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# Smallholder Innovation for Resilience (SIFOR)

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Qualitative Baseline Study,  
Mijikenda Community,  
Kenyan Coast

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*Traditional Duruma community house. Photograph by Stella Mutta.*



*Rabai traditional dance group performing during a ceremony. Photograph by Stella Mutta.*

## 1.0 Executive summary

This report presents the findings of a qualitative baseline study on the farming systems, livelihoods, crop varieties, forest use and indigenous knowledge and practices of the Mijikenda community in the coastal region of Kenya, and the trends over the last 30 years. It explores the climatic changes and challenges faced by coastal communities and ways of improving their adaptive capacity through use of existing indigenous knowledge, systems and practices. The study aimed to identify and disseminate traditional knowledge-based innovations that enhance productivity, including traditional crop varieties with important traits such as drought and pest resistance, traditional farming practices and climate change response strategies. It also sought to understand the factors or conditions that promote innovation including traditional cultural practices and community institutions.

The survey covered the Giriama, Chonyi, Rabai, Digo and Duruma sub-tribes which form part of the wider Mijikenda community. The cultural practices of the Mijikenda communities are similar although with slight variations. While the Giriama are the most traditional, the other four have some dilutions to their traditional culture and this provided a basis for comparison of results. Literature review, Focus Group Discussions (FGDs), and key informant interviews were used to collect data. A total of 155 households were interviewed in 31 villages. One FGD meeting was held in each of the five communities with key informants comprising *Kaya* elders, herbalists, farmers and community leaders.

The main effects of climate change highlighted include reduced crop production due to reduced rainfall, high incidences of pests and diseases for crops and livestock, reduced soil fertility, and more extreme weather. In all the communities, rainfall has significantly declined and become more erratic and unpredictable, resulting in longer dry spells and droughts and a considerable decline in crop productivity. However, the five communities have come up with several adaptations and innovations in response to these climate change effects. Although cultural values and traditional knowledge have become weaker in the last 30 years, the communities have retained some traditional practices that enhance productivity and complemented these with modern technologies.

Many farmers have adopted faster maturing modern varieties in response to reduced water, and this has been a key reason for the loss of traditional varieties in some cases. However, one innovation has been to plant different crop varieties together – improved, hybrid and traditional – especially for maize and cassava, to reduce the risk of crop failure. The traditional varieties usually take longer to mature but can tolerate pest, disease and water stress, while the modern varieties mature fast but cannot tolerate these stresses. Frequent incidences of hunger and drought have necessitated a switch from maize to cassava as a major crop in all the Mijikenda communities.

Livestock diseases have also got worse and traditional knowledge has provided the basis for developing some effective treatments for chickens and cattle (e.g. using dung from donkeys that graze in the wild). The communities have also domesticated a number of wild forest plants on farm to generate income in response to reduced crop productivity – e.g. fruit trees, and a tree with medicinal value. Farmers obtained the propagation material from the forest and raise the seedlings before transplanting them. They came up with propagation protocols after trying several methods, and now know plants that can be propagated using cuttings, seeds and wildings.

Other innovations include a method of planting coconut seeds that prevents termite attacks, use of nitrogen fixing plants, agroforestry and uprooting of deep rooting cassava to enhance soil nutrients, and the discovery that using pruned cassava tops as planting materials produces early maturing and highly productive cassava. In many cases, local community organizations, such as farmers' and women's groups and the *kaya* elders' council have been important factors contributing to the innovations by promoting the sharing of knowledge and innovations, and the maintenance of traditional knowledge and practices. The Rabai community has established a cultural village to increase income and this is also helping to strengthen traditional practices and has allowed the community to network through exchange of planting materials of traditional crops which are grown in the cultural village.

However capacity building and further discussion is needed with the communities on the concept of 'biocultural innovation' and how best communities can enhance these innovations to increase their resilience to climate change.

## 2.0 Introduction and objectives

As global temperatures continue to rise, and both the intensity and frequency of extreme climate events increases, climate change adaptation and disaster risk reduction are becoming increasingly urgent. Measures to adapt to climate change and reduce disaster risks are gaining increasing international attention, and will be essential for ensuring the wellbeing of the global population, both now and in the future. Developing countries, particularly in Africa, are hardest hit by climate change mainly because they have few resources and low capacity for preparedness and response to climate change crises and are more vulnerable to hunger and food insecurity. For instance, extreme heat is likely to reduce nutrients in crops, affect livestock growth and productivity and increase crop loss due to attack by pests and diseases hence resulting in higher food prices, lower earnings and lower quality food. In the US, the price of maize shot up by 40% following the 2012 drought in the Midwest, while in the UK, wheat yields fell to their lowest level in 20 years following the 2012 wet year (FAO 2013).

Climate change poses countless challenges to farmers, pastoralists and others who depend on natural resources for their living. Poor rural communities in developing countries are most affected by climate related disasters, and while most climate change adaptation strategies have focused on large scale infrastructure for physical protection, the local initiatives of communities offer environmentally sustainable innovations for climate change adaptation. Therefore climate change adaptation strategies should recognize the creativity of local people in adapting to climate change, strengthen their local adaptive capacity and channel adaptation funds to local organizations to support grassroots level adaptation initiatives. Furthermore, policy responses to climate change should support and enhance local knowledge systems.

A number of initiatives have been started to address food security and climate change impacts among the local communities in rural areas which depend on agriculture for livelihood. One of such initiative is the **‘Smallholder Innovation for Resilience: Strengthening Innovation Systems for Food Security in the Face of Climate Change’**, a project funded by the European Union (EU). In Kenya it is being implemented by Kenya Forestry Research Institute (KEFRI) in collaboration with International Institute of Environment and Development (IIED). The project aims to improve the adaptive capacity of coastal communities to climate change impacts by identifying and disseminating traditional knowledge-based innovations which enhance productivity in the face of climate change. The specific objectives of the project are:

1. TK-based innovations that enhance productivity and conditions which foster vibrant and resilient innovation systems, identified and disseminated.
2. Tools that increase resilience of smallholder innovation systems, and improve rights security, developed and spread.
3. Capacity and preparedness of smallholders, including women and indigenous peoples, to sustain resilient innovation/TK systems and agro biodiversity enhanced.
4. Understanding and commitment of scientists, opinion formers and policy makers — at local, national, EU and international level changes needed in policies, laws and institutions enhanced, and a number of changes instituted.

The qualitative baseline study was undertaken between January and June 2013 to provide a baseline for M&E and to address the first specific objective above. It focused on livelihoods, farming systems (including livestock and forests), agrobiodiversity, traditional institutions, social networks, changes and trends in the last 30 years. It documented indigenous and new crop varieties cultivated in the target communities, traditional and modern farming practices, agrobiodiversity conservation practices, disaster and coping strategies, and important community innovations based on traditional knowledge that enhance productivity and resilience. It also sought to understand the conditions that support innovation including cultural values, biodiversity conservation, collective resource management, access to wild gene pools and sacred sites, and sharing and exchange of seeds over large areas.

### 3.0 Study communities

The study sites are located in Kilifi and Kwale counties and the target communities are the Giriama, Chonyi, Rabai, Digo and Duruma which form part of the wider Mijikenda community. These are the SIFOR target communities, except for **Chonyi** which was included in the baseline survey as a control community for M&E purposes. The Mijikenda are Bantu-speaking people consisting of nine sub-communities that are linguistically and culturally closely related, the Chonyi, Digo, Duruma, Giriama, Jibana, Kambe, Kauma, Rabai and Ribe (Willis, 1996). The target communities are spread along the Kenya coast in different agro-ecosystems both near the coast and more inland in the case of the Duruma community.

To date, natural resource use and management practices get some guidance from the customary rules, whose central premise is the sacred *Kaya* forests culture, although the degree of its influence and acceptance differs from one community to another. The Giriama are the most traditional, and the other four have some dilutions to their cultural attachments. The word “Kaya” means homestead in the local Mijikenda dialect and refers to small isolated patches of forest ranging in size from 2ha to 200ha. Historically these forest patches sheltered small fortified villages (*Kayas*) which were set up by the Mijikenda people when they first appeared in the region many centuries ago, after fleeing their enemies in the north. As they became more secure in the last century the Mijikenda groups moved out and settled in the surrounding areas, but the *Kaya* forests were preserved as sacred places where prayers, rituals, sacrifices and burials took place. Protection of the *Kayas* was deeply entrenched in traditional Mijikenda culture and their integrity and sanctity were safeguarded by a council of *Kaya* elders who employed a system of taboos and traditional rules to protect the forests.

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. Infrastructure development is still low with very few households having access to electricity. The community depends on regional markets (such as Kongowea in Mombasa), although there is a large market in Malindi which sources its goods from Mombasa. The road network is fairly good with the Mombasa- Lamu high way being the only tarmac road.

The Chonyi community occupies a wet fertile ridge (*Ngama*) that is continuous with the lower Shimba Hills in Kenya and the Amani forests of Tanzania. Hence they are mostly crop farmers with both annual and perennial crops cultivated. Other economic activities include small scale businesses and tourism along the coastal beaches, with the major towns in the area being Shariani and Kikambala. The area extends to about 202.2km<sup>2</sup>, while annual rainfall ranges between 400mm -1,300mm with the short rains running from October to December while the long rains run from April to July. Temperature ranges from between 22.5°C and 34.0°C. *Kaya* Chonyi is the main *Kaya* for the community living around the forest. It has been used over time by elders to offer prayers and sacrifices and has been conserved mainly through cultural beliefs.

The Rabai occupy a hilly area that has average rains, and thus local communities practice mixed farming, i.e. both livestock and crops. Infrastructure development is relatively good with most households having access to electricity, piped water and regional as well as local markets. In addition, the community is served by a tarmac road as well as the main Nairobi-Mombasa Highway.

The Digo community occupies Kwale County. Kwale covers a total surface area of 8,270.2 square km and accounts for nearly 1.42% of Kenya's total surface area. The major towns in the county are Ukunda, Msambweni, Kinango and LungaLunga while the main topographical features are the coastal plain, flood plateau, coastal uplands and Nyika plateau. The county has a monsoon climate, that is, it's hot and dry from January to April and cool from June to August. Short rains are experienced from October to December while long rains run from March to June/July. The average temperature is 24.2°C, while rainfall amounts range between 400mm to 1680mm per annum. The main rivers and streams are Marere, Mwaluganje and River Ramisi which form the drainage pattern in the district. Rivers such as Marere and Mwaluganje have also been harnessed to provide piped water. The combination of monsoon climate, diverse rivers and streams and rainforests and national parks offers great potential for livestock keeping, agricultural production and ecotourism respectively.

*Kaya Kinondo*, also known as *Kaya Ngalaani*, is a gazetted National Monument under the National Museums Act located in the South of the Kenyan coast in Msambweni District and is the main Kaya for the Digo community who live around the forest. *Kaya Kinondo* has survived pressures from population growth, poverty and tourist development because of the cultural beliefs of the Digo Mijikenda people who have used the Kayas such as *Kinondo* to commune with their ancestral spirits through worship and sacrificial offerings. The main forms of livelihoods in the area are farming (mainly fruits for sale and grains for subsistence), fishing, small business and employment in beach activities. On the 4<sup>th</sup> of July 2003, the *Kaya Kinondo* Eco-Tourism Project was started with the aim of generating additional funds for the local community.

The Duruma community is located in the Kinango District of Kwale County. Kinango District occupies the semi-arid Nyika plateau and has much lower rainfall amounts than the rest of Kwale County. The Durumas reside along the Nairobi- Mombasa Highway (which goes south to the Tanzania border) and is marked roughly by the triangle of Taru, Mazeras and Lunga on the border. Kinango District is characterized by high poverty levels with livestock keeping and subsistence crop farming being the main economic activities supporting local livelihoods. The District faces a myriad of other challenges including deforestation and charcoal production, high unemployment rates, high rate of school drop-outs and early marriages, all of which further exacerbates the levels of poverty.

Table 1: Population of Mijikenda by sub-tribe (Source: KNBS, 2010)

Mijikenda sub-tribe	Population	No. of Households
Giriama	798,000	114,000
Duruma	421,000	60,143
Digo	333,000	47,571
Chonyi	158,000	22,571
Rabai	105,000	15,000
Kauma	56,000	8,000
Jibana	37,000	5,286
Kambe	27,000	3,857
Ribe	14,500	2,071
<b>Total</b>	<b>1,949,500</b>	<b>278,500</b>

## 4.0 Methodology

The methods used were:

- a) A literature review on the Mijikenda community farming systems, indigenous traditional knowledge, cultural practices, customary laws and practices, conservation of sacred *Kaya* forests, extreme weather events, socio-economic profile, agrobiodiversity conservation and TK-based innovations. Both published reports and grey literature were reviewed.
- b) PRA with a special focus on meetings: Focus Group Discussions (FGDs) were held with key informants in each community.
- c) Two different questionnaires were administered at village and household level: 31 village level surveys were conducted (with one key informant from each village) to provide baseline information on each village; and then interviews were conducted with 155 households.

### 1. Questionnaires

The survey involved open-ended discussions, complemented with key informant interviews and focus group discussion. The questionnaire was developed by considering the three pillars of innovation – livelihood, agro-ecosystems, and social networks. It explored the key trends and changes in these areas and the responses and innovations developed to address them. The questionnaire was developed in consultation with SIFOR partners and other researchers, following a common checklist developed by the China team. This was followed by training of the field coordinators on the questionnaire content and administration. Detailed discussions were conducted with the community field coordinators from the five target communities, who made their own comments drawing on their knowledge of the unique features in their respective communities. The questionnaire was then subjected to a pre-test in Malindi involving all the field coordinators. The pre-test session was followed by discussion to establish the workability and precision of the questionnaire. Some changes were made to accommodate the observations made during the pre-test. The community field coordinators were charged with the administration of the questionnaire, as the researchers made ad hoc visits and participation in the interviews. Technicians inputted the data and prepared summaries, and the researchers reviewed the summaries against the original questionnaire and in consultation with the field coordinators.

### 4.1 Village questionnaires

In each Mijikenda sub-tribe, a few villages were selected for the study. A village was defined as the area under the smallest possible administration system – under the Village Chairman (Kenyan system), where village elders form the first decision making organ. Seven villages were selected in each target community with the exception of Digo and Duruma communities where 6 and 4 villages were selected respectively, and one was questionnaire administered in each village. A total of 31 surveys were conducted at village level with the assistance of village elders. The villages were selected on the basis of:

- 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 purposes)
- e) Geographical features and unique landscapes.
- f) Geographical positioning and distribution in the overall area.

Within the above considerations, more traditional villages with a history of diverse and established traditional practices were the preference for selection. General village data was captured, detailing the socio-economic, infrastructure and general developments in the village; as well as its proximity and accessibility to urban markets and health facilities.

## 4.2 Household questionnaires

Purposive sampling was used to select 5 households with rich knowledge of traditional practices and agrobiodiversity conservation in each of the 31 villages in the five project sites. A total of 155 households were interviewed, including herbalists, rainmakers, kaya elders and traditional farmers. The household questionnaire covered broad themes such as past and current sources of income, rainfall patterns and their effect on crop production, farming practices, agro-biodiversity conservation, past and current food and cash crops, social networks and biocultural innovations.

## 4.3 Focused Group Discussions (FGDs)

The objectives of the FGDs were to share the findings of the household questionnaires with the community, validate the information collected through the village level and household surveys and gather new information especially on biocultural innovations. A checklist was used to guide the discussions on the following broad thematic areas: community livelihoods, agrobiodiversity, social networks and biocultural innovations. The discussions were held with members of community with exceptional knowledge on traditional practices and innovations and the following criteria were used to select participants:

- Gender composition (at least a third of the participants were women).
- People with special knowledge relating to agro biodiversity such as herbalists, traditional spiritual leaders, rainmakers and local farmers growing traditional crop varieties.
- People with special roles in society such as Kaya elders.
- Representatives of various community groups such as farmers' groups, micro-finance groups and bee keeping groups.

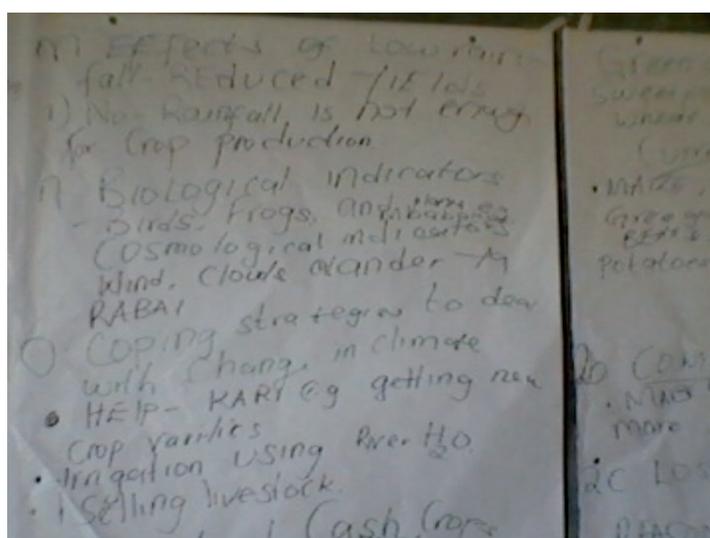


Figure 1: Flipcharts showing some of the responses during a focus group discussion. Photograph by Stella Mutta.

Table 2: Data collection methods and the number of respondents in Giriama, Chonyi, Rabai Digo and Duruma communities

Site	Number of respondents per method		
	Village questionnaires	Household questionnaires	Focus group discussions
Giriama	7	35	19
Chonyi	7	35	21
Rabai	7	35	30
Digo	6	30	14
Duruma	4	20	12
<b>Total</b>	<b>31</b>	<b>155</b>	<b>96</b>



Figure 2: Participants in a Focus group discussion. Photograph by Stella Mutta.

## 5.0 Results and discussion

### 5.1 Sources of income and production systems

Crop farming was the main source of income in the Giriama in the past; the cash crops that were grown were *Sesamum indicum* (a tropical plant with edible seeds), cotton, cashew nuts and castor seeds. These crops had a good market then and fetched high prices; cotton was the only exotic crop among the four. Other income sources included livestock keeping and fishing. Likewise the main source of income in the past for the Chonyi community was crop farming followed by tapping of coconut wine, livestock keeping, weaving thatch using coconut leaves (*Makuti*), pottery and fishing. The main source of income in Rabai in the past was coconut wine tapping; other sources of income were crop farming, livestock keeping, fishing and bee keeping. Similar to the first two communities the main source of income in Digo was crop farming followed by fishing, livestock keeping, barter trade, businesses and tapping of coconut wine. In Duruma community, the main sources of income in the past were crop farming followed by livestock keeping, fishing, basketry and weaving, honey harvesting, sale of traditional artifacts such as grinding stones and pounding tools, tapping, pottery and sale of fermented milk and tobacco.

Currently in **Giriama** people not only depend on other sources of income but have also adopted different types of crop as cash crops. The cash crop contribution to household income in Giriama has reduced to about 30% as compared to 100% 30 years ago. The crops which are currently regarded as cash crops include maize, cassava and cowpeas which in the past were regarded as food crops. The change has been due to loss of market of the previous cash crops and increase in their production cost. Cotton was commonly cultivated through subsidized seeds, fertilizer and pesticides. When these stopped the cotton farmers could not keep up with the cost implication of growing cotton. In addition, since cotton is exclusively for the market and not for subsistence, many farmers decided to abandon it. Cashew-nut and coconut have been affected by low market pricing resulting from lack of industries to process and carry out value addition of the commodities in order to increase their price. In the recent past, middlemen started to purchase coconut for the regional market (Tanzania) and this has contributed to a slight increase in coconut farmers. The cashew nut has not been rescued. Although the Ministry of Agriculture offers free seedlings for high yield and quick maturing to cashew nut growers, the offer has not been captured with enthusiasm because of low prices attributed to mismanagement of the sector and eventual privatization of Kenya Cashewnut Limited in 1993– this has had a devastating effect on farmers whose livelihood entirely depended on the crop. Cashew nut trees have also seen considerable pest infestation that increases its growing cost. *Sesamum indicum* is hardly grown due to the changing weather patterns. It is cultivated within a specified time plan of a predictable rain pattern. The disarray in the rain patterns affected the farmers' knowledge in patterning the crops, and since it is not grown with the onset of rains, inability to predict the growing timing has made it less popular. Some respondents also mentioned lack of market as a reason for its minimal farming.

In **Chonyi** the current sources of income include tapping of coconut wine; which is the leading source of income followed by small businesses, crop farming, and casual employment, coconut leaves thatch (*Makuti*), village micro-finance schemes and brick making. The dependency on some sources of income such as *Makuti* selling and coconut wine tapping has increased in the recent past. Demand for coconut leaves thatch (*Makuti* for construction) has resulted from the growing hotel industry at the coast while regional markets are now available for the palm wine that was previously sold locally hence more profits. Besides, more people including the youth are now involved in the coconut wine tapping industry unlike in the past when it was done by a few elderly people. Crop production has significantly reduced while new sources of income such as motorcycle operation and village micro- finance schemes have been gained. Traditional sources of income such as pottery on the other hand have reduced mainly due to loss of skills.

Tapping of coconut wine was the main source of income in **Rabai** in the past, mainly due to the large population of coconuts that existed. This has however changed due to decrease in the amounts of rainfall experienced which has in turn led to decline in coconut population. Tapping of coconut wine is now practised on a smaller scale hence the profits are lower.

Generally in Rabai the past income sources had huge profit margins as compared to current sources. The magnitude of crop farming and livestock keeping has also declined due to reduced farming and grazing land as well as reduced rainfall. Besides, the seasonality of rainfall is highly variable and difficult to predict. Livestock production methods have also improved in the recent past; the farmers have cross-bred indigenous traditional breeds that can survive harsh climatic conditions such as drought with new hybrids that can produce a lot of milk, meat and other livestock products. This has enhanced production of livestock products. Some traditional sources of income such as weaving have been lost. This can be attributed to loss of skills due to modernization. Some new income sources have also been gained. They include tree farming and sand harvesting. Tree farming can be attributed to increased levels of environmental awareness among locals, while sand harvesting can be attributed to the increasing demand for the commodity for infrastructure development projects.

Crop farming is still the main source of income in **Digo** followed by business, casual employment, livestock keeping, fishing and loans from commercial banks and micro-finance institutions. The magnitude of fishing, crop farming and livestock keeping has however declined. Fishing has largely been affected by the neglect of cultural beliefs that were traditionally used to conserve the ocean and ensure adequate fish reserves throughout the year while crop farming and livestock keeping have mainly been affected by the negative effects of climate change such as reduced rainfall and frequent droughts that have resulted to low crop and animal production. Furthermore population increase has resulted in reduced farming and grazing land. Traditional income generating activities such as pottery have been lost while others such as weaving have significantly reduced in magnitude. New income generating activities have however been gained by the community. They include motorcycle operation, taxi business, microfinance groups and rental houses business.

In Duruma community, the main source of income is crop farming, followed by livestock keeping, petty trade, witchcraft, micro-finance, charcoal burning, farming, masonry and quarrying. In the recent past however, farming and livestock keeping have recorded reduced productivity mainly due to poor climatic conditions; mainly reduced rainfall and frequent and recurring droughts. Consequently the community has resorted to environmentally degrading activities such as charcoal production. In addition, new sources of income such as petty trade, village savings and credit schemes and motorcycle transport business have been gained in a bid to diversify income sources. Traditional income sources such as sale of traditional artifacts, sale of fermented milk and honey harvesting using traditional beehives have however been lost mainly due to modernization which has contributed to erosion of traditional culture.

## 5.2 Crop varieties and their sources

### 5.2.1 Staple and important foods

In the past, the main food crop for the **Giriama** was maize and the staple food was maize pulp (*Ugali*). Maize has always been considered a subsistence food and was never grown for sale. It is only recently that maize selling was noted among some Giriama, and this has remained very minimal. Other important foods were cowpeas, cassava, green grams, millet and sorghum. However, following the variability in weather patterns maize failure has been more frequent. This led to the Giriama depending more on cassava than maize, as cassava is considerably tolerant to drought. The main food crops in the community are still the same only that the farmers have adopted improved and hybrids varieties which were introduced by KARI since they are short term varieties and have high yields. But these modern varieties are susceptible to diseases and pests, which the farmers manage through application of pesticides.

The main staple foods in **Chonyi** community in the past are maize, cassava, sweet potatoes, bananas, pumpkins, cowpeas, millet and sorghum while current staple foods include maize, cassava, cowpeas, green grams and beans. Other important food and cash crops in the community include coconuts, rice, wheat, pigeon peas, mangoes, oranges and tangerine

Maize and cassava were the staple foods in **Rabai** in the past. They were mainly dried and grinded into flour and used to cook *Ugali*, which was the staple food. *Jora*<sup>1</sup> was also a key staple food among the Rabai community that was prepared especially during drought. Maize still remains the staple food in Rabai, cassava follows, while *Jora* has been lost mainly due to modernization. The other important foods are cowpeas, bananas, sweet potatoes, millet, sorghum wheat, pumpkins, green grams, and wheat.

The main past staple foods in the **Digo** community include maize, dried cassava, millet, green grams and rice. Current staple foods include maize, cassava cooked with coconut milk (*Papasha*), fish and bananas. Other important food and cash crops in Digo include groundnuts, pigeon peas, cowpeas, sweet potatoes, pumpkins, wheat, millet, sorghum, *Chimanga*, *Sesamum indicum*, bananas, mangoes, oranges, coconut, guavas and pawpaw.

In the **Duruma** community, the main staple foods in the past were *Jora* and *Chitapwa* (crushed green maize that is then steamed), while the current staple food is maize pulp since *Jora* and *Chitapwa* have been lost mainly due to modernity. Other important food and cash crops in the community include maize, cassava, sweet potatoes, green grams, cowpeas, groundnuts, cashew nuts, pumpkins and bananas in that order.

### 5.2.2 Crop varieties

The maize varieties consumed by all five communities in the past were indigenous varieties which include Mdzhiana, Mengawa, Kanjerenjere, Mwangongo, Mulunguhodi, Mbembei (the names are in Giriama dialect; the dialect varies among the five communities).



Mdzhiana



Mengawa



Mwangongo



Kanjerenjere

Figure 3: Indigenous maize varieties grown by the Mijikenda communities. Photographs by Stella Mutta.

<sup>1</sup> *Jora* is a mixture of fine cassava petals and bananas

Similarly, the cow peas varieties were also indigenous - *Munyenze* and *Simpemutu* - as well as the cassava varieties that include *Kibandameno kathithe*, *Kabandameno*, *Mbomu*, *Msolo*, *Chijenje*, *Bofu*, *Gufe*, *Mgiriama*, *Msenawangu*, *Mwafrika* (the names are in Giriama, Rabai and Digo dialect).



*Kaleso*



*Gufe*



*Kibanda meno*

Figure 4: Cuttings of indigenous cassava varieties grown by the Mijikenda communities. Photographs by Stella Mutta.

### 5.2.3 Lost and gained crops and varieties

Some of the indigenous maize and cowpeas grain varieties in **Giriama** have been lost - e.g. *Kanjerenjere*, *Munyenze*, *Mwandato* and *Simpemutu* - due to the lack of market and long maturation time and the preference for short lived new varieties. Likewise some traditional food crops like millet, sorghum, *Dolichos lablab*, sweet potatoes, mushrooms, *Matango*, *Mamumunye*, *Pupu*, and *Njugumawe* have been lost due to invasion of pests, reduced fertility, high production cost, preference of new crops and reduced rainfall. Cabbage, kales and peas have been adopted as an alternative to the traditional vegetables for their sweet taste.

In **Chonyi** crops such as millet have been lost mainly due to loss of seed banks while sorghum, bananas and groundnuts have reduced. Beans on the other hand have been gained mainly due to diversification of eating habits. Other crop varieties that have been introduced mainly by the Ministry of Agriculture include fast maturing maize and cassava varieties, water melons, kales, tomatoes and grafted fruits such as coconuts, mangoes and oranges.

Most crops in **Rabai** have been retained and are still used as both food and cash crops while a few crops have been lost. Such traditional crops include millet and sorghum and the loss was mainly attributed to the loss of local seed banks following the introduction and promotion of modern crop varieties by the government authorities/agencies. The modern food and cash crop varieties introduced in the community include beans, vegetables such as kales and tomatoes and grafted fruit varieties such as mangoes, oranges and avocados.

In **Digo** some food crops such as groundnuts, millet, *Chimanga*, and traditional cassava varieties such as *Chijenje*, *Gofu*, *Mgiriama*, *Msenawangu* and *Mwafrika* have been lost. The loss of these varieties can be attributed to changing weather patterns resulting in reduced rainfall amounts and loss of seed banks due to introduction of modern high yielding and fast maturing crop varieties. Cultural practices such as controlled harvesting that were previously used to preserve some crop varieties have also been abandoned hence leading to their loss. There are however modern crop varieties that have been gained by the community, they include beans, kales, cabbage, tomatoes and grafted fruits such as mangoes, oranges and cashew nuts. In addition, traditional early maturing cassava varieties such as *Ndزالاوكا* (traditional) and modern varieties like *Shibe*, *Tajirika*, *Karemba* and *Siri* have been gained. Hybrid maize varieties such as *Katamani* maize have also been gained.

In the **Duruma** community, Bixa and cotton were previously major cash crops but have been lost. The loss of cotton was attributed to reduced rainfall, while that of Bixa was attributed to lack of market following the closure of Bixa Limited in Ukunda which was the main market for Bixa. Important food crops have also been lost and these include groundnuts, millet and arrow roots whose loss was mainly attributed to inadequate rainfall and loss of local/community seed banks for traditional crop varieties due to hunger and hence community's inability to save the seeds for planting. New food and cash crop varieties have also been gained by the community. These crops include hybrid maize varieties such as Pwani (Coast) Hybrid one (PH1), Duma and Pwani (Coast) Hybrid four (PH4), groundnuts (*Chimakoko*), hybrid millet, grafted fruits such as mangoes and citrus and cashew nuts, and exotic vegetables like kales, tomatoes and cabbages. Most of the introduced crops are preferred for their high productivity and fast maturing traits.

#### 5.2.4 Sources of food

In the past, farming used to be the source of food in Giriama, but since crop productivity has acutely declined due to reduced and unpredictable rainfall, decline in soil fertility, pest and diseases, the community now depends on other sources such as shops, markets and relief for food. Previously, the staple foods in Chonyi were obtained from the farms; currently they are obtained from farms and shops. This can be attributed to changing climatic patterns that have resulted in reduced agricultural productivity hence farms cannot adequately provide for the community's food needs. In the past, food crops in Rabai were mainly obtained from the farms while currently, the trend has changed and the main source of food has become market and shops. This trend has been attributed to reduced farm lands mainly due to increased population and land sub-division, high production costs associated with application of pesticides to manage high incidences of pests and diseases infestation as well as the high costs of farm inputs such as fertilizers required to ameliorate declining soil fertility and unpredictable rainfall patterns. All these climate change associated factors have led to reduced crop productivity. The high demand for scarce commodities in markets and shops has in turn resulted in increased commodity prices. Similar to the previous first three sites, the Digo and Duruma communities no longer solely depend on farms as their source of food; instead they complement it with food obtained from shops and local markets mainly due to low farm productivity compounded with unpredictable weather patterns.

### 5.3 Livestock

Cattle, goats, sheep, ducks and chicken were the main livestock kept in the past by the Giriama community. These were indigenous varieties kept in large numbers. For chicken, the varieties included *Kidemu*, *Kisiyesiye*, *Ngilishi* and *Mtsanga wa Pwani*. The Chonyis kept local poultry, goats, sheep, duck and cattle as their livestock. In Rabai local poultry were the main livestock kept; other livestock kept were goats, sheep and cattle. Just like Rabai the main livestock kept in Digo were local poultry- *Mbete*, *Chisingosingo*, *Chidzundzu*, *Chidimu*, *Miirimiiri* (names are in Digo dialect), goats, sheep and cattle. In Duruma, the main livestock kept in the past were local breeds of poultry, goats, sheep and cattle.

Currently the **Giriama** community keeps other livestock species which are cheap to maintain, small in size and can survive the adverse weather conditions, including rabbits, guinea fowl, guinea pig, chicken and turkey. In addition, a few farmers have also adopted the hybrid cattle and goats but these are kept in small numbers due to reduced land space and are costly to maintain. Ducks and sheep are

no longer kept by most farmers due to their low preference as a source of meat so farmers cannot sell them, furthermore ducks are costly to maintain and cannot survive in the adverse weather conditions. The indigenous chicken variety is currently facing the threat of extinction due to their over-exploitation for cultural practices such as traditional healing and this is compounded by the weakening of cultural beliefs which have made local farmers stop keeping the indigenous chicken varieties.

A combination of both local and hybrid poultry, sheep, goats, and cattle are currently kept by the **Chonyi** community alongside ducks and newly introduced livestock types such as guinea fowls and donkeys. Some livestock types such as turkey have significantly reduced in number. Poultry still remains the main livestock kept by the Rabai community with the main local poultry varieties kept being *Kidimdim*, *Mtune*, *Walubaga*, *Mwiru*, *Mwerurewa Mwirimwiri* and *Mtsanga wa Pwani*; other livestock include goats and sheep. New livestock breeds such as hybrid poultry, goats, sheep and cattle have been gained. Likewise new livestock type have been gained by the community, they include pigs, rabbits, ducks, guinea fowls and donkeys. The hybrids are aimed at increasing productivity while the other varieties are mainly kept for diversification purposes.

Currently, the main livestock kept in the **Rabai** community include poultry, goats, sheep and cattle (both local and hybrid varieties) while others include donkeys, ducks, guinea fowl, rabbits and pigeons. The hybrids were mainly gained to enhance productivity. Similar to the Rabai community, the main livestock kept in Digo are poultry, in addition the community keeps goats, sheep and cattle (both local and hybrid varieties) while others include donkeys, ducks, guinea fowl, rabbits and pigeons. The hybrid varieties were mainly gained to enhance productivity. In **Duruma** the main livestock kept now include poultry, goats, sheep and cattle. Others are rabbits and donkeys that were previously not kept. Local breeds are preferred since they can easily adapt to the harsh climatic conditions in Kinango District where the Duruma community reside. However, a few livestock cross-breeds of exotic and indigenous (local) breeds have been introduced in order to enhance productivity and increase economic gain.

## 5.4 Climatic patterns and biological and cosmological predictive indicators

The amount of rainfall in **Giriama** has greatly reduced in the last 30 years making it inadequate for crop production; rainfall has also become unpredictable. The reduction in rainfall is thought to be the result of excessive cutting of trees even the big trees where people used to offer prayers in the past; of curses from ancestors due to abandoning traditional culture and rituals; and ill behaviour in most parts of the community. In the past (about 30 years ago), the amount of rainfall in **Chonyi** was high, adequate, predictable and reliable compared to currently, where rainfall amounts have reduced and patterns become unpredictable. The current rainfall amount is not adequate for crop production and this has led to reduced yields. Livestock production has also been affected by droughts, hence the low productivity. Just like the two previous communities, the amount of rainfall in **Rabai**, **Digo** and **Duruma** has greatly reduced and the pattern is unpredictable making it an unreliable source of water for crop production. This, along with prolonged dry periods, has resulted in a decline in crop and livestock productivity.

In the **Giriama** community, villagers no longer use the biological and cosmological predictive indicators as in the past in fear of being regarded as a witch, as witches are usually hacked to death by youthful community members who have abandoned traditional beliefs and cultural practices for modernity. Some of these cosmological indicators include migration of birds, star patterns, winds and clouds.

In sharp contrast, the **Chonyi** community still uses various biological and cosmological predictive indicators for agricultural seasons. The flowering of trees such as *Erythrina abyssinnica*, *Adansonia digitata*, *Milicia excelsa* and *Mware* (local names are in Chonyi dialect) predicts the onset of long rains the movement of butterflies and birds from east to west predict short rains, while the movement of stars (*Nyuni*) from South to North (cosmological indicator) predicts the occurrence of crop, livestock and human diseases.

The **Rabai** still use some of the biological and cosmological indicators, including movement of birds and butterflies, croaking of frogs and flowering or fruiting of key indigenous plants namely *Miize*, *Munyenze*, *Azelia quansensis*, *Utsani* and *Adansonia digitata* (the local names are in Rabai dialect) to indicate rainfall and drought patterns. For instance, the flowering of *Munyenze* plant indicates onset of long rains, while the movement of big white butterflies implies the beginning of the planting season.

The main biological predictive indicators that are still being used for agricultural seasons in **Digo** community include fruiting and flowering of plants and movement of butterflies, while the main cosmological indicator entail observation of star patterns. Fruiting of *Adansonia digitata* and *Mngo'ng'o* trees, as well as movement of white butterflies in large groups from south to north indicates onset of long rains, while fruiting of cashew nuts indicates onset of short rains. Presence of *Chirimira* stars also indicates onset of long rains.

In the **Duruma** community, the main biological predictive indicators used for agricultural seasons include fruiting and flowering of plants such as *Ganga*, *Mnyenze*, *Mbambakofi*, *Mrihi*, *Muwawa*, *Mukupha*, *Kolonyi* and *Vimbangu*. Others include the movement of birds and butterflies and observation of wind direction and ocean tide patterns. For instance, the movement of white butterflies in large groups from South to North indicates onset of long rains. The main cosmological indicators used in the community are the *Rambo* and *Kirimira* stars whose appearance signals the onset of rains.

## 5.5 Coping mechanisms

The farming community in **Giriama** is adopting modern crop varieties and even different crop species to ensure they produce enough to feed their households. In addition, farmers have adopted technologies which enable them to utilize the little resources available and at the same time get high yields. The low input agricultural technologies were introduced by Kenya Red Cross Society (KRCS) and Kenya Agricultural Research Institute (KARI) where the farmers were trained in groups (registered community groups). The farmers also plant trees like *Casuarina equisetifolia* and *Leucaena leucocephala* on their farms to increase the forest cover in their villages. Livestock keepers in the community are now keeping smaller animals like guinea pigs and rabbits, as opposed to the cows, goats and sheep kept in the past. Herbalists have not been much affected by the reduced rainfall as they have established their own herbal groves in their homesteads which they utilize sustainably and manage well.

It was noted that community projects usually collapse after the donors have withdrawn because of a lack of entrepreneurship/business skills required to efficiently run the enterprises without the donors' input. Weak governance and management structures in the Community Based Organizations (CBOs) results in conflicts over benefit-sharing and contributes to the collapse of project sustainability after the donors withdraw. Most of the community groups are usually formed hurriedly for convenience to get support from donor funded projects, without having effective structures in place – such groups disintegrate when the support comes to an end.

The fishing community in Giriama has resorted to deep sea fishing, dividing the fishing grounds and fishing into cycles and catching different fish varieties from previously. Those fishermen who cannot afford deep sea fishing implements have formed groups which enable them to access loans to purchase the implements.

Various coping strategies have been put in place by the **Chonyi** community to deal with changing weather patterns. These new coping strategies which the community has developed over the last 30 years include offering prayers and sacrifices, construction of artificial dams along rivers for water harvesting, planting trees to attract rainfall, irrigation during dry spells and use of early maturing and drought resistant crop varieties to enhance production. These methods have mainly been used as adaptation strategies aimed at coping with the effects of climate change.

The **Rabai** people have embraced several mechanisms to deal with changing weather patterns which include: use of drought resistant seeds of traditional maize varieties such as *Kanjerenjere* and *Mdzihana*, adopting early maturing drought resistant modern hybrids (such as *Chibandameno* and *Chilesa* cassava varieties) from Kenya Agricultural Research Institute (KARI) and other research institutions, irrigating crops using river water, and selling excess livestock to cushion them against livestock death resulting from drought. Cultural interventions such as prayers and sacrifices are also often used in the community.

The **Digo** community has employed various coping mechanisms to deal with changing weather patterns which include adopting early maturing crop varieties such as cashew nuts, coconut, oranges and cassava from KARI and embracing tree farming. These coping mechanisms have been developed by scientists and adopted by local communities to respond to climate change and improve their livelihoods, hence they are external innovations. Additionally, the community offer traditional prayers and sacrifices led by elders in the *Kaya* forests.

The **Duruma** community has also embarked on various coping strategies that include offering prayers and sacrifices in the *kaya* forests during disasters such as drought, and adoption of alternative sources of income such as charcoaling, petty trade and motorcycle transport business to diversify their income sources. Planting of early maturing crop varieties such as green grams and grafted fruit varieties is another coping mechanism that the community has put in place to overcome challenges of reduced and erratic rainfall patterns.

## 5.6 Wild plants and forest products

### 5.6.1 Wild plants collected from the forest

The main plants collected by the **Giriama** community from the forest in the past to make herbal medicines were *Encephalartos hildebrandtii*, *Mthunguru*, *Dalium orientale*, *Ladonpholia kirkii*, *Vitoria*, *Brachystegia speciformis*, *Dalbergia melanoxylon*, *Azelia quanzensis*, *Brachylaena hulliensis*, *Vepris glometar*, *Mfuranje*, *Konzi* (for making *Halua*, *Bokoboko* and *Starch*) and *Manilkara sansibarensis*. The plants are no longer collected from the forest due to restricted access. The restricted access is due to the presence of wildlife and in particular elephants and the herbalists require armed wildlife rangers to escort them to the forest to collect the plants, but these rangers are not available in most cases due to other assignments allocated to them. A number of plants have become extinct from the forest as a result of over exploitation: *Brachystegia speciformis*, *Dalbergia melanoxylon*, *Azelia quanzensis*, *Brachylaena hulliensis*, *Vepris glometar*, *Manilkara sansibarensis*, *Adansonia digitata*, *Mfuranje*, *Mthunguru*, *Vitex doniana* and *Vitex payos*.

The most commonly collected plants from the forest in **Chonyi** include fruit plants such as *Vitoria*, *vipo*, *Lilium orientale*, *Majaji*, *Ladonpholia kirkii*, *Ancylobotry spetersiana*, *Vitex doniana*, *Manilkara sansibarensis*, *Syzigium cuminii*, *Fyofyo*, *Vangueria madagascarensis* and *Ximenia americana*. Vegetable plants, on the other hand, include *Mchunga*, *Vombo*, *Mnavu*, *Mwanjere*, *Mwangani*, *Vongonya* and *Mtsalafu*, while herbal plants include *Mdungu*, *Mung'ang'i*, *Azadirachta indica* and *Mrerengwa*. In addition, these plants are used as sources of construction poles and timber. Some important plants that were formerly collected from the forest such as *Vivu* and *Mariga* have been lost, while *Vitoria*, *Ladonpholia kirkii* and *Majaji* have become rare mainly due to deforestation for agricultural expansion and settlement.

The common plants collected from the forest in the past in **Rabai** are *Strychnos mombasae*, *Mdzaja*, *Mbambara*, *Oldfieldia somalensis*, *Manilkara sulkata*, *Mtunguja*, *Azadirachta indica*, *Azadirachta indica*, *Aloe Vera*, *Kkibohoya*, *Thambia*, *Chitingiri* and *Polyalthia stuhlmannii*. These plants are important sources of timber, fruits and herbal medicine for human, animal and crop diseases. The medicinal plants are used to prevent, treat and cure many diseases and conditions in humans, animals and plants. For instance, *Polyalthia stuhlmannii* is herbal plant used for treating skin ailments, and *Uvaria lucida* is a remedy for digestion and stomach upsets. *Milicia excelsa* and *Polyalthia stuhlmannii* on the other hand are good timber species. Some of these species that were commonly collected from the forest in the past have become rare due to over-exploitation. They include *Polyalthia stuhlmannii* and *Mwerekera* which are important timber and medicinal species. Due to the growing trend of key species becoming rare and depleted, members of the community have resorted to domesticating important wild species on-farm in order to ensure their continued availability.

The main wild plants commonly collected from the forest by the **Digo** community include *Ziziphus mauritiana*, *Strychnos mombasae*, *Nyunzu*, *Tsaye*, *Psidium guajava*, *Mohonga*, *Mziji*, *Mkwamba*, *Chinyapala*, *Msalasanga Mbokwe*, *Syzygium cumini*, *Adansonia digitata* and *Mkunguma*. Most of these plants are important sources of fruits, timber and herbal medicine. Some important plants that were formerly collected from the forest have become rare, including *Mahonga*, *Strychnos mombasae*, *Syzygium cumini*, *Mkunguma*, *tsamvia*, *Vitoria*, *Ladonpholia kirkii* and *Vangueria madagascarensis*. This is mainly due to deforestation for development and charcoal burning as well as erosion of traditional knowledge that was previously used to protect important plant species.

In the **Duruma** community, the main plants that are commonly collected from the forest include *Mnango*, *Mrihi*, *Mzungi*, *Mtanga*, *Mdokadoka*, *Mbambara*, *Mdzombadzomba*, *Mwanga*, *Mkone*, *Mdzala* and *Mbambakofi*. Some important plant varieties such as *Milicia excelsa* and *Mfunne* have however become extinct, while others such as *Msufwi*, *Mkulu*, *Mgoma* and *Mzambarau* have become rare and difficult to get due to overexploitation for construction materials and charcoal production.

### 5.6.2 Domesticated wild plants

Domestication involves planting priority herbal plants on farm using TK-based innovative technologies that enhance the plant's productivity. In **Giriama** *Lilium orientale* (fruit), *Monanthotaxis fornicate* (medicine), *Tamarindus indica* (fruit and timber), *Oldifieldia somalensis* (medicine), *Vitoria* (fruit), *Azadirachta indica* (medicine), *Mhegakululu*, *Mkulukazingwa*, *Fernandoa magnificia* (medicine) *Ladonpholia kirkii* (fruit), *Mukuha* (medicine) *Konzi* (*Starch*, *Halua*, *Bokoboko*), *Sisyphus mauritiana* (fruits), *Mkwalina* (medicine) and *Salvadora persica* (medicine) are the most domesticated trees in the community, have been domesticated by the community itself. The most common utilized forest products in the site are herbs, firewood and fruits.

In **Chonyi** the community has domesticated important forest species to ensure their sustainability. The trees include *Syzygium cumini* (fruit), *Psidium guajava* (fruit), *Tamarindus indica* (fruit), *Afzelia quansensis* (timber) and *Aloe* species (medicine). Other commonly used forest products in the area include firewood, timber and coconut leaves thatch (*Makuti*), while the best forest products for the market include timber and construction poles.

Some of the wild plants domesticated by the community in **Rabai** using TK-based technologies/innovations include *Afzelia quansensis* (timber), *Azadirachta indica* (medicine), *Milicia excelsa* (timber), *Syzygium cumini* (fruits), *Mnavu* (vegetable) and *Tindihoho* (vegetable). The commonly used forest products in the community are firewood, herbs and timber. The **Digo** community has resorted to domesticating key species on-farm as a way of ensuring their sustainability in response to climate change which has seen forests face the threat of degradation due to poor and changing seeding patterns of the trees, affecting natural regeneration. Seeding patterns have changed to the extent that they are not synchronized with rainfall seasons. The most commonly domesticated species in **Digo** include *Psidium guajava* (fruits), *Afzelia quansensis* (timber), *Milicia excelsa* (timber), *Mkungu* (timber), *Mtsani* (timber), *Tamarindus indica* (fruit and timber), *Syzygium cumini* (fruit) and *Mkunguma* (timber and fruit). The commonly used forest products in the community are firewood, poles, timber and herbal medicine. In **Duruma** community, *Mkulu* (fruits, poles, herbal medicine and shade), *Terminalia spinosa* (timber), *Tamarindus indica* (fruits, timber), *Adanisonia digitata* (fruits), *Aloe species* (herbal medicine, cosmetics) are the most commonly domesticated plants.

### 5.6.3 New forest products and best products for the market

The Giriama community has adopted beekeeping, butterfly farming and selling of wild fruits. Honey, wild fruits, herbs, charcoal and firewood are the common forest products used by the community. Wild fruits, charcoal and honey are the best forest products in the market in Giriama. Meanwhile in Chonyi, there are new forest products and corresponding uses that community members have discovered in the recent past- use of the forest for educational purposes, commercial charcoal production and ecotourism. Correspondingly, in Rabai and Digo ecotourism has been introduced in the recent past as a new income generating forest use. Firewood is the best product for the market in Digo since it's used by the majority of the residents for cooking and is thus in high demand. In the Duruma community, *Aloe* species are used for making soaps and lotions while in the past it was mainly used for medicinal

purposes, while the *Mbambara* tree which was previously used for making frankincense (*Ubani*) is currently used in furniture construction. Charcoal, herbal medicine, poles and firewood were identified as the best products for the local market.

## 5.7 Farming technologies and tools

Slash and burn, fallow cropping, intercropping, rotational cropping and broad casting were the common traditional farming methods used by the **Giriama** community in the past. Small hoes (*Viserema*) and machetes were the traditional farming tools. The tools are still in use, but farmers have adopted modern methods of farming like planting in lines and do not burn vegetation anymore as they have realized it reduces soil fertility (by killing the microorganisms which decompose organic matter in the soil). The community still practices intercropping and rotational cropping but not fallow cropping due to reduced land space. Intercropping and rotational cropping increases or maintains soil fertility, and reduces weeds and susceptibility of the community to hunger in case one crop fails due to crop diversification. It also enables farmers to harvest continuously as different crops mature at different times.

The main traditional farming methods used in **Chonyi** were: slash and burn, broadcasting planting system and terracing. Traditional tools such as hoes and machete were also widely used. These traditional methods are still widely used because they are fast and cheap. Likewise in **Rabai** the main traditional farming method used are slash and burn method, intercropping with legumes, crop rotation and broadcasting. The main traditional farming technologies used in the community is slash and burn for land preparation and broadcasting during planting. Traditional farming tools and implements such as machete, hoe, axe and traditional baskets for carrying farm ware are also still in use due to their availability and community familiarity with them. The same farming methods are also applied by both the **Digo** and **Duruma** communities except that traditional tools are often complemented with modern tools such as jembe and ox-plough while broadcast planting has been fully replaced with line planting. The traditional farming methods were said to be less costly and very effective.

Traditionally the **Giriama** community used tree leaves as manure (*Moria*, *Mtserere* and *Adansonia digitata*) and applied mulch to increase productivity since mulch increases water retention in the soil. Currently the community has adopted the use of animal manure and even inorganic fertilizers to increase crop productivity. The **Chonyi** community has also employed various traditional methods to improve crop productivity which is threatened by unpredictable variability in weather patterns. These methods include mulching, intercropping with legumes, use of animal manure, timely weeding and crop rotation. In **Rabai** crop productivity is improved through adding animal manure to the soil, mulching and mixing crops residues with soil; this increases soil organic matter as a result of decomposition of the crop residues and timely weeding. Whereas in **Digo** ash fertilizer, crop rotation, animal waste as manure, mulching and proper weeding have been used to improve crop productivity for a long time. In **Duruma**, the main methods used to improve crop productivity are mulching, application of animal manure, planting of legumes for nitrogen fixation and crop rotation. These methods are still widely used since they are cheap, easily available and effective.

## 5.8 Food preservation methods

A traditional granary was the most common traditional food preservation method used by the Giriama in the past. Maize and millet were dried without removing the husks and kept in the granary and a fire was lit below it so that the smoke could preserve the maize, cassava and mangoes were chopped into pieces dried and kept in the granaries. Cowpeas were dried and kept in the granary without removing the pods and kept in calabash if pods are removed. Calabashes were mainly used to store planting seeds which were to be used the following year. Honey combs were hung in granaries as they were thought to scare away pests. The community also used to dry fish and wild meat.

Likewise, in Chonyi drying and storage in traditional granaries was the common food preservation method used in the past; cereals such as maize and cowpeas were sun-dried after which they were stored in granaries and cassava was chopped then dried before storing them in granaries. Other food preservation methods were used by the community such as smoking of meat, coagulation of milk, use of ashes to preserve seeds, and smoking grains such as maize using pepper.

Just like the Giriama and the Chonyi, the Rabai community used sun-drying and granaries to preserve their harvested grains. The grains in the granary were then smoked with pepper, and smoking was used to preserve meat. Similarly the Digo used sun-drying as a food preservation method for maize, cowpeas and cassava. Some dried grains were then stored in granaries, while others were stored in sacks which were used as seats near cooking places to preserve them using both heat from the fire and friction generated as a result of sitting on the sack. Fresh cassava was buried in the ground and sprinkled with water to keep it fresh for long. Similarly, the Duruma community used sun-drying to preserve meat and grains like maize, cowpeas and cassava. Additionally, harvested cereals were stored in traditional granaries constructed above the fire place.

At present the Giriama have adopted the use of plastic containers to store dried food crops mainly maize; cassava is not dried anymore as it is either eaten or sold, and calabash are becoming extinct in the community. The Chonyi, Rabai and Duruma use the same preservation methods as the Giriama except that in addition to drying they use conventional chemical preservatives. Contrary to the other communities, the Digo still use most of the traditional food preservation methods but the communities now use them alongside modern chemical preservatives.

## 5.9 Natural disasters and community coping mechanisms

Drought, floods along river banks, strong winds, and pests and diseases are the major disasters the **Giriama** community has so far encountered, and the community has developed a number of locally driven responses. It has adopted more perennial than annual crops as the perennial crops are more tolerant to drought than the annuals. They farm away from river banks during the rainy season to prevent their farms from being flooded. They also spray their plants with pesticides and plant less vulnerable crops during long rains as it is the season of a lot of pests and diseases.

Whereas in **Chonyi** the most common natural disasters that have occurred in the recent past include drought that has resulted in poor crop harvests, crop and animal pests and diseases and the El Niño of 1997. In order to effectively respond to these and other disasters, the community has put in place various locally driven and TK-based coping mechanisms, including tree planting which is a new practice to curb drought, undertaking peace campaigns and awareness creation to promote ethnic cohesion. Mitigation strategies such as restriction of settlement in disaster prone zones have also been initiated.

The most common natural disasters that have occurred in **Rabai** community in the recent past are El-Niño rains (1997) which caused floods, and drought, famine and plant and animal pests and diseases, all of which are as a result of the changing climatic patterns. The community have undertaken tree planting in order to attract rainfall and avert drought in addition to constructing dams through funding from organizations such as Coast Development Authority. Local remedies such as ash and *Mziduzi* plant mixture are used to control plant pests and diseases.

Likewise in **Digo** the most recent natural disasters that have occurred in the community are El-Niño (1997) and drought, which are attributed to the changing climatic patterns. The community has also undertaken various preparedness measures such as digging terraces, evacuation to safer areas and marking of hazardous areas to mitigate the impacts of El-Niño. In **Duruma**, the most common natural disasters that have occurred are El-Niño (1997 and 2006), frequent droughts and livestock diseases such as *Kideri* in poultry. Some of the coping mechanisms developed in order to cushion themselves against the effects of these natural disasters include the mixing of poultry feed with traditional herbal plant varieties such as *Mnyundonyundo*, whose stems are crushed, to treat *Kideri* disease in poultry; spraying crops with neem soup (a filtrate of neem leaves soaked in water and mixed with ash and indigenous variety of pepper to prevent crop pests); and offering prayers and sacrifices in the kaya forests during the occurrence of disasters.

## 5.10 Weeds, pests and diseases

The most notorious weeds in Giriama are *Ndago*, *Kakoka*, *Kahumbo kambuzi*, *Kimбири*, *Kasumba*, *Mgalagala*, *Mwambanyama* and *Kitoria*. While in Chonyi the most notorious weeds are *Chitsai*, *Mwambanyama*, *Ndago*, *Chimbimbi* and *Mgalagala*. The notorious weeds in Rabai include *Mwambanyama*, *Ndago*, *Muhani*, *Chibunda* and *Muhaya*. *Ndago* is the most notorious plant weed in Digo and Duruma. The weeds are controlled through intercropping, frequent weeding and use of herbicides.

Stalk borers, *Funzi*, *Chenene*, *Madama*, *Nyunza* and termites were identified as the most notorious plant pests, while crop wilt is regarded as the most notorious plant disease in Giriama. Notorious plant pests in Chonyi include *Chikombe*, *Chikongomwa*, *Chongwa* and *Gunza*. In Rabai the most notorious crop pests in Rabai are *Vikobwe*, locust, *Mngunza*, *Fumbiri* and *Vikongomwa* that attack crops at germination. Whilst in Digo the most notorious plant pests include army worms (*Fumburi*), stalk borers (*Mabuu*), beetle kind (*Vidundu*) and aphids. All these pests in Rabai and Chonyi have become more intense in severity worsening the food security situation due to reduced harvests. These pests are usually controlled through spraying with *Azadirachta indica* mixed with water and use of modern pesticides. The use of *Azadirachta indica* crushed leaves mixed with water is a traditional innovative practice locally developed in response to increasing incidences of pests in these communities. In Duruma, the most notorious plant pests are army worms (*Fumbiri*), stalk borers (*Mabuu*) and aphids; these pests are controlled using pesticides and neem soup.

The notorious pests attacking the livestock in **Giriama** are ticks, tsetse flies and worms; *Kideri*, *Ngai*, *Chodokera* and wounds were the notorious livestock diseases. Traditionally cattle and goat wounds used to be treated with Konzi and some farmers still use it. A mixture of maize bran and donkey droppings is used by some of the community members to treat *Kideri* and has proven to be very effective. The dung of livestock that graze/browse different species of vegetation and coconut oil is an effective remedy for healing animal wounds. These innovations are based on traditional knowledge.

In **Chonyi** the notorious animal pests include tick, tsetse flies and fleas while diseases include *Kideri*, foot and mouth and intestinal worms. Animal pests and diseases are commonly controlled through use of pesticides, insecticides and conventional drugs respectively. Some traditional methods that are still in use include use of Neem to treat diseases such as foot and mouth, use of *Mshomoro* herb to treat lice in poultry.

Nagana, foot and mouth and Newcastle disease (*Kideri*) are the most notorious livestock diseases in **Rabai**. The community use *Aloe Vera* extract treat to poultry infected with *Kideri* disease, while *Msudu* and *Mziduzi* are used to treat foot and mouth disease in livestock. A mixture of pepper or salt and water is often used to kill pests such as ticks. In the recent past, the community has also embraced the use of modern pesticides and herbicides to control pests and diseases.

The notorious livestock diseases in **Digo** are: foot and mouth, *Kideri* and scabies. The community use *Aloe Vera* and pepper mixed with water to treat *Kideri*. Foot and mouth disease and scabies are mostly treated with conventional drugs. Similarly, in **Duruma**, the most notorious livestock diseases are foot and mouth that affect cattle, lymphatic disease (cattle, sheep and goats) and *Kideri* (poultry). Pests on the other hand include tick and worms (cow, cattle and sheep) and fleas (poultry). These pests and diseases are treated or controlled by observing high hygienic standards, vaccination, dipping, use of conventional medicine and quarantine. In poultry however, a mixture of crushed aloe species, pepper and water is used to treat *Kideri*. Unconventional methods, such as burning of affected parts of an animal body using a hot rod in order to treat lymphatic disease, are also still applied.

## 5.11 Social capital and networks

### 5.11.1 Traditional festivals

In all five communities, there is an array of traditional festivals. These festivals promote social cohesion, facilitate information sharing and encourage values such as reciprocity which play an important role in sustaining local innovations. Reciprocity ensures that traditional knowledge is transferred from one generation to the next, thereby sustaining Biocultural Heritage (e.g. traditional crops), and providing a platform for new innovations to emerge, while at the same time improving and sustaining the existing ones.

However, among the **Giriama**, some of the historical traditions have stopped, others have been modified and some remain as they were in the past. Some of the traditional festivals of the Giriama are: *Kuikakoma* (pitching the spirits of the living-dead) – these are symbolic entities, used for prayers and thanks giving. Specific plant species are made into sticks/carvings that will represent the reputable members of the family who died. They make physical contact with the person undertaking the prayer of thanks-giving, and in a way increase the trust and belief of the individual being prayed for in the spiritual powers of the ancestors or forefathers. There is also *Harusi* (wedding ceremony) where the traditional artifacts (*Hando*, *Mafuhaga mbono*) are used to bless the bride (*Kuhasir wamuche*). Furthermore, the community used to hold *Mahanga* (mourning the dead); for a dead married man, the wife must exercise *Kulazakoma* (resting the dead) by engaging in sex with a stranger. Moreover the Giriama also celebrate *Kuogamadzi* (taking a bath) where those left behind conclude the mourning ceremony with a ceremonial bath; this is done with *Kunyola likwachu* (complete shave of the head), to signify a new beginning. There is also *Hangaivu* (mature mourning) which is more of a ceremony than mourn since there is food, drinks and dances. Besides, the community also used to practice *Uganga* (traditional healing) where the healer trainee graduates attend a ceremony indicating their accession into full practitioners' status. This ceremony has prohibitions before undertaking, which includes avoiding sexual acts for a period of time (it can even be for a year), until after the graduation.

The *Kaya* elders in the community used to perform *Alombi a Kaya* (the *Kaya* prayers) where *Vidzumba mulungu* (houses of the gods) are constructed and *Mikahe ya Mtsanga* (sand bread) are made for the *Vitsimbakazi* (bad spirit). The gods will have a house to rest, while the bad spirits will have a food offer in the form of the soil bread, so that these do not reach out to the people and cause harm. Commonly the *Kaya* is used for prayers for the rains, prayers against diseases and pests, for prayers for peace, for thanks giving after a victory or harvest, and for health and success in life.

After a huge harvest the community used to hold '*Kukuta vumbi*' or 'cleansing the dust' ceremony, where animals are slaughtered and food is cooked for enjoyment. Song and dance are also involved, and the community is happy. In addition, the community used to hold *Kwamula* (to decide, i.e. to start maize roasting/flour processing session). This is done by roasting a few maize cobs that are left at a cross path, just like announcing the roasting of the maize. After that the father and mother (heads) of the homestead do a ceremonial roasting and then the rest of the family members are allowed to take part. For flour processing, the household heads again grind some maize and cook some pulp (*Ugali*) which is then fed to the spirits during a prayer ceremony. Another pulp is eaten by the father and mother of the household before the rest of the family.

Most of the above mentioned ceremonies are only done by specific families which adhere to culture. A good part of the community members are not practicing, either because they are 'modern' or have a different faith (Muslims or Christians). Due to the onset of HIV/AIDS, the *Kulazakoma* ceremony is completely dropped.

The main traditional festivals held in the **Chonyi** community are funeral ceremonies, birth ceremonies, harvesting ceremonies and rain making ceremonies. Male funeral ceremonies are held for a period of 10 days (*Mishero mitano*) while female funerals are held for 8 days (*Mishero mine*) and they are characterised by feast. Shortly after funerals, a special ceremony called *Mabulu* aimed at appeasing the spirit of the dead is held and this is repeated annually. New-born baby girls spend three days indoors while boys spend four days indoors before they are taken out, after which girls is given an axe, hoe, machete, firewood and basket to signify her domestic role in society, while boys are given a bow and arrow as a sign of a defender and hero, as well as a knife for wine tapping to signify his special role

in society. Rain making ceremonies are done by *Kaya* elders mainly in the *Kaya* forests and they are often characterised by offering prayers and sacrifices mainly in form of livestock. During harvesting ceremonies, *Dele*, *Gonda*, *Kayamba* and *Mabumbumbu* dances are performed; men celebrate by drinking palm wine while women boil traditional green maize (staple food) which is feasted on by the whole community. When harvests are poor, libations are done using idols where spells are cast away and idols named after ancestors.

Compared to the past traditional festivals, current festivals are done differently with little emphasis on cultural values. The frequency of their occurrence has also reduced significantly. These changes can be attributed to modernisation and introduction of new religion. Traditional knowledge was previously passed from elders to young ones but currently this has changed as young people spend more time in school and less time spent with elders for transmitting traditional knowledge. The young generation has also become non-receptive to traditional knowledge and term it retrogressive. This has in turn contributed to loss of traditional knowledge.

The traditional ceremonies that are most commonly held in the **Rabai** community include funerals (*Hanga*), weddings, '*Mwaka mpya wa Kirabai*' (New Year festivals), prayers for rain events done by *Kaya* elders, cleansing ceremonies, naming ceremonies (*Mwanani*), *Malози* (dowry payment), and circumcision ceremonies. *Hanga* is done to please the dead, comfort the mourners, and ask the ancestors to welcome the soul of the dead person. Wedding ceremonies are a symbol of love and respect and unite the community. The New Year festival is an event for honouring their God and 'chasing away' bad omen and diseases. Although these ceremonies are still observed, the traditional ceremonies were previously performed in traditional regalia, and now they are at times performed using modern attire. Modernization has also changed the way some of these ceremonies are performed. For instance, during circumcision, some families take their boys to hospital and the blade is not shared as before. The modern ceremonies are also distinct from the ancient traditional ceremonies especially weddings and funerals in that, immorality cases are high for instance early teenage pregnancies, violation of human rights such as rape and violence. Furthermore, current ceremonies are used as platforms for generating income, either from monetary contributions by community members or from selling goods to other members of the community as well as tourists (in the case of the cultural village), unlike before when the ceremonies were mainly for social bonding, passing useful messages and entertainment. These changes can be attributed to modernization, religion and western education.

The main traditional festivals held by the **Digo** community are funerals, weddings, and rainmaking, healing and victory ceremonies. The ceremonies provide rules and regulations for collective management of natural resources and show that there is local leadership (council of *Kaya* elders). Traditional dances mark the hallmark of various ceremonies and various dances are performed in different ceremonies. For instance during funerals, *Chifudu*, *Kwarya* and *Zembe* dances are performed, while in weddings *Mdundiko*, *Sengenya*, *Gonda* and *Mzumbano* dances are performed. *Janja* dance is performed during rainmaking ceremonies while *Chibwengo*, *Nganja*, *Kayamba*, *Ndaro* and *Chifudu* dances are performed during healing ceremonies.

In the **Duruma** community, the main traditional ceremonies held are funerals, rainmaking rituals, healing and wedding ceremonies. Various traditional songs and dances are performed during these ceremonies. For instance, *Makayamba* is performed to chase away evil spirits, *Ngonda* is performed during memorial ceremonies to commemorate the dead and *Chifudu* is performed to reverse bad occurrence.

Some of the ceremonies have been lost while others have reduced in the intensity or are done differently with no or very little emphasis on the important traditional practices that were previously undertaken. Some festivals have also become less frequent than in the past while others have lost their relevance due to the emergence of alternative religions (mainly Christianity and Islam) and modernity. For instance, circumcision ceremonies are no longer carried out since they are nowadays done in hospitals; and while traditional festivals were meant for specific age groups, current festivals attract all age groups with no restriction for children. Traditional attire which was worn during traditional ceremonies has either been modified or is not worn at all when performing ceremonies, while traditional instruments have been abandoned and replaced with modern instruments such as the piano and guitar. All these factors have diluted the cultural relevance of these ceremonies. Even though cultural values such reciprocity, solidarity and social cohesion are important as they provide safety nets for survival,

the inter-linkages between survival, economy and culture are not currently prominent among the four communities due to the dilution of cultural ceremonies and values. Economic activities geared towards survival have taken a centre stage, thus relegating cultural issues to the periphery.

### 5.11.2 Community Groups

Community groups generally promote social cohesion, information exchange and exchange of planting materials (seeds, suckers etc.) and hence support local innovation. The formal registered groups in Giriama villages include: *Maendeleo ya Wanawake* (non-profit voluntary women's organization with a mission to improve the quality of life of the rural areas), Savings and Credit Cooperative (SACCO), a Community Based Organization (CBO), Beach Management Unit (BMU), womens' groups, youth groups, self-help groups, farmers' groups and fishermen groups. But all acknowledge the presence of a certain external force leading towards their registration. Already there are memories of groups that ceased to function with the departure of the external support. And one group – the *Fish Farmers with Stimulus Project* – described its position as doomed since the project expectations are not being realized.

The formal groups have access to credit facility, donor funds, convenient extension and capacity building services, and inter-group or inter-community exchange opportunities. However, the complaint is that in most groups a few members who are better conversant with the group activities are benefiting from the exchange.

The historical groups, managed with cultural rules and regulations included *Dhome* (mentor discussions) which have reduced to almost complete disappearance. This group, was constituted of a few Giriama elders who converged before a fire place together with young Giriama and share realities, challenges and guidelines of life through informal discussions. Such sessions have become less popular because the youth do not have time for sharing with the elders any more as schooling and entertainment, mainly sports (e.g. local soccer tournaments), take their entire time. Although the elders lament the position, they can hardly change it. In addition, the elders lack external links, access to credit, and donor support. This is in addition to being invisible for capacity building and any extension services.

In **Chonyi** the formal community groupings include women's groups, farmers' groups, youth groups and a council of elders' association. Women and youth groups mainly undertake capacity building programmes and provide saving and credit services. Farmers' groups offer training on modern farming methods mainly provided by KARI and MoA, search for markets for their produce and provide forums for linkages and partnerships with other organizations and groups. The *Kaya* elders' association brings together *Kaya* elders from all the Mijikenda communities and enables them to advocate for the protection of all *Kaya* forests.

Community groups link with other community groups outside the community as well as with NGOs, CBOs and governmental organizations mainly for information and knowledge exchange, to seek funding, and to initiate community development projects on health, education and livelihoods among others. Some of the organizations the community link with include Kenya Medical Research Institute (KEMRI), KARI, Population and Health Integrated Assistance plus (APHIA PLUS) and Plan international. Most of the community groups do not however have access to information technology and formal credit facilities.

In **Rabai**, formal community groups include: micro-finance groups (village *Chama's*), Village elders' Committee, Conservation groups, dancing groups, farmers' associations, women's groups and youth groups. These groups link with other groups outside the community mainly for information access. In addition, they also link with NGOs, CBOs and research institutions such as KARI to build their capacity through training, introduction of new technologies and funding. Most community groups don't have access to Information Technology facilities but a few have access to credit facilities from commercial banks, local NGOs and micro-finance organizations such as k-rep bank, *Faulu* Kenya, Kenya Women Finance Trust (KWFT).

At present, the **Digo** community has formal community groups such as village micro-finance groups (*Chama's*), women's groups, youth groups, farmers' groups, water resource users associations (WRUAs), CBOs and Kaya elders associations. Micro-finance, women and youth groups provide capacity building and funding services to members, while farmers' groups and WRUAs train members and link them to relevant partner organizations. On the other hand, the CBOs help initiate community development projects.

These formal community groups link up with community groups, NGOs and government institutions outside the community mainly for mutual (two-way) exchange of technologies which facilitate local innovation, funding and experience sharing. Hence women and youth groups in the Digo community have linked up with organizations such as AIDS, Population and Health Integrated Assistance plus (APHIA II plus), Plan International, Red Cross, Paul Scerrer Institute (PSI) and Aga Khan Foundation. These organizations have initiated community capacity building and poverty eradication programs aimed at empowering the community. Government institutions such as KARI have also been instrumental in introducing high yielding fast maturing maize, cassava, vegetables and grafted fruit trees crop varieties in the community.

In **Duruma**, formal community groups mainly comprise village micro-finance groups (*Chamas*), women's groups and youth groups, who mainly provide capacity building, credit and saving services to members and help link them to relevant partner organizations. These groups link with NGOs and government institutions mainly for technological information exchange and sharing, funding and experience sharing. Some of the key organizations which link with community groups in Duruma are World Vision, Aga Khan Foundation and Kenya Red Cross Society, all of which spearhead community capacity building and poverty eradication programs aimed at empowering the community. Government institutions such as KARI and the Ministry of Livestock have also been key in introducing high yielding and fast maturing crop and livestock varieties in the community.

A major gap observed among the community groups is that they lack information technology services (both internet and computers) while only a few groups have access to credit facilities. Greater collaboration is needed in information technology and credit facilities to enhance the community groups' capacity to share information effectively and provide capital to grow their business ventures.

## 5.12 Innovations developed by the Communities

### 5.12.1 Technological innovations

#### **Planting diverse varieties of the same crop to reduce risk of crop failure**

The farmers in all the five target communities plant different varieties of the same crop especially maize and cassava - traditional, improved and hybrid varieties. The traditional varieties usually take long to mature but can tolerate the pests, diseases and dryness, both the improved and hybrid mature fast but cannot tolerate the diseases, pests and even extended dry periods. This acts as a security to the farmer in the case one variety fails due to drought, diseases or pests. This is a technological innovation developed by members of the five communities in the last 30 years in response to increased incidences of crop pests and diseases and reduced rainfall that have made most crop varieties less productive. The innovation has largely been promoted through peer learning and information sharing during meetings, 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 the use of big hoes as they can dig deeper. Some farmers also using ox ploughs and those with ability to hire tractors use them to plough their farms. The farmers then plant the indigenous maize variety, a case of *Kanjerenjere* was given, and manure is added to the farm to ensure high productivity. The farmers have realized when they plough the farms well and add manure the indigenous maize variety does very well. This is due to the adequate aeration owing to good ploughing, and increased water holding capacity, water use efficiency since indigenous varieties requires less water compared to hybrids and nutrients as a result of adding manure. 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 resulting from declining soil nutrients and changes related to the climate. Traditional planting methods like broadcasting are being replaced by line planting for crops like maize and cowpeas to enhance productivity. The farmers also weed their crops early (immediately after germination) to reduce incidence of diseases. The community has up taken planting of nitrogen fixing trees with food crops (Agro-forestry) to improve soil fertility; the increase in soil nitrogen content ensures high grain production. These changes in practice are aimed at responding to the effects of climate change and improving crop productivity. The community currently uses animal manure instead of slash and burn practiced in the past, as burning usually ends up killing the microorganisms which decompose organic matter in the soil; some farmers also make their own compost manure at their farms.

### Planting large quantities of cassava in response to drought

The farmers in the community have discovered that it is safer to allocate more land under cassava than maize as cassava can tolerate drought more than the maize. In the past cassava was never planted in large quantities but due to the prolonged dryness period the community is experiencing, they have opted to plant more cassava. This ensures that the farmers have food even in dry periods. Frequent incidences of hunger and drought necessitated the adoption of this innovation which has now spread to all the Mijikenda community through peer learning and information sharing through established networks such as traditional festivals. Consequently food security has improved.

### 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 chicken. This is an innovative way of treating the chicken disease using the local knowledge and local resources. Fresh donkey dung is mixed with water and then squeezed using a piece of cloth to obtain a filtrate. The filtrate obtained is mixed with maize bran and is fed to the chickens which have been infected with *Kideri*, the two are mixed in a proportion of 1:2 (Dung filtrate: maize bran). This is believed to cure the disease within a week. The donkeys usually graze in the wild and it is believed that some of the forage they feed on has some medicinal value therefore the waste can be used to treat diseases. Furthermore, 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 grinded to powder form and mixed with coconut oil. The mixture is then applied on the wounded area. It is believed that the droppings of the livestock have some antiseptic value to treat wounds.

The community also uses sea shells to treat eye infection in cattle. The shells are usually crushed to powder and applied to the infected eye. The community has confirmed this to be a successful way of treating eye infection in cattle. Although dung filtrate and animal droppings has been widely used to cure livestock diseases traditionally, the mixing of the dung filtrate with maize bran, or mixing of animal droppings with coconut oil is a new technological innovation aimed at increasing the effectiveness of treating livestock diseases in the face increased incidences and severity of livestock diseases which are thought to be related to 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 technological innovation was developed by elders in the Duruma community through trial and error many years ago and has since been used as a more affordable but effective and locally available treatment for livestock wounds.

### Domestication various wild forest plants on farm for increased income

Wild plants like *Lilium Orientale* (fruit), *Tamarindus indica*, *Ancylobotrys petersiana*, *Ladonpholia kirkii* and *Sisyphus mauritiana* have been domesticated for their fruits. The fruits are usually sold for income, these plants can tolerate prolonged dry periods which ensures that the farmer has a source of income in case of crop failure. Other crops like *Adansonia digitata* are not usually domesticated but the fruits are usually sold either raw or after value addition through sweetening hence generating income for communities. Plants like *Monanthataxis fornicate*, *Oldifieldia somalensis* (medicine), *Fernandoa magnificia*, *Acacia melifera* and *Salvadora persica* have been domesticated by herbalists because of their medicinal value. Farmers obtain the propagative materials of these trees from the forest and raise the seedlings in their farms before transplanting them. Initially, the plants lacked propagation

protocols because no scientific research had been conducted to propagate such plants. However, the communities (in groups and at individual level) have been able to come up with these protocols after trying several methods. Consequently, plants that can be propagated using cuttings, seeds and wildings are known and now the communities are raising the plants in their nurseries for planting on their farms. Furthermore, by domesticating these plants on their farms, the pressure on the forest are reduced hence the biodiversity is conserved. Domestication also ensures sustainability of these plant species in the wake of forest degradation resulting from climate change. 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 increased incidences of crop pests and diseases that necessitate development of local remedies.

Among the Duruma community for instance, *Hyphaene compressa* (Doulm tree) which often grow in riverine areas mostly in the wild is now being domesticated on-farm. The species has in the past couple of years become rare in Duruma area following massive deforestation. It is however in demand for its use in weaving and basketry which is a common practice in the community, some farmers and especially those who undertake commercial weaving and basketry at cottage level decided to domesticate this species on their farms as a source of raw materials. An additional advantage is that the species is also an important material used in the construction of traditional Duruma houses. This 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 sustaining traditional skills in weaving and basketry.



Figure 5: Wild palms domesticated on farm. Photograph by Stella Mutta.

#### **A method of planting coconut seeds which reduces 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 before being removed from the husk. In this innovation, the coconut seed is planted with the soft spot on the protruded side lying downwards in the soil in a slanting position and this leads to faster germination. This method was invented about three years ago by an individual farmer in Rabai community as a remedy to frequent termite attack on coconut seeds upon planting. The increased frequency in termite attack is thought to be linked to recent climatic changes because a long time ago, the attack never existed. The faster germination has helped minimize the period of termite attack hence solving the problem. This has in turn ensured faster growth and high productivity of coconut fruits.



Figure 6: An illustration a coconut fruit with the three 'eyes'

### **Planting and uprooting of cassava first to turn the soil and preserve nutrients**

This innovation entails planting cassava on huge areas of land and upon harvesting, the deep rooted cassava plants are all uprooted leaving the entire farm soil turned and well mixed, after which a crop of one's choice is planted on the farm. This method ensures that all the soil nutrients are preserved and the soil texture maintained. It was invented by the forefathers – the first generation back 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.

### **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 wine to their wheat flour mixture in preparation for cooking, only to realise that the fresh wine had 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 information sharing during 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*. The innovation has helped the locals to save on the cost of buying yeast and has contributed to food security since it is cheaper to make pastries like bread. Additionally, the palm wine is considered as a healthier alternative to conventional yeast that community members claimed causes stomach upsets amongst some people. The innovation can be summarised as follows:

- A cup of freshly harvested palm wine is added into a mixture of wheat flour.
- The mixture is then thoroughly kneaded and rolled to desired shapes which are then cooked or deep fried.

### **Use of 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 5 years ago. He noticed that the young cassava pruning tops that fell on the ground soon after pruning sprouted very fast and thereafter started growing 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 prompted the farmer to start using the pruning tops as an alternative that ensures both faster maturity and higher productivity since prior to this, farmers had to wait for about two years for cassava to grow and mature. This innovation has since been used in the farmer's village and is fast spreading to neighbouring villages mainly through linkages with other communities and information exchange during inter-community workshops and farmers' fairs organised by external organizations such as KARI and KEFRI. It has helped address the challenge of slower crop growth and lower productivity due to reduced rainfall, since it is able to circumvent rainfall shortage

by maturing within a shorter period, hence improving food security. The process of implementing the innovation can be summarized as follows:

- Young pruned cassava tops are cut into 30cm pieces.
- The cuttings are planted slanting at about 45 degrees.
- The plantings grow very fast and at about 3-4 weeks, the cuttings start forming about 10-12 small tubers which then grow and mature at 12 months. The young cassava pruning absorbs and stores nutrients from the soil better than the mother plant thus producing more tubers and maturing faster.



*Figure 7: Freshly pruned cassava that is then cut and planted (left); and a 3-4 week old cassava crop planted from the pruning's that have started forming tubers (right). Photographs by Stella Mutta.*

#### **Use of seed storage sacks as cooking seats to prevent insect attack**

This innovation was developed by female farmers among the Digo community and has since spread to the entire community. It is a seed storage technique whereby seeds mainly from grains are dried and then kept in a sack after which it 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 resulting from fire and friction resulting from movement during cooking prevents insects from attacking the seeds which are planted at the onset of rains. This method has been used to preserve maize seeds for up to four months before planting while cowpeas, groundnuts and green grams seeds can be preserved for up to one year. In recent years, increasing temperatures has resulted to an increase in the range and severity of crop pests and specifically insect borers that attack harvested grains. The innovation provides an effective way for the local community to prevent the borers and keep the harvested food reserve for longer periods.

The earlier traditional known method of preserving seeds is hanging maize cobs and bean and vegetable pods above the fire place. However, this technique of de-podding the seeds and removing maize seeds from cobs, and putting them in a sack beside the fire place where it also acts as a seat, is a new practice developed by the current generation.



Seed storage bag near the fire place



A woman sitting on the sack

*Figure 8: A seed storage sack placed near the fire place and a woman sitting on the sack while cooking. Photographs by Stella Mutta.*

### **Digging of livestock water pans in homesteads to improve animal health**

This innovation by the Duruma community was first developed by a few livestock farmers from Mwalukombe village in Kinango District about 9 years ago. Kinango district is a semi-arid area that is often faced with acute drought and as a result livestock often trek for long distances in search of drinking water and pasture. This has often impacted negatively on animal health while cases of disease transmission resulting from shared water points have become rampant. This innovation was developed in order to avail safe drinking water within the vicinity of the homestead, thus reducing both the long distances trekked and the spread of waterborne diseases, improving the overall health of livestock and increasing their production. The innovation has since been embraced by other farmers mainly through emulation after the realization of its benefits.



*Figure 9: A water pan dug next to a homestead. Photograph by Stella Mutta.*

### 5.12.2 Market innovations

#### Rabai cultural village

*Kaya Mudzi Muvya* is one among the five *Kayas* of the Rabai community; the *Kaya* faces a major threat due to the rapid socio-economic and cultural changes in Kenya which has affected the value and cohesiveness of the local traditional values. This has been coupled with growing human demands for forest products and land for farming. Local communities are responding to low agriculture productivity caused by unpredictable weather conditions by seeking expansion of area under cultivation of food crops. As a result, there has been encroachment of *Kaya Mudzi Muvya* forest to create the cultivable area. Besides, incomes from agricultural crops are dwindling because of the low productivity. Thus, the Rabai community through collective action have come up with a Cultural Village in the *Kaya Mudzi Muvya* forest as an alternative source of income. The cultural village provides a central venue for showcasing the cultural ceremonies, rituals and agro biodiversity related practices of the Rabai community.

Since it was formed the village has brought together different groups who are involved in traditional dancing or exhibiting cultural practices and rituals which are a tourist attraction; this has enabled the community to market their culture and diversify and increase their income sources. The community has also adopted dances from other Mijikenda tribes and modified them using different traditional instruments as well as different genders to perform the dances. This has made the village have a diversified cultural exhibition making it an attractive place to visit to both local and international tourists. This collective action has also allowed the community to network through exchange of planting materials of traditional crops like cowpeas and sweet potatoes which are grown in the *Kaya*. The cultural village was aimed at promoting social cohesion, conserving the *kaya* forest and generating additional income to the community, and it has largely been promoted through cultural festivals coordinated by *kaya* elders. Inside the cultural village traditional huts have been built using traditional architecture, exhibiting the layout of a traditional Rabai village. It includes a traditional spiritual healers' hut, a shrine where evil spells are exorted, a traditional granary, a typical Rabai kitchen as well as an area where indigenous crops like cowpeas and sweet potatoes are cultivated.

### 5.12.3 Institutional innovations

#### Conserving the traditional culture

The cultural village was formed in order to ensure the Rabai cultural practices are not lost and also to protect the *Kaya* forest. The cultural village therefore provides cultural, economic and conservation benefits to the Rabai community. Pregnant women, men and women who have engaged in sexual intercourse the previous night, women in monthly period and young babies of less than 6 months of age are usually not allowed to enter the *Kaya*. The cultural village allows people who have not met these conditions to be allowed to enter the *Kaya* forest to access services like healing, fore-telling and removal of spells otherwise done in the *Kaya*. Apart from these services, one is able to see the different ceremonies, dances and even games of the Rabai community.

Table 3: TK-based Innovations developed by the five Mijikenda communities

Innovation	Type of innovation	Innovator community
Planting diversified varieties of the same crop in the same piece of land in a single season	Technological	Giriama
Combination of technological and traditional tilling practices	Technological	Giriama
Change in farming practices	Technological	Giriama
Planting large areas of resilient crops	Technological	Giriama and Chonyi
Treating livestock wound and diseases using donkey, cattle and goats' dung	Technological	Giriama and Duruma
Domestication of wild plants	Technological	Giriama, Chonyi, Rabai Digo and Duruma
A more effective way of planting coconut	Technological	Chonyi
Use of young cassava tops as planting materials	Technological	Rabai
Use of seed storage sack as cooking seats near fire place	Technological	Digo
Digging of livestock water pans in homesteads	Technological	Duruma
Formation of a cultural village to showcase culture	Market	Rabai
Use of coconut wine as yeast	Technological	Chonyi
Formation of a cultural village to conserve culture	Institutional	Rabai

#### 5.12.4 Factors that have supported the innovations

There are several factors that support the innovations. These factors could be classified into people/innovators, institutions/organizations, networks, and community level factors. A number of individual farmers have developed local technological innovations which they are freely sharing with other farmers in their vicinity to enhance production. Examples include the cassava farmer who developed a new propagation method to ensure early maturity and increased yield in Rabai and the female farmer who preserves maize in a sack near the fire place. These two farmers have shared their experience and knowledge with others and are typical innovators who are promoting their unique local knowledge based innovations. Regarding institutions, the Kaya elders' council is 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 promote TK-based innovations. Community based groups/organizations like herbal groups, women's groups and farmers groups promote social cohesion, information exchange and exchange of planting materials (seeds, suckers etc.), which supports local innovations. They also provide a wide network for exchange of knowledge, skills and a wide range of seeds and planting materials for crops and other plants. The many different traditional ceremonies and festivals provide a network for the members of the communities to share information on various innovative practices and are therefore important in supporting local innovations.

## 6.0 Recommendations

- i. Awareness raising and further discussion is needed with local communities on the concept of traditional knowledge based (or biocultural heritage-based) innovations and how best communities can identify these innovations and enhance them in order to increase their resilience to climate change, and on the factors and conditions that foster resilient innovation systems.
- ii. Policy responses for climate change adaptation should support and enhance indigenous knowledge and strategies for resilience.
- iii. Promotion of modern crop varieties should be accompanied by efforts to ensure that this does not lead to the loss of local varieties and seed banks.
- iv. Inter-community visits should be facilitated to scale up useful innovations such as the cultural village.
- v. There is need to enhance the role of local organizations e.g. herbal, farmer and women's groups, in promoting and supporting innovation. These organizations should be made more community-driven to ensure their sustainability.
- vi. Strengthening of inter-village governance and of the role of traditional authorities/elders, is critical for the preservation of cultural practices, beliefs and traditional knowledge.

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SIFOR (Smallholder Innovation for Resilience) is an action-research project working with indigenous and local communities in India, Peru, China and Kenya, coordinated by the International Institute for Environment and Development (IIED). It aims to revitalise traditional knowledge, crops and innovation systems for food security in the face of climate change.

This report presents the findings of a Qualitative Baseline study conducted in 30 project villages in coastal Kenya. The study explored the farming systems and changes that have occurred in the last 30 years, the innovations developed in response to these changes, and the social factors that support traditional knowledge-based innovation.



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## Project materials

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### Food and Agriculture

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