the hybrids having fast growth and big seeds, their productivity was considered low because they are susceptible to drought, pests and diseases, and they were said to be poor in taste.

5.4 Importance of seed security

All communities reported seed security to be important or very important (Figure 16). This is confirmed by the fact that most farmers store landrace seeds from the previous harvest for the next planting season. In the case of crop failure, the community also relies heavily on purchasing and borrowing seeds from friends and relatives for planting.

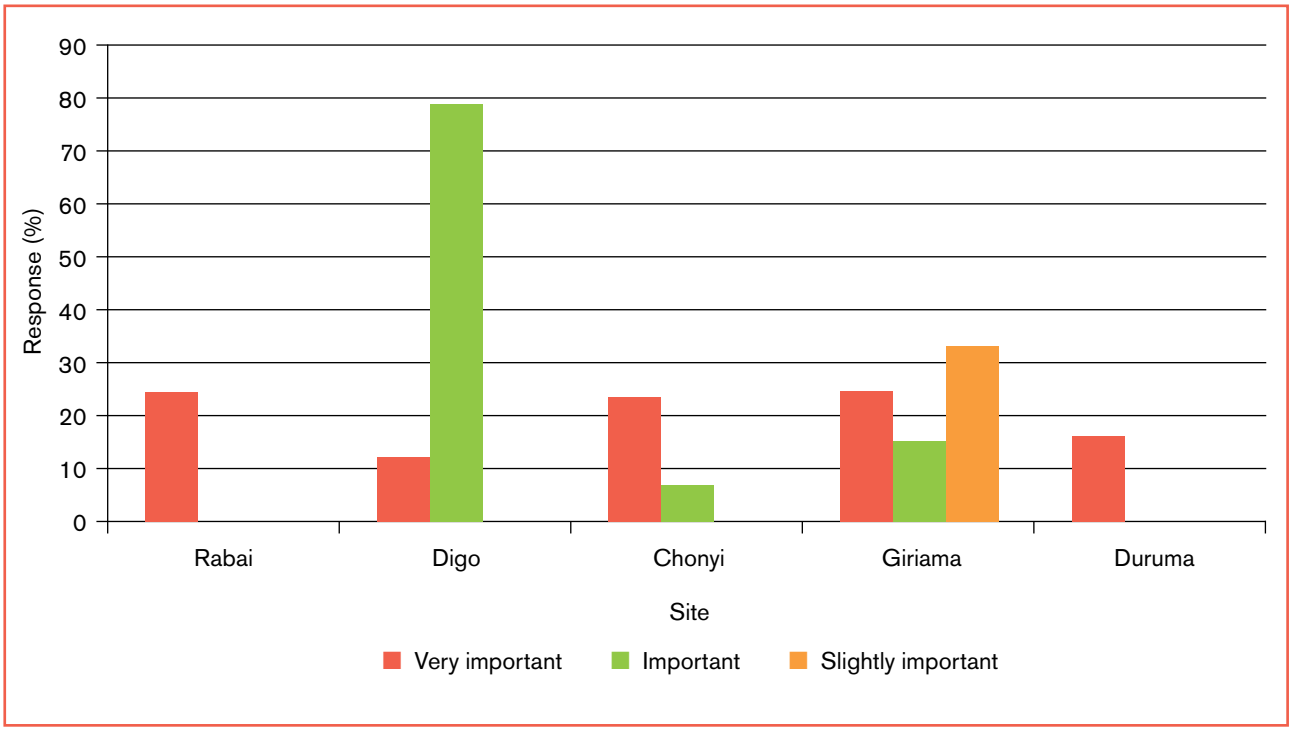
Table 15: Strengths of maize, cassava and pulse varieties selected from previous harvest

STRENGTHS	PERCENT OF HOUSEHOLDS IDENTIFYING DIFFERING VARIETIES AS BEING STRONG FOR SELECTED TRAITS				
	LANDRACE	SELF-IMPROVED	COMMUNITY IMPROVED VARIETY	INTRODUCED IMPROVED VARIETY	HYBRID
Drought and pests resistant	91.7	4.9	0.0	1.4	2.1
Short time to mature	80.0	1.3	1.3	7.5	10.0
More productive	80.6	0.9	0.0	12.1	6.5
Grow with little rainfall	100.0	0.0	0.0	0.0	0.0
Big seeds size	0.0	0.0	0.0	20.0	80.0
Strong and sweet	82.6	8.7	0.0	0.0	8.7
Seeds easily stored and available	100.0	0.0	0.0	0.0	0.0
Easy to pound	100.0	0.0	0.0	0.0	0.0

Table 16: Weaknesses of varieties selected from previous harvest

WEAKNESS	PERCENT OF HOUSEHOLDS IDENTIFYING DIFFERENT VARIETIES AS BEING WEAK BECAUSE OF SELECTED TRAITS			
	LANDRACE	SELF-IMPROVED	INTRODUCED IMPROVED VARIETY	HYBRID
Small seeds size	100.0	0.0	0.0	0.0
Seeds not readily available and stored	79.3	3.4	10.3	6.9
Not sweet and strong	0.0	20.0	20.0	60.0
Easily affected by pests	24.0	0.0	0.0	76.0
Not drought resistant	14.7	2.9	17.6	64.7
Cannot survive in a heavy rainy season	30.0	0.0	0.0	70.0
Need expert to select seeds	0.0	0.0	0.0	100.0
Requires more rainfall	0.0	3.1	6.3	90.6

Figure 16: Importance of seed security



Social capital and biocultural heritage

6

Traditional knowledge (TK) and cultural values, as well as networks and institutions, are a vital part of communities' 'social capital' that enhances resilience and ability to adapt to climate change (Ongugo et al., 2014; Wekesa et al., 2015). For example, cultural ceremonies and community events can encourage collective action, create a sense of belonging, enable exchange of ideas, and facilitate access to common property resources including seeds. Hence they contribute to local innovation for adaptation to climate change and socio-economic development of communities (Ansari et al., 2012). Social capital and biocultural heritage were assessed using the following sub-indicators: number of households speaking native language, having traditional houses, participating in traditional rituals and festivals, using traditional clothing and participating in collective activities; networking within and between villages; and use of traditional farming technologies.

6.1 Households speaking native language

Of the communities studied, Rabai has the highest percentage of households speaking the native language, at 46.5 percent (Table 17). This was attributed to the fact that the community has strong cultural values and a robust *Kaya* elders governance system and is therefore closely knit. By contrast, in Duruma only 2.9 percent of households surveyed still speak the native language. A downward trend in native language speaking over the past three decades is quite pronounced in all the communities – a reduction of nearly 40 percent in Rabai and 55–60 percent in the other communities, compared with 1982. More people, especially the youth, are embracing Swahili (the national language). This conincides with the introduction of formal education, modernization, youth migration to urban areas and increasing cases of intermarriage with non-Mijikenda tribes.

Table 17: Households speaking native language across sites

SITE	HOUSEHOLDS SPEAKING NATIVE LANGUAGE IN 1982 (%)	HOUSEHOLDS SPEAKING NATIVE LANGUAGE IN 2012 (%)
Rabai	83.7	46.5
Digo	81.3	23.2
Chonyi	72.3	12.1
Giriama	76.6	15.3
Duruma	58.0	2.9

6.2 Households with traditional houses

Rabai has the highest number of households built in the traditional style (43 percent), due to this community's strong traditional culture. Digo has the lowest number of traditional houses (2.9 percent), owing to rapid modernization and development of the tourism industry in nearby Diani and Mombasa (Table 18).

Table 18: Households with traditional houses (2012)

SITE	HOUSEHOLDS OCCUPYING TRADITIONAL HOUSES (%)
Rabai	43.0
Digo	2.9
Chonyi	9.0
Giriama	15.9
Duruma	29.8

6.3 Households participating in traditional rituals and festivals

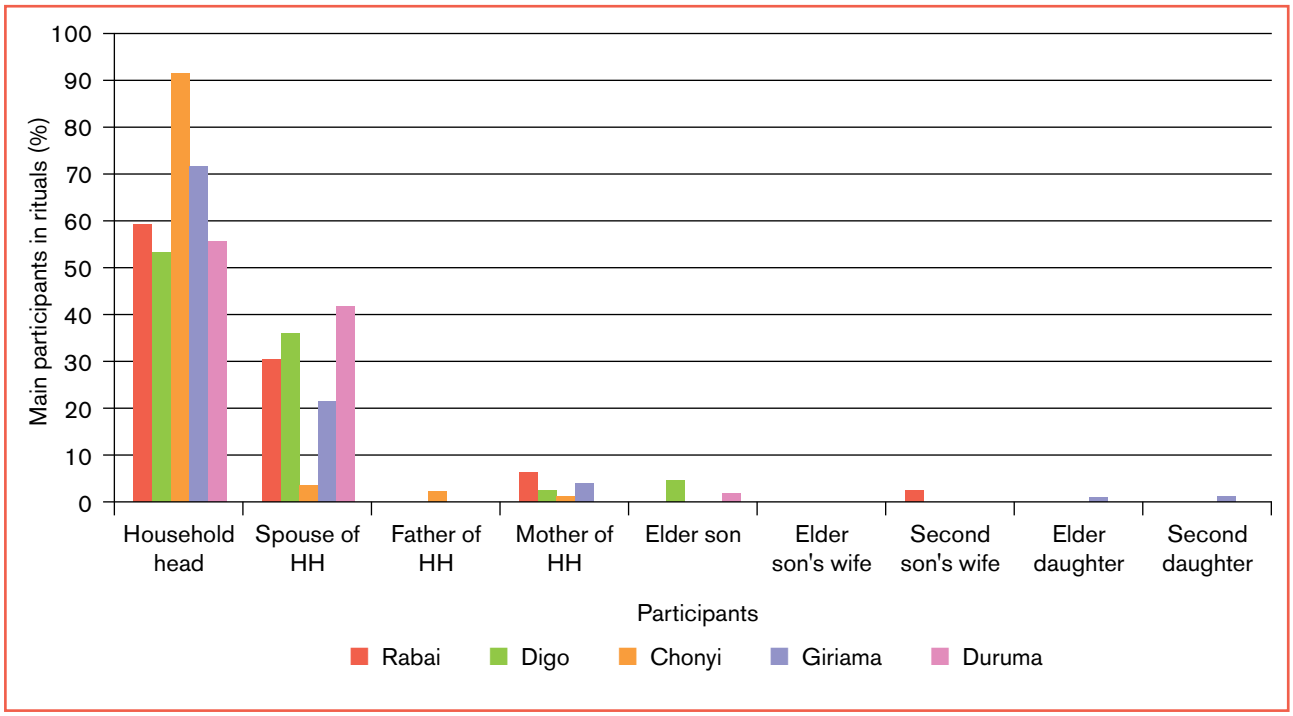
The Rabai community has a slightly higher participation in traditional rituals, ceremonies and festivals than the other communities, as evidenced by the many traditional festivals that the community holds annually. Examples are the Rabai new year festivals, traditional weddings, dancing festivals and burial ceremonies, as well different rituals (*matambiko*) that the *Kaya* elders undertake for the wellbeing of the community (Table 19). Chonyi has the lowest household participation in traditional rituals and festivals. This community's close proximity to Kilifi town, where the community regularly interacts with members of other communities, has led to erosion of traditional culture (although the difference between Rabai and Chonyi is small).

Table 19: Households participating in traditional rituals and festivals

SITE	HOUSEHOLDS PARTICIPATING IN TRADITIONAL RITUALS AND FESTIVALS (%)
Rabai	20.02
Digo	19.8
Chonyi	19.4
Giriama	19.78
Duruma	20.0

Of those surveyed, 66 percent said the household heads were the main participants in traditional rituals, followed by their spouses (27 percent). Children and grandchildren were the least likely to participate in traditional rituals and festivals (Figure 17). Household heads are responsible for initiating, planning and participating in traditional rituals and festivals, hence their higher participation. The low participation of children and grandchildren is probably due to modern religion, formal education and modernisation.

Figure 17: Main participants of households in traditional festivals and rituals



6.4 Households using traditional clothing

Digo has the highest number of households using traditional clothing, largely because it promotes cultural tourism (Table 20), although traditional clothing for both men and women has been modified. Rabai has the next highest use of traditional clothing, owing to the rich culture in the community. Giriama has the least number of people wearing traditional clothing due to the influence of Christianity and Islam and modern lifestyles. Chonyi's closeness to Kilifi town and location of some villages (Kikambala and Takaungu) near tourist destinations contributed to their minimal use of traditional clothing.

Table 20: Households using traditional clothing

SITE	HOUSEHOLDS USING TRADITIONAL CLOTHING (%)
Rabai	20.0
Digo	42.8
Chonyi	12.7
Giriama	6.3
Duruma	18.8

6.5 Households participating in collective activities

The Rabai community had by far the highest participation of households in collective activities (Table 21), owing to its strong social cohesion, traditional community institutions and cultural values. Giriama had the second highest because, like Rabai, it has strong social cohesion and cultural values preserved and promoted through annual ceremonies. One example is *Mekatilili wa Menza* week, celebrated in August every year to remember the woman leader who actively led the Giriama people in a rebellion against the British Colonial Administration in 1913 – 1914. The Duruma community has the lowest participation in collective activities due to constant migration in search of water and pasture for livestock and employment opportunities in urban areas.

Table 21: Households participating in collective activities

SITE	HOUSEHOLDS PARTICIPATING IN COLLECTIVE ACTIVITIES (%)
Rabai	62.2
Digo	6.8
Chonyi	9.4
Giriama	18.9
Duruma	2.7

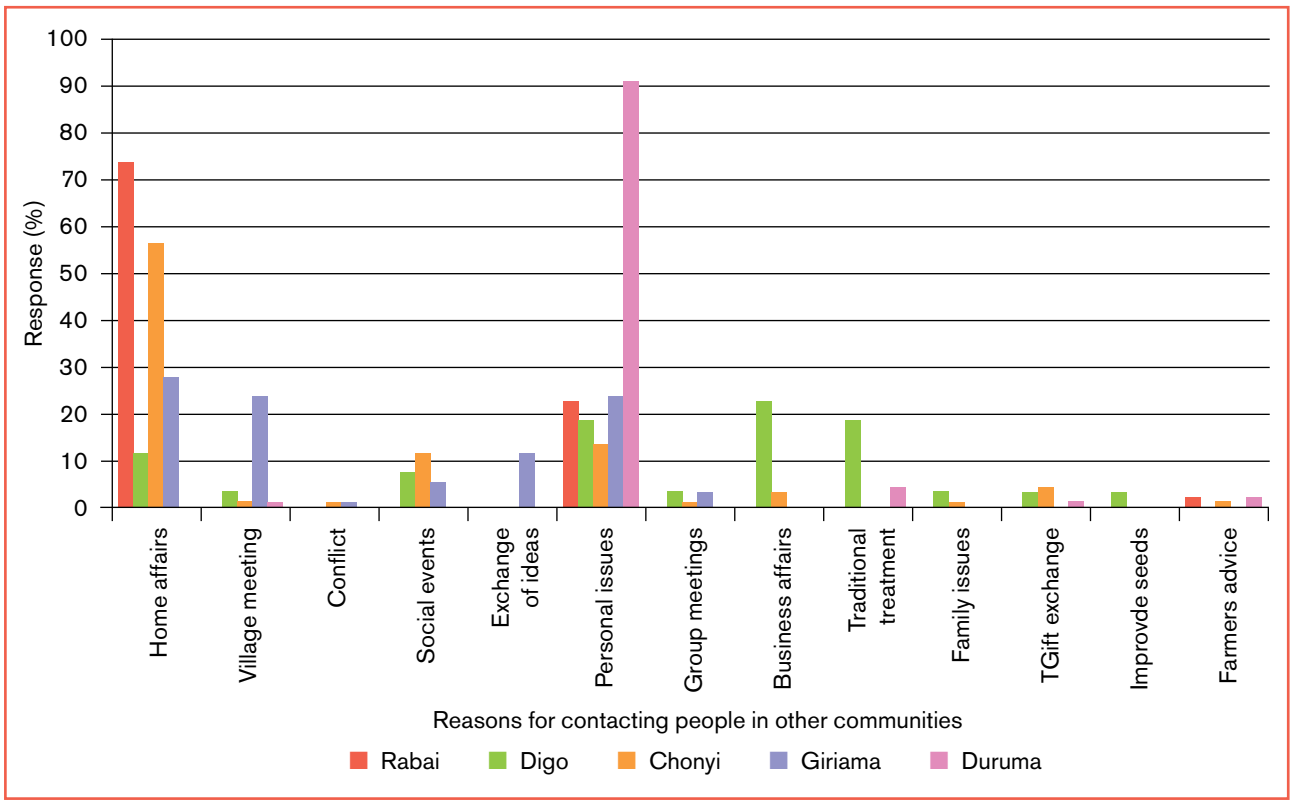
6.6 Networking amongst communities

Networking was assessed because it provides an indicator of social capital, a means for obtaining new information for innovation and platform for sharing innovations. Each Mijikenda community is made up of a number of villages. Households were asked who they normally interact with in their village and in other villages, and for what reason. Social networks mostly exist with family members (50 percent on average), followed by Sub-chiefs or Assistant Chiefs (appointees for coordinating government functions at sub-location level, including dealing with security and resolving disputes) (15%), and friends (11%) (Table 22). However, in Giriama community, the study found there was no networking among extended family members even in the same village. Networking between villages is mainly for dealing with personal issues or home affairs, village meetings, social events, business affairs and traditional treatments (Figure 18).

Table 22: Networks amongst communities within and between villages

CONTACT	SITE (%)					AVERAGE
	RABAI	DIGO	CHONYI	GIRIAMA	DURUMA	
Sub-Chief/Assistant Chief	3.1	0.0	2.8	70.0	0.0	15.2
Village Elder	0.0	3.7	1.4	6.0	0.0	2.2
Chief	0.0	0.0	0.0	18.0	0.0	3.6
Members of County Assembly	0.0	3.7	0.0	2.0	0.0	1.1
Businessmen	0.0	18.5	0.0	4.0	0.0	4.5
Herbalist	0.0	22.2	0.0	0.0	4.3	5.3
Agricultural Officer	0.0	11.1	0.0	0.0	0.0	2.2
Family	87.5	18.5	51.4	0.0	93.6	50.2
Other Farmers	0.0	0.0	1.4	0.0	0.0	0.3
Friends	9.4	7.4	40.3	0.0	0.0	11.4
Group Officials	0.0	0.0	2.8	0.0	2.1	1.0
Fishermen	0.0	3.7	0.0	0.0	0.0	0.7
Government Officials	0.0	3.7	0.0	0.0	0.0	0.7
Politicians	0.0	3.7	0.0	0.0	0.0	0.7
Religious Leaders	0.0	3.7	0.0	0.0	0.0	0.7

Figure 18: Reasons for contacting people from other villages



6.7 Traditional farming technologies

Since time immemorial communities have been using a wide range of traditional farming technologies to meet their food requirements. Rapid modernization in the early 2000s resulted in a decline in these technologies as more farmers embraced conventional farming methods to increase productivity. The changing climatic conditions of recent years, characterised by recurrent droughts, reduced and erratic rainfall and high incidences of pests and diseases, has seen farmers revert back to traditional technologies to cope with these challenges. Traditional technologies are now widely applied by the Mijikenda community although to varying degrees across the sites (Table 23).

The use of inorganic fertilizers decreased in the Chonyi community from 71 percent of households in 1982 to 59 percent in 2012; and in Duruma from 29 percent to 10 percent in 2012. This decline could be attributed to cost as well as erratic rainfall patterns, since inorganic fertilizer requires good rains to enhance yield. In Rabai, inorganic fertilizer use increased from no households in 1982 to 31 percent in 2012. This is driven by increasing demand for food and reduced size of cultivable land, requiring use of intensive farming practices to enhance yields. Moreover, the Rabai community is more educated and exposed to modern society and thus adoption of modern farming practices is faster. As the use of inorganic fertilizers in Chonyi declined, the use of organic manure increased, while in Rabai, both inorganic and organic fertilizer use has increased. In Digo, Duruma and Giriama organic fertilizer use declined from 1982 to 2012, probably due to declining livestock numbers. Huge herds have succumbed to drought and died, reducing the availability of manure.

The use of biological (ie. herbal/organic) pesticides on crop and livestock is increasing in three communities (Rabai, Giriama and Digo) in response to increased pests and diseases but decreasing in Chonyi. Slash and burn farming has increased in Chonyi and Giriama as the two communities search for fertile lands to boost crop production. However, this kind of farming practise has decreased in Digo and Rabai, while Duruma doesn't practise it. Ploughing with oxen is a recently-introduced practice to enhance cultivation depth and improve soil structure and fertility (three decades ago many farmers practiced slash and burn farming to ensure higher yields).

Table 23: Traditional farming technologies used in 1982 and 2012

FARMING TECHNOLOGY	PERCENT OF HOUSEHOLDS REPORTING USE OF FARMING TECHNOLOGY									
	RABAI		DIGO		CHONYI		GIRIAMA		DURUMA	
	EARLY 1980S	2012	EARLY 1980S	2012	EARLY 1980S	2012	EARLY 1980S	2012	EARLY 1980S	2012
Slash/burning	4.3	9.3	16.1	0.9	40.9	41.1	2.3	48.6	36.2	0
Oxen ploughing	0	0	–	7.1	0	7.1	0	42.9	0	42.9
Hand farm tools	51.4	34.4	17.1	39.3	14.3	13.1	2.9	9.8	14.3	3.3
Intercropping	6.8	2	11.4	20.2	40.9	40.4	2.3	1	38.6	36.4
Crop rotation	0	0	83.3	100	0	0	0	0	16.7	0
Bio-pesticides	0	16.7	20	33.3	40	0	40	50	0	0
Mixed crop-livestock farming or planting different crop varieties	3.8	2.7	7.7	16.2	73.1	78.4	11.5	0	3.8	2.7
Weeding	30.4	22.2	–	0	39.1	55.6	8.7	0	21.7	22.2
Manure (organic fertilizer)	0	24	35.6	16	0	44	28	4	36.4	12
Early planting	0	0	–	0	–	100	–	0	–	0
Agroforestry	0	0	–	0	100	100	0	0	0	0
Use of inorganic fertilizers	0	31	0	0	71	59	0	0	29	10

Climatic trends and forecasts

7

7.1 Major climatic changes

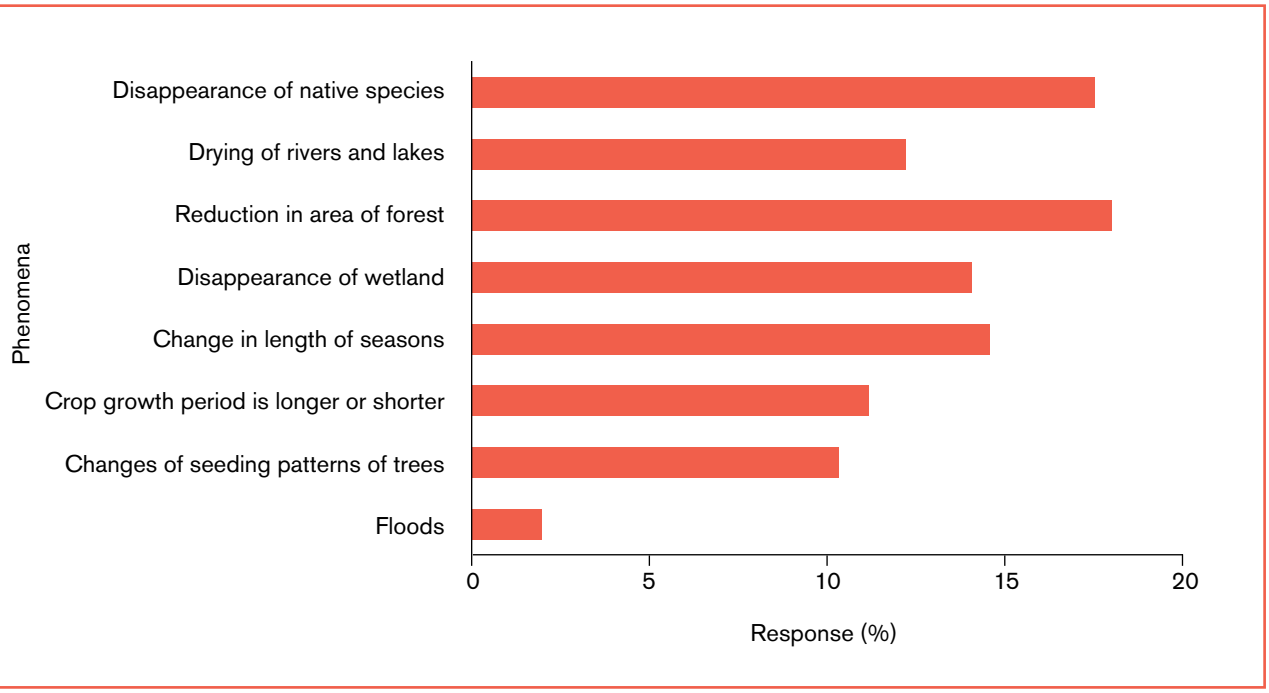
Across all sites, 95 percent of households surveyed reported an increase in extreme weather events since 1982, and 91 percent reported increased temperature (Table 24). Drought has increased according to 90 percent of households, due to prolonged dry periods and reduced rainfall (reported by 78 percent of households), while 89 percent reported increased sunshine strength. Crop and animal diseases have also increased, according to 82 percent of households, along with crop and animal insects/pests (73 percent) – they attribute this to the increase in temperature, which helps pests multiply. Wind strength has been increasing in all the areas (according to 67 percent of households), with deforestation and changes in oceanic cycles apparently contributing to this. Many households also noted a declined in flooding and river water flow.

Respondents reported various ecological changes associated with climatic changes (Figure 19). Reduction in forest area was reported by 18 percent of households. This was followed by disappearance of native species (17.5 percent), most of which occur in the forests; changes in length and period of seasons

Table 24: Major climatic changes observed since 1982

CLIMATIC CHANGE EVENT	INCREASING	DECREASING	CONSTANT
Rainfall	19.1	77.7	3.2
Temperature (summer/winter)	90.7	3.4	5.8
Wind strength	66.7	3.2	30.1
Sunshine strength	88.5	3.8	7.7
River water flow	34.8	47.3	17.9
Drought	89.8	7.2	3.0
Flooding	31.8	51.4	16.9
Insects/pests	73.2	19.5	7.4
Diseases (animal &crop)	81.9	9.1	9.1
Extreme weather events	95.4	2.8	1.8

Figure 19: Ecological changes (phenomena) associated with climatic changes observed



(14.6 percent); and changes in the crop growth period (11.2 percent) and seeding patterns of trees (10.4 percent). Other phenomena observed were disappearance of wetlands (14.1 percent) and drying of rivers and lakes (12.1 percent).

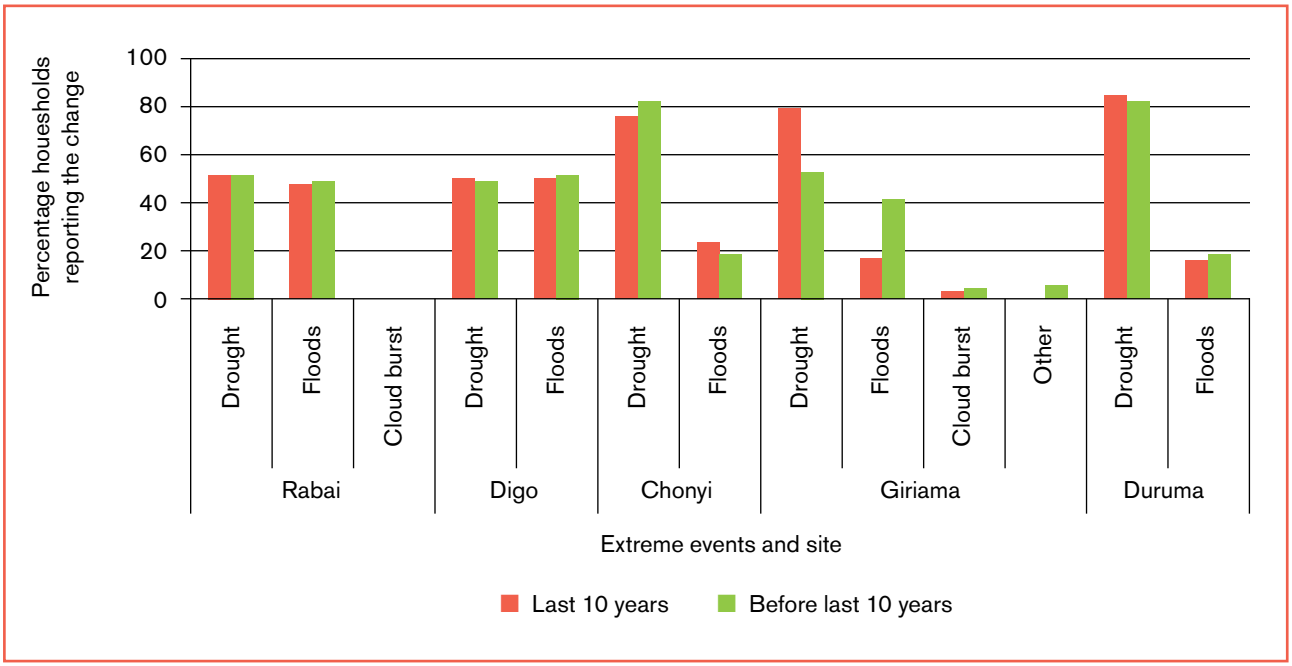
Forty years ago, the rainy seasons arrived pretty much at the same time each year. Now (in 2014) an overwhelming 96 percent of surveyed households said the rains are more variable (Table 25, and see Annexes I and II). The long rainy season now begins in March-May and ends in August, whereas in the past it began in March and ended in September. The short rainy season, which used to begin in October and end in November, no longer occurs as the region rarely receives rains during this period. However, the rainfall seasons vary across the community sites due to differences in agro-ecological zones. The inland drier areas occupied by Chonyi, Duruma and Rabai are more affected than coastal communities such as Digo and Giriama.

Drought was the most frequently observed extreme weather event both in the last ten years (between 2003 and 2012) and before the last ten years, followed by floods (Figure 20). Overall, more households reported drought in the last 10 years than the previous 10 years (significantly more in Giriama), while slightly less households reported floods. Now, as in the past, Chonyi and Duruma have the highest frequency of drought and the lowest frequency of floods. However, the intensity and frequency of drought and floods are inversely correlated – i.e. these events are more extreme where they are less common. Drought has damaged crop and livestock productivity across all the sites. As a result, the communities now depend more on alternative food sources e.g. purchase and relief programmes.

Table 25: Arrival of rainy season

SITE	DOES THE RAINY SEASON ARRIVE AT THE SAME TIME/ MONTH EACH YEAR? (%)	
	YES	NO
Rabai	0	100.0
Digo	6.0	94.0
Chonyi	11.3	88.7
Giriama	2.8	97.2
Duruma	0	100.0
Mean	6.0	96.0

Figure 20: Extreme events experienced in the last 10 years (i.e. between 2003 and 2012) and before the last 10 years (i.e. before 2003)



7.2 Key changes in staple food crops and adaptation strategies

For staple food crops (maize, cassava, cowpeas and pulses), nearly a third of households surveyed (31 percent) reported a decline in crop yield between 2003 and 2012, 15 percent reported a decline in crop quality and 16 percent reported reduced resistance to pests and diseases. They attributed this to reduced and more erratic rainfall, and high incidences of pests and diseases (Table 26). Nevertheless, 14 percent of households reported increased yields, 9 percent reported increased quality (in terms of nutritional value and taste) and 3 percent reported increased resistance. Another key change is the shorter growing season, mainly due to erratic rainfall patterns. The planting locations have also changed. Reduced soil fertility has forced the Duruma and Digo communities in Kwale County to clear more land for planting using slash and burn agriculture.

The communities have developed several local adaptation strategies to respond to the changing climate's impacts on staple food crops. These adaptation strategies vary across the communities, even for those with similar agro-ecological conditions, and depend on socio-economic status and strength of traditional governance institutions and cultural practices (Table 27). The most widely used adaptation strategy in Rabai community is prayers and sacrifices (reported by 88 percent of households surveyed), due to the solid cultural values and traditional resource governance system (*Kaya elders' council*) that connects the community to their gods. The influence of Kaya elders in Rabai remains strong compared with the other four communities. This is followed by petty trade to diversify incomes (55 percent) and reducing the number of livestock kept to create more land for crop production (37 percent).

In Chonyi, a low lying moist agro-ecosystem, households surveyed cultivate large portions of drought resilient crops such as cassava, while almost all households (93 percent) report planting early maturing and drought tolerant traditional crop varieties in order to cope with reduced and erratic rainfall. In the Digo community, a hilly moist forest ecosystem, irrigation farming and afforestation are the main adaptation strategies, reported by 67 and 21 percent of households respectively. In the semi-arid and arid Giriama community, planting of high quality self-saved landrace seeds is the main strategy employed to ensure high crop productivity. The Giriama community is highly innovative and has developed bio-pesticides from traditional herbal plants, which are used to control pests and diseases and ensure high crop productivity.

The Duruma community, which occupies a dryland area with perennial water problems, has developed an innovative method of excavating water pans within their homesteads to provide clean drinking water for livestock and reduce the spread of water-borne livestock diseases. In addition, it undertakes early planting in order to make the most of the little rainfall for crop production. Reducing the number of livestock kept was identified as adaptation strategy by some households (Table 27), even though livestock production increased overall in most communities between 2003 and 2012 (Figure 10).

Table 26: Key changes in staple food crops (maize, cassava, cowpeas and pulses) between 2003 and 2012

VARIABLE	RESPONSE (%)		
	DECREASING	INCREASING	STATIC
Yield	31.2	14.1	4.5
Quality	15.2	9.2	2.8
Characteristics	6.7	3.1	11.5
Resistance	16.1	3.1	2.8
Plant height	10.7	4.9	9.2
Planting location	4.8	9.7	19.2
Planting time	9.2	3.9	14.7
Harvesting time	2.5	3.4	12.0

Table 27: Climate adaptation strategies in each Mijikenda community

ADAPTATION STRATEGY	HOUSEHOLDS TAKING UP STRATEGY (%)				
	RABAI	DIGO	CHONYI	GIRIAMA	DURUMA
Offering prayers and sacrifices	88.2	2.9	0.0	8.8	0.0
Reducing the number of livestock kept	36.7	1.7	43.3	18.3	0.0
Use of bio-pesticides	23.7	8.8	4.6	33.5	29.4
Buying food	35.7	0.0	50.0	14.3	100.00
Afforestation	0.7	21.1	2.0	35.4	40.8
Early planting	4.9	0.0	19.5	0.0	75.6
Planting early maturing and drought tolerant traditional crop varieties	0.0	0.0	92.6	0.0	7.4
Use of traditional house to regulate temperatures	0.0	0.0	100	0.0	0.0
Cultivating big portions of drought tolerant crops	0.0	0.0	100	0.0	0.0
Planting shady trees in homes	20.0	0.0	60.0	0.0	20.0
Irrigation farming	33.3	66.7	0.0	0.0	0.0
Planting of quality seeds	0.0	0.0	0.0	100	0.0
Petty trade to diversify income sources	55.0	5.0	15.0	15.0	10.0
Excavation of water pan	0.0	0.0	0.0	0.0	100.0
Planting high quality self-saved landrace seeds	0.0	0.0	0.0	100.0	0.0

Table 28 explores the main strategies for adaptation and coping with changes in climate and related food insecurity and livelihoods challenges, for the five communities combined. Diversification of crop varieties was the most frequently reported strategy (43 percent), followed by domestication of wild food and medicinal plants (35 percent), conservation tillage (33 percent) and the use of traditional farming technologies (24 percent). Many households diversify their food sources (22 percent), and their income sources (21 percent). Modern farming technologies were adopted by 17 percent of households.

Table 28: Adaptation and coping strategies for the five communities combined

STRATEGY	HOUSEHOLDS REPORTING USE OF THE STRATEGY (%)
Diversification of crop varieties (involving both modern and traditional varieties)	42.8
Diversification of food sources	22.1
Modern farming technologies	17.1
Traditional farming technologies	23.6
Conservation tillage	33.3
Diversification of income sources	20.9
Domestication of wild food and medicinal plants	35.3
Prayers and rituals	20.0
Social networking and internet	3.6
Education and training	2.6
Light clothing and ventilation	0.9
Migration to highland areas	0.5
Seed exchange	0.5
Borrowing food	0.5

Biocultural innovations

8

8.1 Major TK-based innovations since 1982

Communities have developed and adopted several innovations (i.e. new ways of doing things) based on traditional knowledge and/or biodiversity to address climatic challenges and economic needs (particularly poverty and high cost of living). These include livelihood/market innovations, technological innovations and social/institutional innovations. Their origin, factors that led to the innovations, level of adoption and key characteristics are presented in Table 29 and Annex III. Key innovations are further described in section 9.

The most widely adopted innovation is diversifying crop varieties to reduce the risk of crop failure (reported by 43 percent of households), followed by domestication of wild plants for income, medicine and food security (35 percent), forming communal farming and marketing groups (30 percent), and reviving customary laws and practices to preserve traditional values and crop diversity (25 percent). These four innovations have been adopted by all five communities. Wild plant domestication is mainly to generate income from the sale of food and herbal products, but also helps conserve important species.

Village banking was the most embraced livelihood innovation, involving 14 percent of surveyed households. This innovation helps people diversify their income sources and provides socio-economic security in case of emergencies. Village banking is not itself TK-based but is used to market traditional products. Farmers from different communities have also come together to form marketing groups: 10 percent of surveyed households are involved in these in order to access regional markets and fetch competitive prices for their products. In addition, various communities are innovating by adding value to traditional/local food crops and products such as cassava, sweet potatoes and fruits, or selling handcrafts (reported by 13 percent of households).

The reasons for introducing the innovations varied across the five Mijikenda communities (Annex III). However, social and cultural needs, economic and market needs and crop failure were the main reasons why the communities developed various innovations. Ecological risks, accidental discovery and experimentation were the least reported triggers for innovations.

Table 29: Innovations developed by the Mijikenda community

TYPE OF INNOVATION	INNOVATION	COMMUNITY/SITE	ORIGIN OF THE INNO-VATION	REASONS/FACTORS THAT LEAD TO THE INNOVATIONS	HOUSEHOLDS REPORTING ADOPTION (%)
Livelihood/ Market	Village banking*	Rabai, Digo, Giriama, Chonyi and Duruma	Community	Economic empowerment	13.7
	Use marketing strategies to sell products*	Rabai, Chonyi, Giriama	Community	Increased profitability	10.0
	Distribution/sale of products nationally*	Rabai, Digo, Giriama, Chonyi and Duruma	External	Increased profitability	13.0
	Revival of traditional market	Chonyi and Giriama	Community	Preservation of indigenous crops and products	13.8
Technological	Re-introduction of traditional farming methods	Rabai, Digo, Giriama, Chonyi and Duruma	Community	Conservation farming	23.6
	Planting large areas of resilient crop varieties such as cassava and maize	Rabai, Digo, Giriama, Chonyi and Duruma	Community	Increase production	21.7
	Combination of herbal plants to treat livestock diseases	Giriama and Duruma	Community	Improve livestock health	10.0
	Domestication of wild food and medicinal plants	Rabai, Digo, Giriama, Chonyi and Duruma	Community	Economic benefit, medicinal and food security	35.3
	Planting diversified varieties of the same crop in the same piece of land in a single season	Rabai, Digo, Giriama, Chonyi and Duruma	Community	Insurance against risks posed by climate change	42.8
	Preservation of land races in communal seed banks	Rabai	Community	Conserve land races	10.0
	Value addition of traditional crops and products	Giriama, Rabai, Duruma	Community	Enhance economic benefit	13.0
Social/ institutional	Free seed exchange	Rabai, Digo, Giriama, Chonyi and Duruma	Community	Conserve land races Enhance cohesion	17.17
	Formation of communal farming and marketing groups	Rabai, Digo, Giriama, Chonyi and Duruma	Community	Economic benefit Enhance cohesion	30.0
	Formation of cultural centers	Rabai and Giriama	Community	Conservation of cultural practices and enhance cohesion	8.5
	Revival/preservation of customary laws and practices	Rabai, Digo, Giriama, Chonyi and Duruma	Community	Preservation of traditional values Conservation of agrobiodiversity	25.0
	Preservation of community registers	Giriama and Rabai	Community	Preservation of indigenous knowledge	15.0

*These market innovations are not themselves TK-based but are being used to market biocultural products

8.2 Level of innovation adoption

The study assessed the level of adoption of both modern and traditional knowledge-based innovations for enhancing resilience to climate change. Domestication of wild food and medicinal plants (35 percent) was the most widely adopted innovation in all the communities. This was followed by new cropping practices that build on traditional knowledge/varieties[5] (23 percent of households overall, see Table 30), re-introduction of traditional crops (19 percent), use of modified tools and drip irrigation (15 percent), and re-introduction of traditional farming methods (12 percent) which were all geared towards enhancing food security. Seed exchange and protection of crops in seed banks and preservation areas were the least adopted innovations, at 2 and 1 percent respectively.

8.3 Contribution of traditional and external knowledge to innovations

Most innovations were influenced by a combination of both traditional and scientific knowledge, or by TK alone, while a few were influenced by science or modern knowledge alone (e.g. marketing innovations). Traditional knowledge-based innovations that were widely applied in the various communities include revival of customary laws and practices. External knowledge based on modern science has helped to further develop TK-based technological innovations which has led to their wider adoption by communities. The aggressive promotion of science-based innovations by agricultural research organizations has resulted in the spread of modern farming practices and crops, although the communities still use traditional farming methods as

Table 30: Level of innovation adoption

CROP BIODIVERSITY, FARMING PRACTICES/ INNOVATION ITEM	OVERALL PERCENTAGE OF HOUSEHOLDS ADOPTING INNOVATION (%)
Free seed exchanges	2.1
Drip irrigation of crops	14.5
Growth of GM crops	10.0
Protection of crops in seed banks or preservation areas	1.0
New cropping practices that build on TK	23.0
Domestication of wild food and medicinal plants	35.0
New/modified tools	14.5
Re introduction of traditional crops	19.3
Re introduction of traditional farming methods	23.6
Improved/ more resilient crop	9.0
Growth of modern hybrids	11.4

[5] These are: planting large areas of resilient crop varieties such as cassava and maize, planting diversified varieties of the same crop in the same piece of land in a single season, and domestication of wild food and medicinal plants.

well. Innovations influenced by both traditional and external knowledge include the formation of self-help groups, farmers' and marketing groups, and the development of traditional knowledge-based benefit-sharing mechanisms for income generated from table banking. The latter is a group funding strategy where members meet once a month, place their savings, loan repayments and other contributions on the table and then provide loans to interested members. The Mijikenda communities have developed a constitution guiding the management of such funds, including how to share income generated.

8.4 Importance of innovations to community wellbeing

Market innovations such as marketing strategies, distribution and sale of products nationally and village banking have played important roles in increasing incomes and access to financial services. Technological innovations such as planting diverse varieties in the same piece of land, preserving landraces in communal seed banks and domesticating wild plants, have contributed to agrobiodiversity conservation and increased agricultural productivity, bolstering food security. Social and institutional innovations, such as forming farming and marketing groups, and reviving and preserving customary laws and practices, have enhanced social cohesion and helped preserve indigenous knowledge and traditional values for natural resource management.

In terms of the areas where further innovation is most necessary for household well-being, community members identified confronting climate change (19 percent of households), marketing and sale of biocultural products (18 percent), economic growth (16 percent), maximizing agricultural production (15 percent), and reduction in the cost of living (13 percent). Integration in national and international economies and 'models of community participation' were identified by 10 percent of households surveyed (Table 31).

Table 31: Areas where innovations are most needed for well-being

AREAS INNOVATION ARE MOST NECESSARY FOR THE WELL-BEING OF THE HOUSEHOLD	RESPONSE (%)
Maximizing agricultural production	14.8
Economic growth	15.5
Confronting climate change	18.6
Marketing/product sales	17.6
Models of community participation	10.0
Integration with national and international economies	10.0
Reduced cost of living	13.6

Exploring key innovations and innovation factors

9

This section presents a summary of the findings of the qualitative baseline study on biocultural innovations and the social factors/conditions that support innovation. More details can be found in the report of the SIFOR qualitative baseline study (Ongugo et al., 2015)[6]

9.1 Technological innovations

Planting diverse varieties of the same crop to reduce risk of crop failure: Farmers in all five communities plant different varieties (traditional, improved and hybrid) of the same crop, especially maize and cassava. The traditional varieties usually take longer to mature but can tolerate pests, diseases and dryness. Both the improved and hybrid varieties mature fast but cannot tolerate pests, diseases and extended dry periods. These combinations give security in the case one variety fails. This innovation was developed by farmers in recent decades in response to increased crop pests and diseases and reduced rainfall. It has been promoted through peer learning and information sharing during community meetings, and traditional festivals and ceremonies.

Combining modern and traditional tilling practices to enhance productivity: Instead of using small traditional hoes, local farmers from all the five communities have adopted big hoes that dig deeper. Some farmers also use ox ploughs and those who can hire tractors to plough their farms. The farmers then plant traditional maize varieties such as *Kanjerenjere* using farm yard manure. They have realized that these varieties do very well when they plough the farms well and add manure. Good ploughing aids aeration and manuring add nutrients and increases water holding capacity. Indeed, traditional varieties require less water than hybrids. This innovation has largely been developed through linkages with other communities and external organizations whereby improved farming technologies were learnt and the information shared amongst community members.

Changes in farming practices to enhance soil fertility: Farmers are adopting new locally developed farming practices as well as modern farming methods to respond to low productivity. Traditional planting methods like broadcasting are being replaced by line planting for crops like maize and cowpeas. Farmers also weed their crops early (immediately after germination) to reduce diseases. The community has taken up planting of nitrogen fixing trees with food crops (agro-forestry) to improve soil fertility. These changes in practice are aimed at responding to the effects of climate change and improving crop productivity. Using animal manure instead of adding nutrients through slash and burn avoids killing microorganisms that decompose organic matter in the soil. Some farmers also make their own compost manure.

Planting large quantities of cassava in response to drought: Farmers have discovered that it is safer to allocate more land to cassava than maize as cassava can tolerate drought better. In the past, cassava was never planted in large quantities. Planting more cassava helps ensure that the farmers have food even in dry periods. Frequent hunger and drought necessitated this innovation, which has spread to all the Mijikenda community through peer learning and information sharing, through established networks such as traditional festivals. Consequently food security has improved.

Domestication of various wild forest plants for increased income: Domestication of plants as an innovation has largely been driven by the need to diversify community incomes due to massive crop failure, as well as by the increased incidences of crop pests and diseases that necessitate development of local remedies. Wild plants like *Lilium orientale, Tamarindus indica, Ancylobotrys petersiana, Ladonpholia kirkii* and *Sisyphus mauritiana* have been domesticated for their fruits, which are usually sold for income. These plants can tolerate prolonged dry periods, ensuring farmers have a source of income in case of crop failure. Other wild crops like *Adansonia digitata* are not usually domesticated but the fruits are sold either raw or after value addition through sweetening. Plants like *Monanthotaxis fornicate*, *Oldifieldia somalensis*, *Fernandoa magnificia*, *Acacia melifera* and *Salvadora persica* have been domesticated by herbalists because of their medicinal value.

Farmers obtain the propagative materials from the forest and raise the seedlings in their nurseries before planting them in their farms. Initially, the plants lacked propagation protocols because no scientific research had been conducted to propagate such plants. However, the farmers (in groups and individually) have come up with propagation protocols using cuttings, seeds and wildings, after trying several methods. By domesticating them, the pressure on the forests and biodiversity is reduced, and these species are conserved despite forest degradation resulting from climate change.

[6] http://pubs.iied.org/G03830/

The Duruma community is now domesticating the Doum tree (*Hyphaene compressa*), which often grows in riverine areas. The species has recently become rare in the area following massive deforestation, but is in demand for use in weaving and basketry. Farmers undertaking commercial weaving and basketry at cottage level have domesticated it on-farm as a source of raw materials. The species is also important for construction of traditional Duruma houses. This domestication innovation has been in use for the past 20 years and has provided both economic and social benefits to the community through income generation, provision of cheap roofing materials and by sustaining biodiversity.

Planting coconuts with the soft spot facing downwards to reduce termite attack: A coconut fruit has three spots (eyes) at the top of the fruit: one that is soft and often releases water when pierced, and the other two that are very tough and almost impossible to pierce. The side with the soft spot often appears bigger and protruded. In this innovation, the coconut seed is planted with the soft spot lying downwards in the soil in a slanting position which leads to faster germination. This method was invented about three years ago by an individual farmer in Rabai community as a remedy against increasingly frequent termite attacks on planted coconut seeds (possibly linked to recent climatic changes). The faster germination has helped minimize the period of termite attack. This has in turn ensured faster growth and high productivity of coconut fruits.

Planting and uprooting of cassava first to turn the soil and preserve nutrients: Cassava is planted on large areas and the deep rooted plants are harvested, leaving the entire farm soil turned and well mixed, ready for the following crop. This method ensures that all soil nutrients are preserved and soil texture is maintained. It was invented by the forefathers – and has since been used as an alternative to ploughing. It ensures high crop productivity and is a cheaper and time saving alternative to conventional means.

Using young pruned cassava tops (Matagaa) as planting materials for early maturing cassava: This innovation was developed by an individual farmer through trial and error about five years ago. He noticed that the young cassava pruning tops that fell on the ground soon after pruning sprouted very fast and grew much faster than the original plant. While the original plant would take 18 months to mature and would only produce about 2–3 tubers, the pruned cassava tops matured in 12 months and had about 10–12 tubers. This innovation is fast spreading to neighbouring villages, through linkages with other communities and information exchange events such as field days and farmers' innovation fairs (e.g. organized by KARLO and KEFRI). Faster maturation has helped to circumvent rainfall shortages.

Use of fresh coconut wine (Mnazi) as yeast to reduce costs: This innovation was discovered by some tappers' wives who decided to add freshly harvested palm wine to their wheat flour mixture in preparation for cooking, and realised that it has leavening and flavour building properties just like yeast. This knowledge has since been shared among members of the Rabai community mainly through peer learning and traditional events and has been in use for twenty five years. The innovation was developed as a cheaper and more locally available alternative to conventional yeast commonly used in cooking and baking pastries such as cakes, doughnuts, biscuits and *Mandazi*. It has contributed to food security by making it cheaper to make bread-like pastries, and is considered healthier than conventional yeast, which community members claimed causes stomach upsets for some people.

Using seed storage sacks as cooking seats to prevent insect attack: This innovation was developed by female farmers in the Digo community and has since spread to the entire community. Seeds, mainly from grains, are dried and stored in a sack that is tightly tied and placed in front of the traditional fireplace and used as a seat by women when cooking. The combination of high temperatures and friction from movement during cooking prevents insects from attacking the seeds. Maize seeds can be preserved for up to twelve months before planting, while cowpeas, groundnuts and green grams seeds can be preserved for one year. In recent years, rising temperatures have increased the range and severity of crop pests and insect borers that attack harvested grains. This innovation provides an effective way to store harvested food reserves for longer periods.

Treating livestock wounds and diseases with effective TK-based innovations: Farmers in Giriama have discovered that fresh donkey dung has medicinal value and can be used to treat Newcastle disease in chickens. The dung is mixed with water and then squeezed through cloth to obtain a filtrate. The filtrate is mixed with maize bran and fed to chickens infected with *Kideri*. This is believed to cure the disease within a week. The donkeys usually graze in the wild and it's believed that some of their forage has medicinal value that can be found in the dung. The community has traditionally used the droppings from the cattle and goats which graze or browse in the wild to treat livestock wounds. The droppings are dried, then ground to a powder and mixed with coconut oil, and applied on the wounded area. It is believed that the droppings have

some antiseptic value. They also use sea shells to treat eye infection in cattle and have confirmed this to be a successful treatment. The shells are usually crushed to powder and applied to the infected eye. Although dung filtrate and animal droppings have been widely used to cure livestock diseases traditionally, mixing dung filtrate with maize bran, and animal droppings with coconut oil, are new technological innovations aimed at better-treating livestock diseases that are thought to be on the rise because of climatic changes.

Among the Duruma community, the bark of *Msinduzi* tree is used to treat wounds in livestock. The bark is dried, crushed and sprinkled on wounds. This innovation was developed by elders through trial and error many years ago and is used as an affordable but effective and locally available treatment for livestock wounds.

Digging livestock water pans in homesteads to improve animal health: This innovation from the Duruma community was first developed by a few livestock farmers from Mwalukombe village in Kinango District about nine years ago. Kinango district is a semi-arid area that is often faced with acute drought. As a result, livestock often trek for long distances in search of drinking water and pasture. This has often reduced animal health. At the same time, disease transmission from shared water points has become rampant. The innovation was developed to provide safe drinking water within the homestead. It has since been embraced by other farmers, who emulate the idea after seeing the benefits.

9.2 Market and institutional innovations

Rabai cultural village: *Kaya Mudzi Muvya* forest is one of the five *Kayas* of the Rabai community. It faces a major threat due to rapid socio-economic and cultural changes, coupled with growing human demand for forest products and land for farming due to declining agricultural productivity and farm incomes. As a result, there has been encroachment into the forest. Thus, the Rabai community through collective action has created a Cultural Village adjacent to *Kaya Mudzi Muvya* forest as an alternative source of income and to ensure Rabai cultural practices are not lost. The cultural village provides a central venue for showcasing Rabai cultural ceremonies, rituals and agrobiodiversity related practices. Traditional huts have been built in the layout of a traditional Rabai village, including a traditional spiritual healer's hut, a shrine where evil spells are expelled, a traditional granary, a typical Rabai kitchen as well as an area where traditional crops like cowpeas and sweet potatoes are cultivated.

The cultural village has brought together different groups involved in traditional dancing or exhibiting cultural practices. It has enabled the community to diversify and increase their income sources. The community has adopted dances from other Mijikenda tribes and modified them using different traditional instruments and genders. This has made the village an attractive place to visit to both local and international tourists. It has also allowed the community to network by exchanging planting materials of traditional crops. The cultural village has largely been promoted through cultural festivals coordinated by Kaya elders.

The cultural village is an institutional innovation as well as a market innovation. Pregnant women, men and women who have engaged in sexual intercourse the previous night, women in monthly period and young babies of less than six months are usually not allowed to enter the *Kaya*. The cultural village means these people can access services like healing, fore-telling and removal of spells otherwise done in the *Kaya*. It means everyone can experience the different ceremonies, dances and games of the Rabai community.

9.3 Factors supporting biocultural heritage-based innovations

This section explores social and cultural factors or conditions that support biocultural heritage-based innovations to meet agro-climatic and economic needs (e.g. poverty and high cost of living).

Social factors

The social factors that support biocultural innovations include people/innovators, institutions/organizations, networks and community. A number of individual farmers have developed technological innovations to enhance productivity which they are freely sharing with other farmers in their vicinity. Examples include the male cassava farmer in Rabai who developed a new propagation method to ensure early maturity and increased yield, and the female farmer from Digo who preserves maize seed in a sack near the fire place.

Traditional institutions such as the Kaya elders' council are key in supporting innovative practices among the five communities. The local rules and regulations used by Kaya elders to govern help to preserve the communities' cultural practices and traditional knowledge and promote TK-based innovations. Furthermore, community based groups/organizations such as herbal groups, women's groups and farmers' groups promote social cohesion and information exchange, which supports

local innovation. They also provide a broad network for exchanging knowledge, skills and a range of planting materials (seeds, suckers etc.) for crops and other plants. The various traditional ceremonies and festivals provide a further community level network and are therefore important for promoting local innovation.

Cultural factors

An additional qualitative survey was conducted in late 2014 to explore the role of cultural values in innovation – notably solidarity, reciprocity, equilibrium and collectiveness. Solidarity was defined as togetherness or unity among people with a common interest; and reciprocity as equal exchange or mutual cooperation between people and nature. Equilibrium was defined as a state of balance between people and nature; while collectiveness was defined as the state of togetherness amongst members of the community. Key informants, including Kaya elders, herbalists and village elders were interviewed, and one focus group discussion was held in each of the five communities.

Role of cultural values in innovation: The study revealed that the cultural values of solidarity, reciprocity, equilibrium and collectiveness play an important role in binding the community and hence promoting development, innovation and adaptation to climate change through exchange of ideas. Cultural ceremonies, such as offering of prayers and sacrifices, traditional songs and dances, dowry payments, wedding and funeral ceremonies bring all members of the community together, enhancing solidarity, collectiveness and harmony, which promote the development and spread of innovations. Rabai has the highest level of collectiveness owing to their strong cultural values; while Chonyi has the least collectiveness mainly due to the high number of people migrating to urban areas to seek for employment. Perhaps because of their strong collective identity, the Rabai community has come up with unique innovations, key among them being the cultural village. The study on cultural values also established that women's participation in collective activities was higher in all the communities compared to men, young and the old whose participation was low. Women play an important role in collective activities such as seed exchange and traditional ceremonies such as funerals, weddings and traditional songs and dances – and hence in traditional knowledge-based innovation.

Role of culture in biodiversity conservation: Biodiversity conservation is deeply entrenched in the cultural values of the Mijikenda community and the Kaya forests play an important role in supporting cultural values and conserving wild species for biocultural innovation (e.g. domestication of medicinal and food plants). Most traditional ceremonies are associated with natural resources, and they play an important role in conserving agrobiodiversity. Traditional prayers and sacrifices aimed at appeasing the spiritual world, for example, use grains of landrace varieties such as mustard, millet, sorghum and maize and indigenous animal breeds such as cattle, sheep and chicken. The significance of these varieties in traditional ceremonies has led to their conservation in all the communities. Most traditional healing ceremonies use various plant parts. Furthermore, traditional resource governance systems such as the Kaya elders' institution have been used to conserve important plant species and the sacred Kaya forests, where the ceremonies usually take place.

Various farming activities in the agricultural calendar are associated with traditional ceremonies. For instance, before planting seeds, Kaya elders offer prayers and sacrifices, requesting the spiritual world to bless the seeds and grant the community a bounty harvest. After harvesting, thanksgiving prayers are also offered. Seeds stored after harvests are often used to perform traditional rituals aimed at averting disasters such as crop failure, animal and human diseases.

Traditional knowledge regarding physical coping strategies, agriculture, seed management, weather prediction, oral legends and Cosmo-vision is equally and openly shared amongst members of the community through various methods. These include traditional ceremonies that bring members of the community together, mentoring of girls by elderly aunts and grandmothers, and mentoring of boys by uncles and grandfathers. However, traditional knowledge is slowly being lost, especially among the young, due to the influence of other religions and modern culture and education.

The relationship between culture and climate change: The Mijikenda communities are increasingly employing traditional farming technologies in order to improve agricultural productivity in the face of climate change. They are planting early maturing and drought tolerant landrace varieties together to enhance productivity amidst recurring drought. Some communities, such as the Giriama, have resorted to planting larger areas of resilient traditional crop varieties that are more productive during drought (such as cassava), in order to enhance food security and incomes. Other traditional coping strategies used by different Mijikenda communities to varying levels include crop rotation, planting several crop varieties at a time, conservation tillage,[7] and bio-pesticides. Communities also use 'bio-cosmological indicators' – mainly plant and animal behaviour – to predict climatic patterns in order to effectively adapt and cope with the effects of climatic changes.

However, recent climatic changes have also undermined some cultural aspects of community life. For instance, the decline in livestock and crop production has resulted in less sharing of resources, reducing community collectivity. In the past, clan members used to donate livestock for a bridegroom's dowry payments. Now, only the immediate family members contribute because fewer livestock are kept. Similarly, it was common practice to share crop produce after harvest, but this has declined. Traditional festivals, such as funerals, that previously brought people together for longer periods of time, have been constrained by food scarcity.

Poor harvests have forced people to migrate far away from their original communal land in search of fertile land for cultivation, hence weakening the community's collectiveness and solidarity. Furthermore, land subdivision has threatened collective farming practices as people now farm on individual parcels of land. These factors have restricted social cohesion and consequently constrain the development and spread of innovations.

[7] Meaning soil cultivation that leaves the previous year's crop residue (such as corn stalks or wheat stubble) on fields before and after planting the next crop, to reduce soil erosion and runoff.

Conclusions and recommendations

10

The findings show that that role of crop production as the main source of income declined between 2003 and 2012, due to reduced productivity attributed to changes in climate, notably prolonged dry periods and increased pests and diseases. Consequently, the Mijikenda communities have adopted alternative livelihood sources such as small businesses (particularly motorcycle transport) and labour in urban areas. However, crop production remains an important livelihood activity for both income and food security. Men's involvement in farming activities has decreased, due to income diversification and labour in urban areas, but men still play a greater role than women in crop production and sales.

Net income increased in most of the communities between 2003 and 2012 due to income diversification (e.g. tourism), except in Duruma where expenditure rose to exceed income because long drought periods pushed up food prices. Duruma is the driest community which has been most affected by drought in recent years. Communities near towns have benefited from growing demand for their crops due to decentralization and tourism. In Digo, staple food crop prices are high because much land previously under food crops has been taken over by the Kwale International Sugar Company.

Food self-sufficiency declined considerably between 2003 and 2012 (by about 50% for staple foods) because of low crop and livestock productivity, attributed to changes in climate. Most of the yield for the main food crops is for self-consumption, except in Chonyi, where the proportion taken to markets is higher, as it is near Kilifi town where market prices are higher. The number of livestock kept has increased overall and livestock is increasingly used for self-consumption, except in Duruma where livestock production for market has become a major source of income since crops are increasingly hard to grow. The main coping strategy during periods of food shortages are financial loans, food loans and additional work to buy food, but these strategies have compromised nutrition: most people in these communities eat to survive.

Although based on farmers' perceptions and recall, the findings clearly show that there have been changes in climate between 1982 and 2012. Of the households surveyed, 95 percent reported an increase in extreme weather events, 90 percent reported increased temperature and drought, 89 percent reported stonger sunshine, 82 percent reported a rise in animal and crop diseases, and 78 percent reported decreased rainfall. The drier inland communities (Chonyi, Duruma and Rabai) have been more affected by changes in rainfall than those on the coast (Digo and Giriama). This has clearly affected crop production – over a third of households reported a decline in staple crop yields since 2003.

Adaptation strategies vary across the communities, depending on agroecological, socio-economic and cultural conditions. In Chonyi, a low lying moist agro-ecosystem, the community cultivates large portions of drought tolerant cassava landraces and early maturing varieties to overcome challenges associated with reduced and erratic rainfall. In Digo, a hilly moist forest ecosystem, irrigation farming and afforestation are the main adaptation strategies. In the semi-arid Giriama community, planting of high quality self-saved landrace seeds is the main strategy to sustain crop productivity. In Rabai, where the influence of Kaya elders remains strong, offering prayers and sacrifices is a key coping strategy. The communities have also developed effective bio-pesticides from medicinal plants to control crop and livestock pests and diseases. Overall, crop diversification (using both modern and traditional varieties) was the most frequently reported strategy for coping with climate change (43 percent of households surveyed), followed by domestication of wild food and medicinal plants for income (35 percent), and conservation tillage (33 percent). More households reportedly use traditional farming technologies for adaptation (24 percent) than modern farming technologies (17 percent).

The study found that more households are still growing landraces than hybrids for the two main staple crops – maize and cassava. However, landrace cultivation has fallen substantially from 100% of households in 1982, to 70 percent for maize and 52 percent for cassava in 2012. The loss of traditional varieties reached a peak in 2004 due to the promotion of modern varieties and practices by agricultural research organisations, but has slowed since then as hyrbids and introduced varieties began to have more pests and diseases, did not perform well under frequent drought and needed high levels of inputs for production.

Despite fast growth and big seeds, farmers considered hybrids to have low productivity because they are susceptible to drought, pests and diseases, and rated them poor in taste. Drought tolerance was the main reason cited for conserving crop diversity (by 63 percent of households). Communities often self-save landrace seeds and women play a key role in this, while hybrid seeds are largely purchased in markets by men. Overall, purchased seed was the main seed source (55 percent of households), followed by self-saved seed (27 percent).

Biocultural innovations

It is clear from the surveys that traditional knowledge, biodiversity and cultural values play an important role in innovation for adaptation to climatic changes in the Mijikenda community. The five communities have developed and adopted a number of biocultural innovations– mainly technological, but also market and institutional innovations. These vary from community to community depending on cultural, ecological and socio-economic conditions.

The most widely adopted innovations were planting diverse varieties of the same crop together (43 percent of households), domestication of wild foods and medicinal plants (35 per cent), formation of communal farming and marketing groups (30 per cent), revival of customary laws and practices (25 per cent) and re-introduction of traditional farming methods (24 per cent). Technological innovations such as crop diversification and domestication have increased agricultural productivity, while institutional innovations have enhanced social cohesion and helped to sustain traditional knowledge for natural resource management. Some innovations have proved very effective – e.g. planting pruned cassava tops has shortened maturation times by a third and quadrupled yields.

Diversifying income sources and village banking have also helped to alleviate poverty and improve food security. The formation of a Rabai cultural village has strengthened cultural identity, conserved resilient landraces and enhanced incomes and community networking. Rabai has been highly innovative in developing adaptation strategies because it has solid cultural values and traditional resource governance system (*Kaya elders' council*) that connects the community. The Duruma community which occupies a dryland area with perennial water problems, is the most active in crop variety improvement and has developed several innovations. The Giriama community (in a semi-arid area) is also highly innovative and has developed bio-pesticides from traditional herbal plants to control pests and diseases and ensure high crop productivity.

Traditional institutions such as Kaya elders' councils are important for sustaining traditional knowledge and biodiversity and promoting collective activities for innovation. Community groups and cultural ceremonies bring people together, promote information exchange, sharing of ideas and networking, and reinforce cultural values of solidarity, collectiveness and harmony that promote innovation. Integrating science/external knowledge with traditional knowledge is also important to develop innovations that enhance productivity, and to enhance the quality and marketability of biocultural products.

However, traditional knowledge and cultural values are becoming weaker due to modern culture, religion and education and out-migration of youth. Participation of youth in traditional festivals is low. Recent climatic changes and food shortages have also reduced sharing of resources and participation in traditional festivals. There has been a steep decline in the percentage of households that speak native languages since 1982.

Recommendations

This study shows that traditional farming technologies are as important for adaptation to climate change by Mijikenda communities as modern farming technologies, if not more so. Yet they receive very little formal investment and support. We therefore recommend that:

1. **Policies and laws that safeguard traditional knowledge, innovations and genetic diversity** should be implemented to enhance the adaptive capacity of vulnerable communities. The Convention on Biological Diversity, which has been ratified by Kenya, requires Parties to 'respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities'. Kenya has also ratified the FAO Treaty on Genetic Resources for Food and Agriculture which requires the protection of Famers' Rights to genetic resources and traditional knowledge through national legal and administrative measures. Kenya's new law on traditional knowledge should be implemented by county governments, with the participation of local community custodians of traditional knowledge and genetic resources.
2. **Capacity building for value addition to traditional products** should be supported to increase incomes of local communities and create incentives for sustaining biodiversity and TK. This would also help to revitalize traditional cultural identity, and engage youth, since it offers a vision of development which embraces both modern and traditional knowledge for maximizing livelihoods.
3. **Mijikenda traditional institutions and collective landscape governance** should be strengthened to stem the loss of traditional knowledge and biodiversity resources. This could be done by establishing Biocultural Heritage Territories that can also serve to generate income from biocultural products and services and low impact tourism. The Rabai cultural village could provide the basis for establishing a biocultural territory for integrated landscape management.

4. **Exchange of traditional knowledge, seeds, innovations and technologies** among Mijikenda communities and indigenous people should be supported by governments, NGOs and others, to spread appropriate and effective innovations and strengthen customary institutions, for food security and climate adaptation.
5. **Agricultural policies and research and extension services** should recognize the value of landraces and traditional knowledge, and ensure these are conserved in-situ to sustain processes of crop evolution and co-evolution and provide options for future adaptation and plant breeding.
6. **Climate smart agriculture programmes should support resilient local landraces** and livestock breeds, and prioritise biodiverse agroecological approaches in risk prone areas for stable productivity and multiple co-benefits.
7. **Participatory Plant Breeding should be supported to tailor crop breeding** to the particular needs of Mijikenda farmers, develop new varieties that are both more resilient and higher yielding, conserve resilient local varieties, enhance the protection of farmers' rights and promote agroecological practices with reduced external inputs. PPB should be mainstreamed in agricultural policies and research and extension services, particularly in marginal areas. PPB involves active farmer participation at each stage of the breeding process, not just in varietal selection, and empowers farmers to become active crop breeders for climate adaptation. It is also a faster and cheaper alternative to conventional crop breeding (Ceccarelli et al, 2009).

References

Ansari, S, et al. (2012) Impact at the bottom of the pyramid: the role of social capital in capability development and community empowerment. *Journal of Management Studies* 49: 4, June 2012.

Ceccarelli, S, et al. (eds) (2009) Plant breeding and farmer participation. FAO, Rome.

Creswell, J. W., and Plano Clark, V. L. (2007) Designing and conducting mixed methods research. Thousand Oaks, CA: Sage.

Enete, A.A. et al. (2011) Indigenous agricultural adaptation to climate change: study of Southeast Nigeria. Africa Technology Policy Studies Network (ATPS); Research Paper Number 6.

FAO (2002) Food security: concepts and measurement paper for FAO expert consultation on *Trade and food security: conceptualizing the linkages*. Rome, 11th -12th July 2002

FAO (2006) Food Security [policy brief]. Rome, Italy: Food and Agriculture Organization. Retrieved May 23, 2015, from ftp://ftp.fao.org/es/esa/policybriefs/pb_02.pdf.

FAO (2009) International Treaty on Plant Genetic Resources for Food and Agriculture. Rome, Italy.

FAO (2013) The State of Food Insecurity in the World 2013. The multiple dimensions of food security. FAO, Rome.

Grainger-Jones, E. (2011) IFAD Occasional Paper 3. Climate-smart agriculture: what's different?

Intergovernmental Panel on Climate Change (2014a) Fifth Assessment Report, Working Group II. Impacts, adaptation and vulnerability: Part A global and sectoral aspects.

Intergovernmental Panel on Climate Change (2014b) Climate Change 2014: Synthesis report. contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

IUFRO (2014) International Union of Forest Research Organizations Annual Report. 26 pp.

Jiri, O., et al. (2015) Indigenous knowledge systems, seasonal quality and climate change adaptation in Zimbabwe *Inter-Research Climate Research*: 66:103–111.

Mercer, J. et al. (2010) Framework for integrating indigenous and scientific knowledge for disaster risk reduction. *Disasters* 34 (1): 214–239.

Ongugo, P, et al. (2014) *Smallholder Innovation for Resilience*: *Qualitative Baseline Study, Mijikenda Community, Kenyan Coast*. International Institute on Environment and Development. http://pubs.iied.org/G03830

Portes, A. (1998). Social capital: its origins and applications in modern sociology. *Annual Review of Sociology* 24: 1–24.

Republic of Kenya (2013a) Kilifi County First County Integrated Development Plan 2013–2017.

Republic of Kenya (2013b) Kwale County First County Integrated Development Plan 2013–2017.

UNFCCC (2007) Climate change: impacts, vulnerabilities and adaptation in developing countries. UNFCCC Report, Bonn Germany. https://unfccc.int/resource/docs/publications/impacts.pdf.

Wekesa, C, et al. (2015) Traditional knowledge based innovations for adaptation and resilience to climate change: the case of coastal Kenya. XIV World Forestry Congress, Durban, South Africa, 7–11 September 2015.

Wekesa E, et al. (2003). Adoption of Maize Production Technologies in the Coastal Lowlands of Kenya. Mexico, D.F.: Kenya Agricultural Research Institute (KARI) and International Maize and Wheat Improvement Center (CIMMYT).

Annexes

Annex I: Changes in arrival of long rainy season

SITE	MONTH WHEN LONG RAINS BEGIN	MONTH WHEN LONG RAINS END	HOUSEHOLDS THAT RESPONDED (%)				
			2012	2000	1990s	1980s	1970s
Rabai	March	July	–	25.0	25.0	25.0	25.0
		August	18.5	20.5	20.5	20.5	19.9
		September	16.7	19.4	19.4	25.0	19.4
	April	July	27.3	18.2	18.2	18.2	18.2
		August	26.3	18.9	18.9	17.9	17.9
		September	20.8	20.8	20.8	16.7	20.8
		October	–	–	33.3	33.3	33.3
	May	October	–	100.0	–	–	–
Digo	January	April	–	–	100.0	–	–
		May	–	–	–	–	100.0
	February	May	–	6.3	6.3	37.5	50.0
		June	2.7	2.7	24.3	37.8	32.4
		July	–	–	–	100.0	–
	March	May	–	–	25.0	37.5	37.5
		June	5.1	5.1	28.2	34.6	26.9
		July	36.8	36.8	21.1	5.3	–
		August	–	–	100.0	–	–
	April	June	38.9	38.9	16.7	5.6	–
		July	39.3	39.3	18.8	2.7	–
	May	August	20.0	20.0	20.0	20.0	20.0
Chonyi	March	July	6.0	23.8	32.5	30.5	7.3
		August	–	18.0	36.1	39.3	6.6
	April	June	100.0	–	–	–	–
		July	65.8	32.9	1.4	–	–
		August	80.0	20.0	–	–	–

SITE	MONTH WHEN LONG RAINS BEGIN	MONTH WHEN LONG RAINS END	HOUSEHOLDS THAT RESPONDED (%)				
			2012	2000	1990s	1980s	1970s
	January	June	100.0	–	–	–	–
		July	–	–	–	–	100.0
	February	April	50.0	50.0	–	–	–
		May	–	–	100.0	–	–
		July	–	2.8	11.1	30.6	55.6
		August	–	–	–	14.3	85.7
		September	–	–	–	–	100.0
	March	May	–	50.0	50.0	–	–
		June	57.1	14.3	–	14.3	14.3
		July	3.4	23.3	33.5	25.0	14.8
		August	–	18.8	25.0	31.3	25.0
		September	33.3	–	–	33.3	33.3
		December	–	25.0	25.0	25.0	25.0
	April	April	50.0	50.0	–	–	–
		May	50.0	50.0	–	–	–
		June	83.3	16.7	–	–	–
		July	32.4	37.8	10.8	8.1	10.8
		August	62.5	25.0	–	6.3	6.3
		November	100.0	–	–	–	–
	May	May	100.0	–	–	–	–
		June	100.0	–	–	–	–
		July	75.0	25.0	–	–	–
		August	100.0	–	–	–	–
	July	July	–	–	33.3	33.3	33.3
	August	April	100.0	–	–	–	–
		June	50.0	50.0	–	–	–
	November	January	–	100.0	–	–	–
		December	50.0	–	50.0	–	–
Duruma	March	July	–	–	–	100.0	–
		August	–	23.1	26.0	23.7	27.2
		September	–	–	100.0	–	–
	April	April	100.0	–	–	–	–
		June	100.0	–	–	–	–
		July	100.0	–	–	–	–
		August	26.7	60.0	–	6.7	6.7
	May	June	–	–	–	100.0	–
		August	–	–	–	100.0	–

Annex II: Changes in arrival of the short rainy season

SITE	MONTH WHEN SHORT RAINS BEGIN/RAIN SEASON	MONTH WHEN SHORT RAINS END/RAIN SEASON	2012	2000	1990s	1980s	1970s
Rabai	August	December	20.0	20.0	20.0	20.0	20.0
	September	January	0.0	25.0	25.0	25.0	25.0
		November	15.8	21.1	21.1	21.1	21.1
		December	24.2	21.1	18.9	17.9	17.9
	October	December	19.7	19.7	20.6	20.2	19.7
	November	January	–	–	–	50.0	50.0
Digo	May	June	–	–	33.3	33.3	33.3
		August	–	–	–	–	100.0
	June	July	–	–	–	50.0	50.0
		August	–	–	20.0	40.0	40.0
	July	July	–	–	100.0	–	–
		August	40.0	40.0	20.0	–	–
		September	18.2	18.2	22.7	22.7	18.2
		October	–	–	–	–	100.0
	August	September	42.9	42.9	14.3	–	–
		October	8.2	8.2	26.2	34.4	23.0
		November	23.5	23.5	29.4	17.6	5.9
	September	October	25.0	25.0	6.3	25.0	18.8
		November	34.3	34.3	15.2	8.1	8.1
		December	–	–	33.3	33.3	33.3
	October	September	–	–	0.0	66.7	33.3
		October	–	–	100.0	–	–
		November	24.1	24.1	37.9	10.3	3.4
		December	20.0	20.0	30.0	15.0	15.0
	November	December	10.0	20.0	10.0	30.0	30.0
	December	January	100.0	–	–	–	–
Chonyi	August	November	50.0	50.0	–	–	–
		December	–	–	40.0	40.0	20.0
	September	November	69.0	31.0	–	–	–
		December	16.5	23.1	27.5	26.7	6.3
	October	November	100.0	–	–	–	–
		December	70.0	30.0	–	–	–

SITE	MONTH WHEN SHORT RAINS BEGIN/RAIN SEASON	MONTH WHEN SHORT RAINS END/RAIN SEASON	2012	2000	1990s	1980s	1970s
Giriama	March	June	100.0	–	–	–	–
	April	August	100.0	–	–	–	–
	May	July	–	100.0	–	–	–
	July	December	–	–	33.3	33.3	33.3
	August	January	–	–	–	33.3	66.7
		February	–	–	33.3	33.3	33.3
		October	33.3	–	–	33.3	33.3
		November	50.0	50.0	–	–	–
		December	–	2.9	11.4	25.7	60.0
	September	January	14.3	28.6	14.3	14.3	28.6
		February	–	100.0	–	–	–
		October	16.7	16.7	33.3	16.7	16.7
		November	30.3	39.4	15.2	9.1	6.1
		December	3.9	21.9	30.9	25.8	17.4
	October	January	80.0	–	–	–	20.0
		October	100.0	–	–	–	–
		November	86.7	13.3	–	–	–
		December	31.3	43.8	6.3	12.5	6.3
	November	November	50.0	33.3	16.7	–	–
		December	–	–	–	50.0	50.0
Duruma	August	January	–	–	–	–	100.0
	September	November	–	–	33.3	33.3	33.3
		December	16.0	24.0	20.0	20.0	20.0
	October	January	–	25.6	25.6	24.4	24.4
		November	100.0	–	–	–	–
	November	December	100.0	–	–	–	–
	December	December	–	–	–	100.0	–

Annex III: Key innovations and reasons for introducing them

SITE	LIVELIHOOD, FOOD SECURITY INNOVATION ITEM	KEY REASONS FOR DOING IT							
		Ecological risks/ changes	Major climatic event that led to crop failure/ scarcity	Economic and market needs	social and culture needs	Labor shortage/ saving	Repatriation/ collaboration with scientists	Discovered by accident	Experiment-ation and exploration
Rabai	Micro finance or banking service	0.0	0.0	14.3	76.2	0.0	0.0	0.0	9.5
	Distribution/ sale of crops/ products nationally	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
	Use of marketing strategies to sell products	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
	Use of hybrid	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Digo	Micro finance or banking service	0.0	66.7	33.3	0.0	0.0	0.0	0.0	0.0
	Distribution/ sale of crops/ products nationally	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
	Revival of traditional markets (e.g. Barter)	0.0	42.9	28.6	28.6	0.0	0.0	0.0	0.0
	Use of hybrid	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Chonyi	Micro finance or banking service	2.4	0.0	97.6	0.0	0.0	0.0	0.0	0.0
	Distribution/ sale of crops/ products nationally	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
	Use of marketing strategies to sell products	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
	Revival of traditional markets (e.g. Barter)	0.0	0.0	42.9	57.1	0.0	0.0	0.0	0.0
Giriama	Micro finance or banking service	5.3	31.6	13.2	5.3	36.8	2.6	5.3	0.0
	Distribution/ sale of crops/ products nationally	0.0	33.3	0.0	66.7	0.0	0.0	0.0	0.0
	Use of marketing strategies to sell products	0.0	50.0	0.0	50.0	0.0	0.0	0.0	0.0
	Use of financial accounting principles	10.0	50.0	30.0	10.0	0.0	0.0	0.0	0.0
	Revival of traditional markets (e.g. Barter)	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0
	Use of hybrid	0.0	50.0	0.0	50.0	0.0	0.0	0.0	0.0
Duruma	Micro finance or banking service	0.0	83.3	16.7	0.0	0.0	0.0	0.0	0.0
	Distribution/ sale of crops/ products nationally	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
	Use of financial accounting principles	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0

Smallholder farmers in coastal Kenya are already significantly affected by the impacts of climate change, particularly in semi-arid and dryland areas. They have developed a number of innovations based on traditional knowledge to enhance resilience and productivity– e.g.: crop diversification using resilient local varieties, new planting techniques and wild tree domestication. This report explores key trends in climate, livelihoods, food security, crop diversity and social capital in five Mijikenda communities, as well as traditional knowledge-based innovations to address climatic and socio-economic challenges. It is based on research conducted as part of the SIFOR project (Smallholder Innovation for Resilience).

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Knowledge Products

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