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## **INCEPTION REPORT**

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### **COUNTRY CASE STUDY ON PATHWAYS FOR INNOVATION FOR SUSTAINABLE AGRICULTURE INTENSIFICATION IN KENYA**

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## LIST OF ACRONYMS AND ABBREVIATIONS

<b>Abbreviation</b>	<b>Full name/ meaning</b>
AfDB	African Development Bank
ASAL	Arid and Semi-Arid Lands
ASTGS	Agricultural Sector Transformation and Growth Strategy
ATVET	Agriculture Technical Vocational Education and Training
AU	African Union
AUC	African Union Commission
CBO	Community-Based Organization
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FPEAK	Fresh Produce Exporters Association of Kenya
GoK	Government of Kenya
HCDA	Horticultural Crops Development Authority
ICT	Information and Communication Technology
IFAD	International Fund for Agricultural Development
JICA	Japan International Cooperation Agency
KALRO	Kenya Agricultural and Livestock Research Organization
KDB	Kenya Dairy Board
KEPHIS	Kenya Plant Health Inspectorate Service
KEPSA	Kenya Private Sector Alliance
KNBS	Kenya National Bureau of Statistics
M&E	Monitoring and Evaluation
MALFC	Ministry of Agriculture Livestock, Fisheries & Cooperatives
MDAs	Ministries, Departments and government Agencies
MFI	Micro-Finance Institution
MWS&I	Ministry of Water, Sanitation and Irrigation
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organization
NSA	Non State Actors
PPP	Public Private Partnership
R&D	Research and Development
RWH	Rainwater Harvesting
SAI	Sustainable Agriculture Intensification
SLM	Sustainable Land Management
UPA	Urban and Peri-Urban Agriculture
USAID	United States Agency for International Development
WFP	World Food Programme
WRA	Water Resources Authority

## 1. COUNTRY BACKGROUND AND AGRICULTURAL CONTEXT

### 1.1 Kenya: Extent, Topography and Administrative units

**Location and Extent:** The Republic of Kenya is in East Africa, located between latitudes 4°N and 4°S and longitudes 33°83' E and 41°75.5' E. Straddling the Equator, Kenya shares borders with Uganda to the west, Tanzania to the south, Ethiopia in the north, South Sudan in the north-west, Somalia in the east and the Indian Ocean to the southeast (Figure 1). The country covers a total area of 582,646 km<sup>2</sup>, of which 11,230 km<sup>2</sup> (1.9%) are water bodies. Of the remaining 571,416 km<sup>2</sup> landmass, some 490,000 km<sup>2</sup> (or 84% of total land mass) comprises arid and semi-arid lands (ASALs) which are characterized by low, erratic rainfall, high evapotranspiration rates, poor soil fertility and scarce water resources. The remaining 16% of Kenya's landmass is of high and medium agricultural potential with adequate and reliable rainfall.

**Topography:** The geography of Kenya is diverse, with relief, climatic and ecological extremes affected by altitudes, which vary from sea level to over 5,199 m a.s.l. on Mt. Kenya, the highest mountain in the country. The terrain (Figure 1.1) ranges from coastal reefs to inland plains, plateaus, with dominant features being major highlands which constitute the "Water Towers" of the country. These are the Mt. Kenya, the Aberdares, the Mau escarpment, Cherangani/Tugen Hills and Mt. Elgon. Other smaller water towers and catchment areas include low mountains and hills in the drylands, which include the Chyulu, Iveti, Nyambene, Manga, Maragoli, Ngong hills, Shimba and Taita Hills, Mts. Kulal, Marsabit, Ndoto and Nyiru. Geographically, the country may be divided into seven major topographic regions: a coastal belt; plains adjoining the coastal strip; a low plateau; northern plains; the fertile central Kenya highlands; the north-south Rift Valley region and the western plateaus that form part of the Lake Victoria basin. Moreover, Kenya has an 880 km long coastline extending from Ishakani in Somalia in the north, to Vanga in the south and an Exclusive Economic Zone of 200 nautical miles.

**Administrative Units:** Kenya is divided into 47 Counties in a devolved system of Government, enshrined in the Constitution of Kenya (GoK, 2010). Kenya's devolution model has seen the National Government transfer certain powers, functions and responsibilities to the 47 counties. The devolved government system recognizes the right of communities to take charge of their own affairs and development. Some of the functions devolved to counties that are relevant to SAI include; agriculture, environment and natural resources (including forestry), lands, housing, urban development, health and social services. Thus, devolution requires that agricultural development to be factored in County Integrated Development Plans (CIDPs), which should be in line with the Kenya Vision 2030 and national Government plans and strategies.

### 1.2 Population

**Population:** According to the Kenya Population and Housing Census (KNBS, 2019), Kenya as at 2019 had a population of 47.64 million, with growth rates averaging 2.2% annually (KNBS, 2019) With a household size averaging 3.9 individuals, living in 12.1 million households, Kenya's population density averages 82 persons per km<sup>2</sup>. The country has a youthful rural population as 35.7 million Kenyans (75.1%) are below 35 years of age. A majority of the Kenyan population (68.9%), live in rural areas, but rural-urban migration has been increasing. Overall, Kenya's population is projected to reach 67.84 million by the year 2030, by which time some 63% of the people will be living in urban areas. Meanwhile, poverty is a major problem albeit incidences of poverty have been dropping, from 52.2%

in 1997 to 38.7 % in 2020 (UNDP, 2020). Kenya ranks 143 out of 189 countries and territories on UNDP Human Development Index (UNDP, 2020).



**Figure 1: Kenya: Extent, topography and major towns**  
*(Source: Republic of Kenya, 2013).*

### 1.3 Climate

Kenya has a moderate tropical climate which is tempered by topographic relief, as well as the movement of the Inter Tropical Convergence Zone (ITCZ). Rainfall is also affected by large water bodies like the Indian Ocean and Lake Victoria. The country generally experiences two seasonal rainfall peaks of the long rain (March – May) and short rain (October -December) in most places. Most of the country is relatively dry with mean annual rainfall estimated at 680 mm per year. But this rainfall is unevenly

distributed over country in both spatial as well as temporal scales, varying from about 200 mm in the dry areas to over 2,000 mm in the humid zones, mostly in the highlands.

**Agro-climatic zones:** The country is commonly divided into seven agro-climatic zones, namely; (i) Afro-Alpine, (ii) humid, (iii) sub-humid, semi-humid, (iv) semi-humid to semi-arid, (v) semi-arid, (vi) arid and (vii) very arid. About 84% of the land area is classified as arid and semi-arid lands (ASALs), which also include the very arid zones. Thus, most of the country suffers low and erratic rainfall, with recurrent droughts and floods. These in turn affect agriculture, livelihoods, household incomes and the national economy.

**Climate change threats:** There is growing evidence that climate change is occurring in Kenya. The minimum temperature has risen generally by 0.7–2.0°C and the maximum by 0.2–1.3°C, depending on the season and the region (GoK, 2010). Temperatures are increasing and the six warmest years have all occurred since 1987. Also, the frequency of ‘hot’ days has increased dramatically, by 57 days per year whilst cold nights have declined by 42 days per year. Projections indicate increases of 1-3.5 degrees centigrade by 2050s (GoK, 2010).

**Drought Prevalence:** Kenya is prone to weather related disasters particularly droughts and floods. Climate change has seen drought become more frequent and intense particularly in the ASALs (Republic of Kenya, 2012). About 6.5 million people (13%) per year are exposed to droughts in Kenya and this number is expected to increase to 34% (more than 25 million people) by 2050 in tandem with population growth. Drought particularly affects agriculture which is mostly rainfed in Kenya. Drought adaptation and resilience initiatives are important SAI initiatives.

#### 1.4 Natural Resource Base

**Land:** Land represents one of Kenya’s most important natural resources and upon which the livelihoods of a majority of the population are dependent. Kenya’s Land Policy (Republic of Kenya, 2009) describes land as having multiple values which include: (a) Land is an economic resource that should be managed productively; (b) Land is a significant resource to which members of society should have equitable access for livelihood; (c) Land is a finite resource that should be utilized sustainably; and (d) Land is a cultural heritage which should be conserved for future generations. Kenya’s Vision 2030 describes land as a critical resource for socio-economic and political development of the country. About 42% of Kenya’s GDP and 70% of employment is derived from land-specifically natural resource-based sectors, including agriculture, water, energy, forestry and tourism.

**Freshwater Resources:** The total renewable freshwater resources of Kenya are estimated to be 76.610 billion m<sup>3</sup>/year, of which 20.637 billion m<sup>3</sup>/year is surface water and 55.973 billion m<sup>3</sup>/year is ground water (Republic of Kenya, 2013). Kenya’s surface water resources are distributed across five major drainage basins: the Tana, Athi, Ewaso Ng’iro north, Rift Valley and Lake Victoria Basin. These basins drain from the major water towers, i.e. Mt. Kenya, the Aberdares, the Mau escarpment, Mt. Elgon, Cherangani/Tugen Hills and other water catchment areas. These diverse water towers contain about 164 sub-basins with perennial rivers, of which 33 have ephemeral flows, while 90 sub-basins suffer from surface water deficits. About 54% of Kenya’s water is in transboundary basins, shared with other countries. Although Kenya has poorly distributed rainfall, in absolute terms, the country has adequate rainwater to meet all her water requirements. The total volume of rainfall in Kenya is estimated as 365.6 billion m<sup>3</sup>/year, (FAO, 2015) which is a substantive amount of water. The main disconnect is failure to



harness the rainfall potential and store it strategically and in substantial amounts. In addition, the country has nine lakes larger than 40 km<sup>2</sup> but only four are freshwater lakes; i.e. lakes Naivasha, Olbolosat, Baringo and Victoria. The rest are saline lakes located in the Rift Valley, such as Lakes Turkana, Nakuru, Baringo, Bogoria, Elementaita, Magadi and Jipe. There are also reservoirs created from dams and ponds, spread across the country.

**Water Scarcity:** Kenya is a water-scarce country<sup>1</sup> with rapidly dropping fresh water availability as the demand for water supplies and services continues to grow. The total water demand for domestic, industrial irrigation, livestock, wildlife and inland fisheries is expected to increase from 3,218 million m<sup>3</sup>/year in 2010 to 21,468 million m<sup>3</sup>/year in 2030 and growing to 23,141 million m<sup>3</sup>/year in 2050. But the greatest water resource in Kenya, the rainfall, remains largely untapped and thus, under-utilized.

**Soils:** Kenya has a wide range of soils emanating from the variations in geology, relief and climate. The country has 25 major soil types but in terms of geographic coverage, about 15 soil types dominate. These include; Nitisols, Regosols, Cambisols, Luvisols, Solonetz, Ferralsols, Acrisols, Alisols, Fluvisols, Andosols, Arenosols, Calcisols, Lixisols, Planosols and Vertisols (Sombroek et al, 1982). The distribution of soil types varies substantially. In Central Kenya and the highlands, soils are of volcanic origin, mainly Nitisols and Andosols. In western Kenya the soils are mainly Acrisols, Cambisols (WRB, 2014). In the ASALs, the soils are mostly Vertisols, Gleysols and Phaeozems, characterized by low fertility, pockets of sodicity/salinity and vulnerability to erosion. Coastal soils are mostly Arenosols, Luvisols and Acrisols, being coarse textured and low in organic matter. About 59% of Kenya's soils have moderate to high fertility, meaning they are suitable for growing crops, but rainfall is usually the main limitation.

## 1.5 The Economy

The economy of Kenya is largely dependent on agriculture and tourism. The per capita Gross Domestic Product (GDP) of Kenya in 2019 (KNBS, 2020) was KSh.204,783 (equivalent to US\$ 2,048). Indeed Kenya has transformed from a developing country to a Lower Middle Income Country, as declared by the World Bank<sup>2</sup>, when in 2015, the country's per capita GDP exceeded the US\$1,000 mark. However, poverty prevalence is estimated at 38.7 % in 2020 (UNDP, 2020), and thus, the economy needs to perform better, to create more jobs, bridge the poverty gap and reduce inequality. According to the Kenya National Bureau of Statistics (2020), the country has an average GDP growth rate averaging 5.4% in 2019, but this was before the COVID-19 Pandemic broke out. The GDP growth rate is estimated to have dropped to 1.4% in 2020 due to the pandemic, but is expected to bounce back to 5.0% in 2021 (AfDB, 2021). Agriculture, water, manufacturing, services sectors, infrastructure, trade and human resources capacity development form key drivers of Kenya's economic growth.

## 1.6 The Agricultural Sector

Agriculture is the mainstay of Kenya's economy, contributing 34.1% of the annual Gross Domestic Product (GDP) in 2019 (KNBS, 2020) and thus provides critical supportive linkages to other sectors. The agricultural sector accounts for 65% of Kenya's total exports, 75% of industrial raw materials, 60% of export earnings (Republic of Kenya, 2018). The sector employs about 57.5% of Kenya's population

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<sup>1</sup> A country is considered water scarce if the total per capita water availability is less than 1,000 m<sup>3</sup>. It is water stressed if the values is below 500 m<sup>3</sup>.

<sup>2</sup> [worldbank.org/indicator/NY.GNP.PCAP.CD?order=wbapi\\_data\\_value\\_2014+wbapi\\_data\\_value+wbapi\\_data\\_value-last&sort=desc](https://worldbank.org/indicator/NY.GNP.PCAP.CD?order=wbapi_data_value_2014+wbapi_data_value+wbapi_data_value-last&sort=desc)

and over 70% of the rural population majority being small scale farmers (Kipra, 2020). The broad agriculture sector comprises five subsectors; industrial crops, food crops, horticulture, livestock and fisheries and farmer institutions (e.g. co-operatives). Crop production accounts for 27.8% of total GDP (82% of agricultural GDP) in 2019 (KNBS, 2020). The livestock sector account for 12% of agricultural GDP with the rest being taken up by fisheries and forestry subsectors. There are over 8 million farmers in Kenya, equivalent to about 4.5 million farming households. The categories and proportion of farm holdings are as shown in Table 1.

**Table 1: Farm holding categorization in Kenya**

Category	Small-scale	Mid-size	Medium Scale	Large-scale
Size of farm	1.2 – 12 acres (0.5 - 5 ha)		12 – 2,500 acres (5 – 1,000 ha)	>2,500 acres (> 1,000 ha)
Share of farms in Kenya	66%		20%	14%
% marketed produce	65%		5%	30%

Source: GoK (2019): Agricultural Sector Transformation and Growth Strategy

### c) Small-Scale Farming

Kenya’s agriculture is predominantly small-scale farming where production is carried out on farms averaging 0.2–5 ha. Small-scale farms occupy about 66% of agricultural land area, and accounts for 65% of marketed produce (GoK, 2019). Kenya has about 4.5 million small-scale farmers who include 3.5 million crop farmers, 600,000 pastoralists and 130,000 fisherfolk. However, millions of small-scale farmers are unable to afford key inputs, mechanization and new technologies for high productivity. For example, only 7% of small-scale farmers irrigate and just 2.9% of households use motorized equipment. Small-scale farmers produce over 70% of maize, 65% of coffee, 50% of tea, 80% of milk, 85% of fish, and 70% of beef and related products.

### b) Crop Production

Cultivated areas in Kenya occupy about 5 million hectares of land. Some 4.3 million ha are used to grow food crops, 0.56 million ha are under horticultural crops, 0.48 million ha of industrial crops and 0.10 million ha of oil crops. The major food cereals grown in Kenya include maize, wheat and rice. Maize is Kenya’s main staple food crop for about 90% of the population in Kenya<sup>3</sup> and is also a key component of feedstuff for livestock. The area under maize cultivation has stagnated at around 1.6 million ha, producing about 2.5 million metric tonnes per annum against an estimated consumption of 3 million metric tonnes. Other food crops include beans, roots and tubers (cassava, potatoes), millets and sorghums, while major export crops include tea, coffee and horticulture. Irrigation is a main source of horticultural produce for both the domestic and export markets (GoK, 2020).

### d) The Livestock Sector

Livestock includes beef and dairy cattle, sheep and goats, camels, poultry and pigs. Livestock products make up 15% of the agricultural GDP, but three-quarters of this amount is from milk production and is the source of livelihoods for over 90% of the pastoral communities living in ASAL areas. Livestock is an important economic and socio-cultural role among many Kenyan communities, particularly the northern ASALs zone, which hold over 60% of Kenya’s beef cattle populations. However, much of these pastoral cattle do not meet the recommended 350 kg minimum market weight. This is partly due to a number of issues including poor feeds and fodders, pests and diseases, water scarcity, drought and

<sup>3</sup> National Food and Nutrition Security Policy, 2011. Government of Kenya.



theft. The herd sizes in the ASALs are considerably large, characterized by communal grazing, with low use of purchased inputs and informal trade (IGAD, 2011). But the dairy sector has been thriving, with smallholder farmers producing 80% of the milk marketed in Kenya. This meets the national demand for milk and with surplus exported mainly to EAC countries.

**e) Food and Nutrition Security:** In Kenya, over 10 million people suffer from chronic food insecurity and poor nutrition, while some 7.5 million people live in extreme poverty. Meanwhile, nearly 30% of Kenya's children are classified as undernourished (GoK, 2011). The national per capita energy supply per day is less than the recommended rates of 2,250 Kcal/day for an active African adult. Thus, for many people, the basic diet is inadequate in terms of diversity and nutrition. Thus, improving agricultural productivity sustainably, will facilitate the attainment of Kenya's food and nutrition security.

## 1.7 Evolution of Agricultural Systems in Kenya

Kenya's agricultural sector development is intertwined with the policies and attitudes that have been initiated at various stages of the history of the country, dating back from pre-colonial era. Indeed, early explorers (Thomson, 1887) reported finding a serene countryside where people, their livestock and wildlife co-existed in an almost untamed pristine environment. A number of chronological phases exist, and simply put, Kenya's agricultural policies can be broadly grouped into two distinct classes; the pre-independence policies (before 1963) and the post-independence period (after 1963). A third phase can be delineated covering Kenya's agricultural reforms from the year 2000 to date.

During the early colonial period (before 1945), agricultural developments was almost entirely oriented to benefit European settlers, with scant attention paid to African agriculture. Land rights were governed by the then British Settlements Act of 1887 and the Foreign Jurisdiction Act (1890). Africans were restricted from occupying particular areas and from growing particular crops that were designated as settler crops, especially cash crops (tea, coffee, wheat). The Africans were designated to live in settlement schemes referred to as "reserves. After the second world war (from 1945) this period was marked by African agitation for political freedom from colonial rule, also calling for land reforms and justice. By then, Africans were greatly disadvantaged, as for example, the Agricultural Ordinance of 1955<sup>4</sup> had reserved 3.1 million ha for the Whites only. The major policy changes for African agriculture occurred in the 1950s with the introduction of the Swynerton Plan (Swynerton, 1955) which proposed settling African farmers on privately owned land, in selected areas, but reserving the more fertile "white Highlands" for large scale agriculture. The Plan formed the basis of policies, largely driven by technocrats, which were later followed even after independence in 1963.

Upon attainment of independence in 1963, agricultural policies were initially based on principles outlined in the *Sessional Paper No. 10* which was based on Socialist principles (Republic of Kenya, 1965). The policy emphasized political equality, social justice, and human dignity. These principles were based on state control of the economy. Resettlement of Africans on white highlands was effected and by 1968, a total of 934,000 hectares of land had been transferred, with about half of these being settled by approximately 500,000 smallholder farmers. In subsequent years, small scale farms were subdivided and titled, a process that continues to date.

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<sup>4</sup> The Official Gazette of the Colony and Protectorate of Kenya, Vol. LVII-No.41, 2<sup>nd</sup> August 1955

Meanwhile, the new Government embarked on a series of five-year development plans. These included the Second Development Plan (1970-1974); Third Development Plan (1974-78), Fourth Development Plan (1979-83), Fifth Development Plan (1984-88), the Economic Recovery Strategy for Wealth and Employment Creation (2003-2007). Thereafter, the formulation of the Kenya Vision 2030 (in 2007) and the promulgation of the new Constitution (2010) ushered in wide sweeping reforms which are guiding the agriculture sector to date

## **1.8 Legal and Policy Environment Impacting on Agriculture**

### **a) Legal Instruments impacting on Agriculture**

Kenya has put in place a number of legal instruments; laws, statutes, regulations that safeguard and regulate the sector agriculture, water, environment which have bearing on the pace of innovations. Some of the most crucial legal instruments include: The Constitution of Kenya, 2010, the Irrigation Act 2019, the Agriculture, Fisheries and Food Authority Act No. 13, 2013, Crops Act, 2013, Land Act-2012 and Dairy Act 2013. The Constitution introduced the devolved system of government which has wide-ranging implications for agriculture alongside environment, trade and other aspects with bearing in rural development.

The Agriculture, Fisheries and Food Authority Act (AFFA) (Republic of Kenya, 2013) and is the current legal instrument regulating the agriculture sector in Kenya. AFFA repealed the former Agriculture Act (Cap 318) (GoK, 1993), which had been encumbered by over 130 laws and regulations that made the sector uncompetitive, inefficient and too bureaucratic for a conducive business environment. AFFA consolidated all these laws to reduce overlaps in the regulation and promotion of agriculture. Unlike other laws which empower the Cabinet Secretary with all powers, AFFA-2019 abrogated all responsibilities to the Agriculture, Fisheries and Food Authority, a body corporate, thereby allowing for some level of consultative decision making.

The Crops Act (Republic of Kenya, 2013b) repealed a number of commodity specific laws such as the Coconut Preservation Act (Cap. 332); Cotton Act (Cap. 335); Pyrethrum Act (Cap. 340); Sisal Industry Act (Cap. 341); Tea Act (Cap. 343); Coffee Act (No. 9 of 2001); Sugar Act (No. 10 of 2001); and the Irrigation Act (Cap. 347), aggregating all these under one law. The Water Act-2016 (Republic of Kenya, 2016) realigns water sector use and regulation thus affects SAI innovations. The Irrigation Act-2019 is a law wholly dedicated to irrigation, and is quite comprehensive. It established the National Irrigation Authority (NIA), giving it wider mandates including small scale irrigation. Counties too are supposed to make laws.

### **b) Policies and Strategies impacting on Agricultural Intensification**

Several significant Policy and Strategy documents have been developed in recent years to functionalize Constitution-2010. The apex policy instrument in Kenya is the Kenya Vision 2030 (GoK, 2007a), which is the country's development blueprint covering the period 2008 to 2030. Sustainable agriculture is well encapsulated in the Vision 2030, including plans for expanding irrigation, water harvesting, seed systems and agriculture as a business. Meanwhile, the Third Medium Term Plan (2018-2022) or MTP-III (GoK, 2018) is the prevailing development plan for implementation of Kenya Vision 2030. Accordingly, the theme of this MTP-III is Transforming Lives: Advancing socio-economic development through the "Big Four Agenda".

The Agricultural Sector Transformation and Growth Strategy (ASTGS), is the current policy document guiding the broad agriculture sector in Kenya. ASTGS is a 10-year strategy for the period 2019-2029 (GoK, 2019). It is structured across three Anchors, viz: (i) Increase small-scale farmer, pastoralist and fisherfolk incomes; (ii) Increase agricultural output and value add; and (iii) Increase household food resilience. The National Agricultural Sector Extension Policy (NASEP) is a broad sector-wide policy (GoK, 2012a). NASEP is the current policy guiding agricultural extension services in Kenya as stipulated in the ASTGS. The National Agribusiness Strategy (GoK, 2012b) was developed to support the need to transform smallholder agriculture from subsistence to innovative, commercially-oriented, internationally competitive and modern agricultural sector. The National Water Management Plan (NWMP-2030) is the contemporary blue print guiding the development and management of Water resources in Kenya (GoK, 2013). The Ending Drought Emergencies, dubbed ‘EDE Strategy’ (GoK, 2015), is a ten-year programme with a goal to end drought emergencies in Kenya. It supports building institutional capacities for drought risk management. These are further cascaded into programmes, projects, activities and initiatives that support drought resilience. The Kenya Climate Smart Agriculture Strategy (2017-2026), has the broad objective to adapt to climate change, build resilience of agricultural systems while minimizing emissions for enhanced food and nutritional security and improved livelihoods (GoK, 2017).

Counties are expected to make various laws and policies. The most overriding is the County Integrated Development Plan (CIDP), of which all the 47 counties have developed (2018-2022). A CIDP is a five-year plan that counties prepare to guide their development activities. The Public Finance Management Act (Republic of Kenya, 2012) stipulates that no county should allocate or spend its funds without a planning framework. All the 47 CIPDs are domiciled in the Council of Governors (CoG) website (<https://www.cog.go.ke>).

### **1.9 Public and Private institutions in Kenya’s agriculture Sector**

A large number of public institutions are active in the agricultural sector. They are engaged in development, capacity building, as well as implementation of diverse projects and programmes. The major public institutions include:

- National government ministries (MALFC, MWS &I, );
- Semi-autonomous government authorities (Parastatals) e.g. AFA, NEMA, KEPHIS, KDB, NIA;
- County Governments;
- Development partners (bilateral, multilateral, funding), e.g. WB, IFAD, WFP, AfDB, DANIDA, USAID, EU, GIZ, JICA, IGAD;
- Research and capacity building institutions (CIAT, ICRAF, CIP, CIMMYT, ILRI, KALRO, universities, ATVETs);
- Banks and MFIs e.g. Equity Bank, KCB, Sidian Bank, Juhudi Kilimo, etc.
- Non-state actors (NSAs) NGOs, CBOs, Self Help Groups, farmers

These institutions are important because agriculture requires an integrated, multi-disciplinary and a multi-sectoral approach where several actors are involved.

## 2 CASE STUDIES OF SUSTAINABLE AGRICULTURE INTENSIFICATION (SAI) INNOVATIONS IN KENYA

### 2.1 Overview of agricultural Innovations in Kenya

Kenya's agricultural sector is among the most innovative in sub-Saharan Africa, driven in part by reducing space for cultivation, weather related limitations and highly competitive markets. In a study of Agricultural Innovations in Kenya (Makini et al, 2016), some 43 innovations were identified and categorized into: technical, organizational and institutional. The innovations were clustered in eight domains: cropping, livestock, governance, marketing, finance, processing, natural resource management and value addition, of which 62% were crop related innovations. The majority (61%) of the innovations were technical, 23% were organizational and 16% were institutional. Since then, there have been many other agricultural innovations and others are still emerging.

### 2.2 Selected SAI Innovations for Kenya

In undertaking the preliminary assessment, a total of seven (7) sustainable agriculture intensification innovations case studies were identified. Of these, **the top four (4)** SAI innovations which meet most of the criteria in the ToR. The descriptions of each innovation are presented in Annexes 1 to 4.

#### ***The top four (3) SAI Innovations for Kenya***

**Case study 1:** water harvesting farm ponds enhancing agricultural intensification and climate change resilience in eastern Kenya

**Case study 2:** Improved availability and access to agri-inputs in Meru

**Case study 3:** solar powered irrigation enhancing agricultural intensification in peri-urban areas of Kajiado

**Case study 4:** blended finance from downstream Nairobi City supporting agriculture and watershed management upstream

#### ***The other Three (3) SAI Innovations that were identified in the preliminary analysis nclud:***

**Case Study 5:** Innovative access to finance supporting agricultural intensification (Kirinyaga)

**Case Study 6:** Smallholder dairy supporting agricultural intensification and circular economy (Nakuru)

**Case Study 7:** Combating striga in maize production in western Kenya for food security (Kisumu and Busia).

### 2.3 Priority Setting for selected SAI Innovations

These case studies are arranged in order of priority, meaning the case studies 6 and 7 will be dropped. The priority was set by considering the impacts on the following SDGs, and the criteria set in the ToRs.

**Table 2: Comparing SAI innovations against SDGs they meet**

Case study	Responding to SDGs	Comments
1. Water harvesting and storage	1, 2, 3, 5,6, 8, 12,13, 15, 16	Transforming lives, easily replicable
2. Access to agri-inputs	1, 2, 3, 5, 8, 13, 15, 16	Upgrading agricultural productivity
3. Solar powered irrigation	1, 2, 3, 5, 6, 7, 8, 13	Productivity and clean energy
4. Blended Financing for sustainable watershed management	1, 2, 3 5, 8, 13, 15, 16	Financing model supports agricultural intensification with conservation
5. Solar powered irrigation	1, 2, 3, 5, 6, 7, 8, 13	Productivity and clean energy
6. Innovative agricultural finance	1, 2, 7, 8, 13	Agricultural finance at the fingertips
7. Smallholder dairy	1, 2, 3, 5, 8, 15	Increased productivity and nutrition
7. Combating striga	1, 2,3	Increased food production.

*Details of each case study are presented in Annexes 1 – 7.*

### 3. APPROACH AND METHODOLOGY

#### 3.1 Tasks to be Implemented

The Approach and Methodology for this assignment will be implemented through some 15 Tasks (Activities) as outlined here below:

##### ***Task 1: Conducting a Thorough Literature Review***

During the inception phase, literature review has been conducted will continue as a main activity throughout the main project. The review seeks data, information, material content, case studies, reports, records and other knowledge with bearing on SAI in Kenya. It seeks acceptable global, regional, national and local data sources, websites and from the internet in general. The literature review exercise has been used to identify the first round of 10 SAI innovation cases, cutting across a wide range of topics including research papers, programmes and projects, technologies, approaches, financing, institutions, laws, policies and strategies, economic, environmental, social equity and other issues relevant to SAI in Kenya. The possible reference material is available from among others: Government of Kenya databases and reports by Ministries, Departments and Agencies (MDAs), international databases, e.g. the United Nations (e.g. FAO, IFAD, WFP, UNDP, UNEP, UNECA), bilateral and multilateral organizations (e.g. World Bank, AGRA, African Development Bank, USAID, JICA, GIZ, Sida, DANIDA) international research centers (e.g. IWMI, ILRI, ICRAF, CIAT, CIP) and national research organizations e.g. KALRO, universities, private sector institutions NGOs and CBOs.

##### ***Task 2: Preliminary Identification of Candidate SAI Innovations***

The first round of seven (7) candidate SAI innovations has been identified during the Inception phase and forms part of this report. It utilizes information gathered from literature reviews (Task-1), the knowledge and experience held by the consultants and informal discussions with key informants (via telephone, e-mail or other media). This exercise sought a broad list of activities, programmes and projects that meet the definition of SAI as per the ToR. The seven starter candidate SAI innovations were selected using a criteria that includes:

- a) SAI innovation that capture a variety of interesting and important cases across the country.
- b) Innovations that have been achieved recently, at least from 2000 to date;
- c) Innovations that have impacted at least 100,000 people, preferably targeted at groups or regions (excludes individual farmer innovations);
- d) Preferably home-grown innovations – Have physical presence in Kenya
- e) Transformative innovations that demonstrate trade-offs between different objectives and how these were handled;
- f) Representing a variety of ‘initiators’, e.g., public sector R&D institutions, private sector civil society and public-private partnerships;
- g) Representing a variety of innovations in policy, social institutions and finance as well as science and technology (or ideally combined); and
- h) The blend of SAI Innovations is representative of Kenya’s major agroclimatic, geographic and agricultural landscapes.

##### ***Task 3: Preparation of the Inception Report***

The review of literature and the selection of the preliminary list of SAI innovations in Kenya have been used to prepare this Inception Report. Meetings were held with the IWMI and COSAI teams to fine tune the methodology and formulation of the ‘Hypothesis’ that will be used for testing the significance of each SAI innovation. In addition, in-house meetings were held by the Kenyan team of consultants to internalize a clear understanding of the project and to identify the starter list of innovations. Guided by the information from the meetings and the project ToR, this Inception Report was prepared.

#### ***Task 4: Stakeholder Mapping***

Stakeholders are the people and institutions that are associated with a specific SAI innovation, either directly or indirectly (some may have retired). These will be identified from literature review (in tandem with Task-1), and from contacts known to the research team and affiliations and networks. The stakeholder mapping will contain summaries of contacts of identified organizations and individuals matched to each SAI innovation. These will include; MDAs, development partners, private sector, NGOs, research institutions, UN agencies, financing and MFI institutions, private sector and organizations involved in SAI. It gives a glimpse of who is doing what, where, in the SAI space. This list will seek individuals and institutions that are currently active and can have contact information.

#### ***Task 5: Seek Details on Selected SAI Innovations from Relevant Organizations***

Using the contacts from the stakeholder mapping (Task-4), respondents likely to provide further information and details on the selected SAI innovations will be contacted for Key Informant Interviews (KII). Semi-structured questionnaires will be developed to guide the detailed data collection. The KII interviews will be conducted through ICT modes such as; e-mail communications, telephone interviews, WhatsApp, Zoom meetings and where possible, face to face meetings with observance of all COVID-19 safety protocols. These interviews will seek to authenticate or dispel important details regarding SAI innovations (Tasks 1 & 2). Further details will be sought from literature to correlate or dispel information from KII and to fine tune the innovation. Annex 8 provides a detailed list of stakeholders to be interviewed in KII.

#### ***Task 6: Ground Truth the Existence and Innovativeness of the Case Studies***

Aware that the COVID-19 containment measures are likely to remain in place for quite a while, and Government of Kenya (GoK) lock-downs are a possibility (currently 13 counties in western Kenya are under partial lock-down), there is possibility for some limited field visits to confirm or reject, the existence and current condition of the selected SAI innovations on the ground. Two logistical possibilities for field work, and respective actions in each include:

- (i) *Restricted case*- GoK regulations could restrict movement into/ out of some counties. In that case, ICT (telephone, E-mail, zoom) interviews of grassroots organizations and individuals will be conducted (like with KII).
- (ii) *Open case* – That the country is open for free movement and physical meetings are fully allowed. Then field visits and stakeholder interviews at grassroots level will be conducted.

Semi-structured questionnaires will be developed to guide the data collection at grassroots levels, mostly by interviewing selected individuals (will avoid meeting groups, due to COVID-19 containment).

#### ***Task 7: Data Analysis and Priority Setting***

The information, data and material gathered from literature, stakeholder mapping, KII and grassroots work will be analyzed creating complete profiles of the four (4) case studies. The seven (7) SAI case studies will be prioritized to bring out the innovation niches represented, strengths and weaknesses. SAI innovation that fail to meet a minimum thresholds for ‘innovation pathways’ will be removed to retain at least four (4) best case studies. However, if more than four are authenticated, they will be retained.

#### ***Task 8: Preparation of 1<sup>st</sup> Draft Report & Submission***

Based on the four final selected SAI innovations (Task 7), as well as the material and information gathered from literature, grassroots studies and other sources, a comprehensive report will be prepared which brings out the overall content of the “*Kenya case study on pathways for innovation for sustainable agriculture intensification*”. The report, will be written in acceptable technical language, as guided by the ToR, for audiences that include researchers, policy makers and development partners.



### ***Task 9: Submission of the 1<sup>st</sup> Draft Report for Peer Review***

The first draft Report (Task 8) will first be submitted to the project leaders (IWMI) for perusal and peer review. The comments and/or corrections suggested by peer reviewers will be incorporated into a revised Draft Report and shared to relevant stakeholders before the consultation workshop.

### ***Task 10 Conduct First Stakeholder Consultation***

A stakeholder consultation forum will be organized to engage a number of relevant experts and stakeholders on the contents of the draft report (*note that the draft already has been grounded through grassroots work, so that it is factual*). Due to the current COVID-19 restrictions, this forum will be conducted as a webinar. It will hopefully be co-hosted by the Ministries responsible for agriculture, water and county government representatives in Kenya. The stakeholder representation will include policy makers, researchers, development partners, NGOs, CBOs, private sector and farmer representatives. The Draft Report will be presented for inputs and critique by the stakeholders.

### ***Task 11: Revision of Draft Report and Authentication of SAI Innovations***

Based on the inputs and critiques from peer reviewers and the stakeholder consultation, the Revised Draft Report will be updated and improved. If deemed necessary, extra data will be collected to authenticate and enrich the report, which will subsequently be revised to international standards.

### ***Task 12: Submission of Semi-final report to IWMI and Partners***

The revised semi-final report will be submitted to the project leaders (IWMI & COSAI) for final review and editing.

### ***Task 13: Preparation of Final Report***

Any further corrections and improvements deemed necessary (from Task 12), will be effected to create the Final Report. This will subsequently be submitted back to IWMI as the final agreed version.

### ***Task 14: Launch of the Final Report to Stakeholders***

The report will be launched to national and international stakeholders organized as a webinar.

### ***Task 15: Final Corrections and Publishing***

Any major issues raised during the report launch that require minor corrections or updating will factored into the report and effected before its publication by IWMI/COSAR and their partners.

## **3.2 Key assumptions, Limitations and Risks**

### **a) Key Assumptions are as follows:**

- These top selected innovations have visibility or tangible impacts on the ground
- Information and data to authenticate the SAI innovation is available and reliable
- It will be possible to ground truth the innovations and show evidence of their existence

### **b) Limitations**

- ❖ Information available on the internet is inadequate – the best data is with implementers of projects
- ❖ COVID-19 restrictions make it difficult to do field visits and personal interviews,
- ❖ The time allocated for the different stages of the assessment is rather short.

### **c) Risks**

- Some of the Hypothesis for identification of SAI innovations are not easily applicable to Kenya
- Possibility of little evidence to proof at least four SAI innovations after they are selected.

#### 4. REFEEENCES

- AfDB, 2021. African Economic Outlook 2021. From Debt Resolution to Growth: The Road Ahead for Africa. <https://www.afdb.org/en/knowledge/publications/african-economic-outlook>
- Akech, Norbert Opiyo, Omuombo, Christine A., Masibo, Moses. 2013. Developments in Earth Surface Processes Volume 16, 2013, Pages 3–10 Kenya: A Natural Outlook - Geo-Environmental Resources and Hazards. University of Nairobi.  
<http://www.sciencedirect.com/science/article/pii/B9780444595591000013>
- Critchley W and Siegert K. 1991. Water harvesting: A manual for the design and construction of water harvesting schemes for plant production. Rome: FAO.
- FAO Aquastat 2015. <http://www.fao.org/nr/water/aquastat/data/query/results.html>
- FAO, 2015. The Economic Lives of Smallholder Farmers, Food and Agriculture Organization of the United Nations, Rome.
- Gachene, C.K.K. and Kimaru, G. (2003). Soil Fertility and Land Productivity - A guide for extension workers in the eastern Africa region. Technical Handbook No.30. Regional Land Management Unit (RELMA)/ Swedish International Development Cooperation Agency (Sida).
- GoK, 1993. The Agriculture Act (Cap 318) (as amended by Act No. 11 of 1993 and No.2 of 2002), Government of Kenya
- GoK, 2010. State of the Environment Report. Government of Kenya, Ministry of Environment and Natural Resources.
- GoK, 2010. The Constitution of Kenya. The Government of the Republic of Kenya
- GoK, 2011. National Food and Nutrition Security Policy, 2011. Government of Kenya.
- GoK, 2012a. National Agricultural Sector Extension Policy (NASEP). Agricultural Sector Coordination Unit (ASCU), Government of Kenya, Nairobi.
- GoK, 2012b. National Agribusiness Strategy. Agricultural Sector Coordination Unit (ASCU) Republic of Kenya,
- GoK, 2013. National Water Master Plan 2030. Ministry of Environment, Water & Natural Resources and the Water Resources Management Authority, Republic of Kenya
- GoK, 2015. Common Programme Framework for Ending Drought Emergencies. The Presidency and Ministry of Devolution and Planning. Government of Kenya,
- GoK, 2017. Kenya Climate Smart Agriculture Strategy (2017-2026). Government of the Republic of Kenya.
- GoK, 2018. Third Medium Term Plan (2018 – 2022). The National Treasury and Planning. Government of Kenya, 2018. [www.planning.go.ke](http://www.planning.go.ke)
- GoK, 2019. Agricultural Sector Transformation and Growth Strategy (2019-2029). Government of Kenya.
- GoK, 2019. Agricultural Sector Transformation and Growth Strategy (2019-2029). Government of Kenya.
- Government of Kenya, 2010. National Climate Change Response Strategy.
- IGAD (2011). The Contribution of Livestock to the Kenyan Economy. Intergovernmental Authority on Development..
- ILRI, Milk markets as ‘the great equalizer’ in East Africa?  
<http://www.ilri.org/ilrinews/index.php/archives/tag/smallholder-dairy-project>
- KIPRA, 2020. Kenya Economic Report, 2020. Kenya Institute for Public Policy Research and Analysis (KIPPPRA). <http://www.kippra.org>

- KNBS, (2018). Economic survey, 2018. Kenya National Bureau of Statistics Nairobi:
- KNBS, 2019. Population and Housing Census. Republic of Kenya, Kenya National Bureau of Statistics. <http://www.knbs.or.ke>
- KNBS, 2019. Population and Housing Census. Republic of Kenya, Kenya National Bureau of Statistics. <http://www.knbs.or.ke>
- KNBS, 2020. Economic Survey, 2020. Republic of Kenya, Kenya National Bureau of Statistics. <http://www.knbs.or.ke>
- Makini, F. W; Kamau, G; Makelo, M; Mose, L. O; Salasya, B; Mulinge, W and Ong'ala, J (2016). Status of Agricultural Innovations, Innovation Platforms, and Innovations Investment. *2015 PARI project country report: Republic of Kenya*. Forum for Agricultural Research in Africa (FARA), Accra, Ghana.
- Matthew Tyce (2020) A 'Private-sector Success Story'? Uncovering the Role of Politics and the State in Kenya's Horticultural Export Sector, *The Journal of Development Studies*, 56:10, 1877-1893, DOI: 10.1080/00220388.2020.1715944
- Republic of Kenya (2012). National policy for the sustainable development of northern Kenya and other arid lands. Ministry of State for Development of Northern Kenya and other Arid Lands. Sessional Paper No.8 of 2012
- Republic of Kenya (2013). National Water Master Plan 2030.
- Republic of Kenya 2012. Public Finance Management Act, 2012. Kenya Gazette Supplement No. 94 (Acts No. 18)
- Republic of Kenya, 1965. *African Socialism and its Application to Planning in Kenya*. Government Printer.
- Republic of Kenya, 2009. Sessional Paper No. 3 of 2009 on National Land Policy. Ministry of Lands.
- Republic of Kenya, 2016. The Water Act. Kenya Gazette Supplement No. 164 (Acts No.43) of 2016. Government Printer.
- Republic of Kenya, 2018. Third Medium Term Plan (2018-2022). The National Treasury and Planning. [www.planning.go.ke](http://www.planning.go.ke)
- Republic of Kenya, 2019. The Irrigation Act. Kenya Gazette Supplement No. 136 (Acts No.14) of 2019. Government Printer.
- Sombroek, W.G., Braun, H.M.H. and van der Pouw, B.J.A. (1982). Exploratory Soil Map and Agro-Climatic Zone Map of Kenya. Report No. E1. Kenya Soil Survey Ministry of Agriculture - National Agricultural Laboratories, Nairobi, Kenya
- Strohmer, K and Hoeffler, H 2006. Contract farming in Kenya, Theory, Evidence from Selected Value-Chains and Implications for Development Cooperation. Promotion of Private Sector Development in Kenya
- Swynerton, R J M 1955. A plan to intensify the development of African agriculture in Kenya. Colony and Protectorate of Kenya. Government Printer, Nairobi.
- Thomson, J. (1887). Through Masailand; A journey of Exploration among the snow-clad volcanic mountains and strange tribes of Eastern Equatorial Africa.
- UNDP, (2020). Human Development Index (HDI)- 2020. <http://hdr.undp.org/en/countries/profiles/KEN>
- WRB -World Reference Base for Soil Resources (2014). A framework for International Classification, Correlation and Communication. World Soil Resources Reports 106.

## 5. ANNEXES – SUMMARY OF FOUR SAI INNOVATIONS FOR KENYA

### Preamble

The ultimate innovation is one that did not stop after the first kick, but continues to grow, expand evolve and yield goods and services to the present day. Details of the four SAI innovations identified in Kenya are presented here, as **case studies Nos. 1 to 4**.

Another three case studies Nos. 5 to 7, that were assessed as part of the long list are presented here.

### CASE STUDY 1: WATER HARVESTING FARM PONDS ENHANCING AGRICULTURAL INTENSIFICATION AND CLIMATE CHANGE RESILIENCE IN EASTERN KENYA

#### What is the Innovation?

Widespread adoption of water harvesting farm ponds for crop irrigation, improving agricultural intensification and climate change resilience for small-scale farmers in Eastern Kenya.

**When:** From 2006 to 2021

**Where:** Eastern Kenya (Kitui, Machakos, Makueni counties)

#### Innovation pathway

The opportunity for farmers in dry zones to own water ponds at farm level, and irrigate crops even on land without a river or ground water resources, gave this innovation its special niche for agricultural intensification and food production. This was especially made possible by technology advances to harvest and store rainwater on all land surfaces, even on soils those prone to seepage became possible when solar-resistant dam liners became easily available on the market. The starter project to achieve large scale adoption in Yatta subcounty opened the idea to other farmers, especially those from eastern Kenya who have similar climate, soils and agricultural challenges and system. The early initiatives were funded by projects but soon, farmers adopted the system using their own resources. The innovation is spreading fast with adoption across multiple counties. This success is especially evident in the eastern Kenya counties of Kitui, Machakos and Makueni, where farmers excavate farm ponds through own resources and in groups.

#### Background

##### The Food Insecurity Problem

For many years, drought and prolonged dry spells ravaged and continue to affect agriculture in semi-arid eastern Kenya, a zone where farmers predominantly depend on smallholder, rainfed crop production. Between the 1970s and the 1990s, concerted efforts in soil conservation through terracing led to wide scale adoption to the extent that the area became one of the most quoted success cases (Tiffen et al, 1994). But soil conservation, much as it improved crop production marginally, could still not bridge the yield gap caused by recurrent droughts, which have got worse over the years, to the point where farmers stopped planting maize during the long (MAM) rains. The area remained a major recipient of food aid. At the same time, few households had access to drinking water and women walked long distances to look for water – taking away time from other productive activities. Children too were spending much time collecting water.

## **Introducing water harvesting farm ponds in Yatta Sub-County**

The turning point came on the heels of the drought of 2005/2006 and 2009. In Eastern Kenya, the period was marked with below-average rainfall for three consecutive years causing crop failures, while the little food stocks that existed disappeared. Livestock was sold in distress or just died. People ate cooked dogs, mongoose and donkeys (taboo foods) simply to survive while others lost assets. Seeing all this, Dr. Titus Masika, a retired former teacher, started a program dubbed “Operation Mwolyo Out (OMO)”. This is a Kamba slogan which translates into “get rid of recurrent food aid (mwolyo)” and at a deeper level “abandon the dependency syndrome<sup>5</sup>”. With some assistance from the Christian Impact Mission (CIM), farmers were taught to construct water harvesting farm ponds which were about around 4-5 meters deep. Adoption ensued and many families developed their own ‘water pans’. In a short time, some 3,000 such family owned water reservoirs were made. The water collected in the farm ponds was lifted to farm lands and used for supplemental irrigation of food crops. The crops grown also changed, to include more diverse, productive and marketable produce. Farmers now could grow crops throughout the year, bridging the dry season by use of the harvested water, hence intensification. Through availability of harvested water, crop growing became drought resilient, hence cushioning farmers from climate change and variability. Unpublished reports indicate that by 2014, there were over 4,000 such ponds in the Yatta area alone.

The strategy adopted in this innovation sought to change the mindset of local communities to solve their own problems using what is available and what they can afford. A second mindset change was for people to no longer wait for rain. They were reminded that crops need water, not rain so it was important to harvest water and grow crops anytime instead of waiting for the rains. Another mind block had to be overcome – the belief that the land below the feet was the ancestral abode and hence could not be touched – even for the excavation of storage. All these required intensive capacity building and a multi-stakeholder engagement.

## **Out-scaling Water Harvesting in Eastern Kenya**

The success of the Yatta sub-county water harvesting farm ponds attracted many visitors from all over Kenya and new projects and programmes were developed modeled on the same concept. Since then, many projects and programmes were muted to upscale the innovation within Machakos County itself as well as across the entire eastern Kenya region. These programmes were spearheaded by NGOs such as World Vision, ADRA, Caritas and SNV, in collaboration with county government departments and local community organizations. Working with rural communities these programmes sought to increase food and water security, improve access to markets and financing and create an enabling environment for supportive policy. The innovations were implemented visible in three counties (Machakos, Makueni and Kitui) by a consortium of four non-governmental organizations; a market access and financial services linking across all the three counties. Other organizations included the World Agroforestry Centre (ICRAF), Ministry of Agriculture and the county Governments of Kitui, Machakos and Makueni.

## **An Integrated approach**

An integrated approach was adopted that makes use of soil and water conservation techniques, soil fertility management, planting of suitable crop varieties and linkages to microfinance and markets

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<sup>5</sup> <https://thewaterchannel.tv/thewaterblog/mindsets/>

facilitate farming as a business. The initiative was planned with activities designed to Improve water and food security at both farm and watershed levels through: (i) Increased food production through on-farm integrated water harvesting, soil fertility, and agroforestry technologies for enhanced dry season water availability for multiple uses and upscaling integrated water and soil management techniques; (ii) Commercialization of the rural economy through Increased participation of different categories of farmers in strengthened value chains of selected inputs and commodities and Access to credit and financial mechanisms by different categories of farmers improved; (iii) Addressing the policy environment as an enabler of increased water and food security and economic growth to value chain development adapted to different categories of farmers; and (iv) inclusive and integrated approaches to development. The strategy sought to achieve:

- An integrated technical approach: water, soil, and agroforestry
- Assisting farmers shift from subsistence to market oriented agriculture
- Enhancing information exchange, knowledge and advocacy,
- Facilitating sustainable agriculture and
- Adopting a bottom-up approach.

These days, many farmers are adopting solar powered pumps to lift water out of the farm ponds further facilitating use of green energy and reduction in the drudgery of annual pumps and bucket lifting. The win-win solutions of making use of what was considered a menace, runoff into a productive asset – irrigation water, is pushing the adoption of the water pans.

### **Policies and government focus**

Counties of Kenya were envisioned by the 2010 Constitution as the units of devolved government. They are now playing a big role in RWH and have included promotion of water harvesting for irrigation in their county development plans (2018-2022). In the Agricultural Sector Transformation and Growth Strategy 2019-2029, the Ministry responsible for agriculture recognises Water storage as essential to increasing resilience in arid and semi-arid regions that similarly need water for livestock and together with irrigation for crops is seen as a critical enabler to unlocking growth in private sector investment in agriculture. Hence Flagship 6, building food resilience in the ASALs, includes championing water management best practices and coordinating rainwater harvesting interventions, such as developing major rain/surface water harvesting projects.

In its 2018-2022 strategic plan the ministry targets to promote investment in water infrastructure for livestock and agricultural production through construction and rehabilitation of water facilities and building capacities on water harvesting, storage, conservation and distribution technologies including 5,000 on farm water harvesting pans constructed annually. As part of its strategy, the National Water Master Plan 2030 recommends development of small dams and/or water pans are to be constructed in small rivers throughout the catchment area for small and scattered demands including rural domestic, livestock, small scale irrigation, wildlife and inland fisheries water supply purposes at locations where suitable dam sites are not possible for large dams but where surface water is available (The Republic of Kenya, 2013). Hence the policy and strategic plans now recognize water and harvesting including strategic institutions and programmes developed towards water harvesting and storage.

### **Impacts**

The impacts on food security and climate change resilience are substantive. Farmers were able to bridge the dry season when rains fail, hence produce more food crops such as maize, pigeon pea, beans, fruits and vegetables. Moreover, they could grow crops throughout the year, and a wider range of crops including marketable produce, especially fresh vegetables and fruits. The availability of water ensures food security by supporting provision of water for agriculture and livestock at the local level. There is



creation of employment and income generation for the farm families, and increased livelihood options and household incomes – through sales of their produce, with subsequent enhanced living standards. Water harvesting made it possible to improve the nutritional standards by being able to grow nutrient rich crops and kitchen gardens. The water is also used to raise livestock thus enhancing an integrated approach to agriculture.

### **Lessons Learnt**

The importance of water harvesting farm ponds can be made possible almost anywhere in Kenya due to the availability of methods to control seepage, especially use of dam liners. Lined farm have gained growing acceptance by various development agencies as a quick way to provide rainwater harvesting at household level, at relatively larger volumes than conventional surface storage tanks. Whereas surface tanks using roof catchment may range in size from 3 - 50 m<sup>3</sup>, farm ponds can hold larger volumes of water, ranging from 50 – 500 m<sup>3</sup>, amounts capable of supporting supplemental irrigation of crops and livestock watering. Experience from the field suggests that there is always enough surface runoff even after a few storms, to fill a pond at household level. The size of pond is thus limited more by cost consideration than by availability of runoff. To improve safety and to control evaporation losses, the pond may be covered using special nets. The use of an integrated approach that makes use of soil and water conservation techniques, soil fertility management, planting of suitable crop varieties and linkages to microfinance and markets to facilitate farming as a business enhances the adoption of the technologies. Utilization of harvested water has had growing successes when combined with efficient technologies for pumping and/or irrigation especially solar pumps and drip irrigation systems.

### **Reference Material**

- Joshua Black, Maimbo Malesu, Alex Oduor, Kipruto Cherogony and Meshack Nyabenge, 2012. Rainwater harvesting inventory of Kenya: An overview of techniques, sustainability factors, and stakeholders. World Agroforestry Centre (ICRAF). Technical Manual No.18.  
[https://www.researchgate.net/publication/265842519\\_Rainwater\\_Harvesting\\_Inventory\\_of\\_Kenya\\_An\\_overview\\_of\\_techniques\\_sustainability\\_factor\\_and\\_stakeholders](https://www.researchgate.net/publication/265842519_Rainwater_Harvesting_Inventory_of_Kenya_An_overview_of_techniques_sustainability_factor_and_stakeholders).
- Kenya Agricultural and Livestock Research Organization, 2017. KALRO Strategic plan 2017-2021.  
<https://www.kalro.org/sites/default/files/strategic-Plan-KALRO-2017-2021.pdf>
- Koech CE, 2016. Effects of irrigation water on soil chemical properties and rainwater harvesting in Isinya, Kajiado County. MSc thesis of the University Nairobi.
- Kubbinga B, 2013. Road Runoff Harvesting in the Drylands of Sub-Saharan Africa: Its Potential for Assisting Smallholder Farmers in Coping with Water Scarcity and Climate Change, Based on Case Studies in Eastern Province, Kenya. MSc thesis of Free University, Amsterdam, Faculty of Earth and Life Sciences. [http://www.ivm.vu.nl/en/Images/Kubbinga\\_Ben\\_tcm234-352224.pdf](http://www.ivm.vu.nl/en/Images/Kubbinga_Ben_tcm234-352224.pdf).
- Ministry of Agriculture, Livestock, Fisheries and Co-Operatives, 2018. Strategic Plan 2018-2022.  
<https://kilimo.go.ke/wp-content/uploads/2021/02/Strategic-Plan-for-MOALF-for-2018-2022.pdf>
- Mwaura, J Koskei, J. and Kiprotich, B. 2017. Economic value of water harvesting for climate-smart adaptation in semi-arid Ijara Garissa, Kenya. Environmental research systems 6: 2018.  
<https://environmentalsystemsresearch.springeropen.com/articles/10.1186/s40068-017-0088-3>

- National Irrigation Authority (NIA) website. Household Irrigation Water Storage Programme.  
<https://www.irrigation.go.ke/projects/household-irrigation-water-storage-programme/>
- National Water Harvesting and Storage Authority.  
[https://waterauthority.go.ke/index.php?option=com\\_content&view=featured&Itemid=369](https://waterauthority.go.ke/index.php?option=com_content&view=featured&Itemid=369)
- Nelly Aroka, 2010. Rainwater Harvesting in Rural Kenya Reliability in a Variable and Changing Climate Master's thesis Stockholm University. <https://www.diva-portal.org/smash/get/diva2:354235/FULLTEXT02.pdf>
- Recha J.W., Mati, B.M., Nyasimi, M., Kimeli P., Kinyangi, J.M., and Radeny, M. (2016). Changing rainfall patterns and farmers' adaptation through soil water management practices in semi-arid eastern Kenya. *Journal of Arid Land Research and Management*. Volume 30, 2016, Issue 30, Pp 229-238. <http://www.tandfonline.com/doi/full/10.1080/15324982.2015.1091398>
- Republic of Kenya, 2013. National Water Master Plan 2030.  
[https://openjicareport.jica.go.jp/pdf/12146353\\_01.pdf](https://openjicareport.jica.go.jp/pdf/12146353_01.pdf)
- Republic of Kenya, 2016. Water Act No. 43 of 2016.  
<http://kenyalaw.org:8181/exist/kenyalex/actview.xql?actid=No.%2043%20of%202016>
- Reuters, 2021. Water harvesting has added benefit for Kenya: less flooding. Thomson Reuters Foundation. <https://www.reuters.com/article/us-kenya-floods-water-harvesting-feature-idUSKBN1Z21FT>
- Tiffen, M, Mortimore, M And Gichuki, F N (1994). *More people, less erosion: Environmental recovery in Kenya*. Acts Press, Nairobi, Kenya.
- Why the government of Kenya is now investing heavily in water pans for irrigation.  
[https://www.youtube.com/watch?v=Y2\\_JGIQK8-k](https://www.youtube.com/watch?v=Y2_JGIQK8-k)
- World Agroforestry (ICRAF), 2020. Impact assessment report of the The Drylands Development Programme (Drydev). Ministry of Foreign Affairs, the Netherlands

## CASE STUDY 2: IMPROVED AVAILABILITY AND ACCESS TO AGRI-INPUTS IN MERU

### What is the Innovation?

A business model that enables agri-inputs (seeds, fertilizers, pesticides, equipment) to be made available to farmers at farm level or the nearest market center<sup>6</sup> improving access and uptake, thus enhancing agricultural intensification: case study of Meru County.

**When:** From 2005 to 2021

**Where:** Meru County

### The Business Model

The liberalization of the Kenyan economy in since around the year 2000, opening opportunities for private agri-input companies to operate, availability of agri-inputs on demand and in nearby market centers, smaller packaging of seeds, fertilizers and other inputs and release of improved seeds, capacity building of agro-dealers, extension staff and farmers, ICT penetration in rural areas, competition by private sector forcing suppliers to reach out to farmers, improvements in rural transport including expansion of rural roads and availability of motorcycle (bodaboda) riders who can access even the remotest village, and a conducive policy environment.

### Background

Meru County is located in eastern Kenya straddling the slopes of Mt. Kenya and the Nyambene hills. Lying between the two water towers, the county is endowed with a favourable climate for agriculture and rich volcanic soils. As a result, Meru County is the source of a wide array of food and cash crops grown both rainfed and irrigated. These include tea, coffee, potatoes, bananas, maize, beans, fresh vegetables and fruits, including wheat and barley. The typology of crops is, varies according to the agro-climatic zones. However the county is dissected by numerous rivers and stream radiating from the mountain. These rivers have enable Meru County to be a leader in smallholder irrigation, however, their presence also poses another challenge, difficult transportation.

Up to around the end the 1990s, a farmer had to travel to major towns to purchase inputs such as fertilizers, seeds and pesticides. These agri-inputs were also packaged in bulk, rendering them unaffordable to smallholder farmers. At the time, seed production was mainly by parastals, e.g. Kenya Seed Company with a few private operators, and fertilizers were available only at the government managed Kenya Farmers Association (KFA) outlets, which also supplied other farm inputs and equipment. There were few outlets for farmers to access at nearby markets and thus farmers were using low yielding seed and little varietal differentiation for various agro-climatic zones, soils and low economic returns, and few inputs. The problem was exacerbated by ineffective public extension. This was worse in Meru where for many years, the county remained almost closed to the rest of Kenya due to poor road network and the difficulty of building roads across the steep slopes. This made it difficult for farmers to access agri-inputs, as it was difficult to access the Meru town. As a result, farmers used few inputs or improved seeds, and agricultural production remained low in the county, supported mostly by the natural endowments of the land..

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<sup>6</sup> *Agri-input markets have grown. In a recent study by this author (Mati) ( in 2021) profiled 172 irrigation service providers & stockists in Meru County alone. Success in output markets is not easy to prove.*

## **Opening the space for agri-inputs enterprises**

The policy reforms at the national level towards the end of the 1990s opened new impetus in the agricultural sector, both nationally and in Meru. For instance, the liberalization of fertilizer markets in the 1990s saw led to a drop its price by almost 50% between 1990 and 2007 contributing to increased use by farmers. For instance, since 2007, the government subsidized fertilizers through the National Accelerated Agricultural Inputs Access Programme. As a result, fertilizer use increased by more than 50% between 2000 and 2010 while fertilizer use per hectare of arable land continued to grow at a rate of 73% between 2010 and 2013. This policy push also affected seeds and other agri-inputs making them more readily available.

Within Meru County, other developments such as expansion of the rural roads network opened up space for agro-dealers to be closer to farmers. This opened several avenues that saw an increase in the number of operators in the agri-inputs sub-sector. Seed breeding was upscaled through research while private sector engaged in the distribution of seeds and inputs. Several improved varieties of maize, beans, , potatoes, tissue culture bananas, cabbage and other vegetables were introduced to farmers. The growing space for different scales of operators, from seed bulking organizations, wholesalers, transporters, agro-dealers and stockists saw the packing of agri-inputs become available in smaller packages of a few kgs amenable for all scales of agriculture, and more importantly, affordable to farmers. Moreover, the growing space allowed for a number of private sector providing extension services for their value chains of interest. In so doing, they take products and services to farmers. From around 2010, the entry of motor bike (bodaboda) transport further pushed the remaining barriers to transportation, making it possible to access even the remotest corners of the county lacking road transport. The growing agricultural space in Meru saw a boost in the number of private operators to the extent that by May 2021, there were over 172 agro-dealers and stockists spread across nearly all the market centers in the county. The use of ICT over the last ten years has also helped revolutionize access to agri-inputs in Meru County. The numbers of farmers benefitting from this innovation are in the hundreds of thousands.

### ***Main Activities***

A number of activities stand out that facilitated this innovation. They include capacity building of values chain actors from farmers to extension staff to agro-dealers. There were programs targeting microfinance institutions to avail credit to agro-dealers to enable out-scaling of input and output markets. Farmer capacity building was done through on-farm field trials, demonstration farms, field days, extension packages such as FFS, on farm visits by extension workers, and market pull incentives through contract farming. The focus crops for market access activities were maize banana, coffee, tea, vegetables. Also, mass media programmes e.g. Seeds of Gold, Shamba shape-up, and radio programmes making a popular source of new knowledge for farmers. These activities included: raising awareness of farmers on use of certified seeds, training core sets of farmers on seed production and multiplication techniques and identifying seed varieties that were conducive to each situation.

Unlike in the past, when only a few agro-dealers were available, the innovation has been to attract private players into the agri-inputs value chain while working within the existing companies and government entities. This avoids the need for heavy capital investment and approaching the beneficiaries. A close partnership between the farmer also provides agri-input companies a channel for

their products. This has improved farming practices and eventually the yield of smallholders, while also help the companies make greater revenue by increasing demand through awareness.

### ***Impacts***

The crucial requisites to increase the sustainability of input and fertilizer use are a more stable marketing environment, increased private sector participation to enhance input availability locally, the reduction of the distance to the dealers, increase of information and technical training, and the improvement of road infrastructure to decrease costs of transportation (Ariga and Jayne 2011).

There has been marked growth in the number of agro-dealers active in even small market centres in the rural areas. Farmers' access to inputs and extension has been enhanced in terms of distance they travelled to reach suppliers improved to an average of 3 km in Kenya (AGRA, 2016). In one study (Mati, 2021-forthcoming) identified at least 172 agri-input organizations active in the main towns of Meru county alone. This proximity and the availability of inputs in smaller packaging amenable to small farms has encouraged farmers to adopt improved seeds, fertilizers and other inputs. For instance, farmer adoption of improved seeds has been increasing to the point where 80% of farmers use improved seed maize, while over 90% of farmers use improved horticultural seeds and cultivars. The availability of improved agricultural production through strengthening agro-dealer networks to improve smallholder farmers' access to improved agro-inputs and appropriate agronomic practices. In addition, Agro-dealers have recorded increased sales of certified seed, fertilizers and other inputs.

### ***Institutions engaged and Partnerships***

Government Ministries (Agriculture, Finance, County Governments), Research institutes (KALRO, universities), International organizations (AGRA, CiMYTT, ICRISAT), regulators (KEPSA), Private Sector (Kenya Seed Company, Simlaw, Syngenta, Bayer, Freshco Seeds, Pioneer Hi-Bred International, Monsanto, Pannar Seeds, Amiran, East African Seed Co, Elgon, Premier Seed) local NGOs, farmers, traders and agro-dealers.

### ***Challenges still remain***

A number of challenges still remain in the agri-inputs subsector. These include:

- Farmers ability to afford agri-inputs and improved seeds is still low, especially those in rainfed systems.
- Poor quality fertilizers, seeds and other inputs sold to farmers thus demoralizing them
- Private sector faced challenges in dealing with poor farmers with low capacity base, and who can opt for non-certified seeds or other inputs
- Destabilizing natural biodiversity – Impacts of cross-pollination and use of too much chemicals on exotic crops reducing natural agro-biodiversity (bees, ladybirds, butterflies, earthworms etc. going into extinction)
- Challenges in maintaining phytosanitary planting material especially in small scale farms.
- Expectation for Government to provide subsidized fertilizers and other inputs
- Lack of information: Seed companies rarely promote newly released performing seeds and prefer for results from tested areas before marketing it. It is possible for high-quality seeds to gather dust for years before it reaches farmers

### ***Reference Materials***

- Alliance for a Green Revolution in Africa (AGRA) 2011. Country case studies on the PASS value chain strategy/ approach and its impact/ effect on smallholder farmer yields in africa. East Africa Synthesis Report. (Kenya, Tanzania, Uganda).
- Alliance for a Green Revolution in Africa (AGRA) 2016. Strengthening Agricultural Input and Output Markets in Africa (*SAIOMA*) program. *Final Evaluation Report* Natural Resources Institute (NRI)
- Ariga, J., and T. Jayne. 2011. “Fertilizer in Kenya: Factors Driving the Increase in Usage by Smallholder Farmers.” In *Yes Africa Can: Success Stories from a Dynamic Continent*, edited by Chuhan-Pole, P., and M. Angwafo, 269–288. Washington DC: World Bank. [http://sitere-sources.worldbank.org/AFRICAEXT/Resources/258643-1271798012256/YAC\\_chpt\\_16.pdf](http://sitere-sources.worldbank.org/AFRICAEXT/Resources/258643-1271798012256/YAC_chpt_16.pdf)
- Ariga, J., T. S. Jayne, and J. Nyoro 2006. “Factors Driving the Growth in Fertilizer Consumption in Kenya, 1990–2005: Sustaining the Momentum in Kenya and Lessons for Broader Replicability in Sub-Saharan Africa.” Tegemeo Working Paper 24/2006. Nairobi: Tegemeo Institute of Agricultural Policy and Development, Egerton University. [http://www.tegemeo.org/images/downloads/publications/working\\_papers/WP24.pdf](http://www.tegemeo.org/images/downloads/publications/working_papers/WP24.pdf)
- County Government of Meru (2018). Meru County Integrated Development Plan (2018-2022).
- Cramer, L. 2009. Supplying Improved Seed to Farmers in Rural Kenya: The Case of Freshco Kenya Ltd. The International Food and Agribusiness Management Review.

**KARI, 2012. Inventory of KARI technologies, innovations & information under**  
**Eastern Africa Agricultural Productivity Project**  
**(EAAPP)**

- Mabaya, E. Cramer, L.K., Mahiga, V.K. Pham, H.Q., Simpson, T.M., and Tang, X.C. 2009. Supplying Improved Seed to Farmers in Rural Kenya: The Case of Freshco Kenya Ltd. International Food and Agribusiness Management Review Volume 12, Issue 1, pp 1-20.
- Mutea, E., S. Rist, and J. Jacobi. 2020. “Applying the Theory of Access to Food Security among Smallholder Family Farmers around North-West Mount Kenya.” *Sustainability* 12: 1751. doi:10.3390/su12051751.
- Pierre Boulanger, Hasan Dudu, Emanuele Ferrari, Alfredo J. Mainar-Causapé & Maria Priscila Ramos (2020): Effectiveness of fertilizer policy reforms to enhance food security in Kenya: a macro–micro economics, DOI: [10.1080/00036846.2020.1808180](https://doi.org/10.1080/00036846.2020.1808180)
- Pieter Rutsaert & Jason Donovan (2020) Exploring the marketing environment for maize seed in Kenya: how competition and consumer preferences shape seed sector development, *Journal of Crop Improvement*, 34:4, 486-504, DOI: [10.1080/15427528.2020.1737296](https://doi.org/10.1080/15427528.2020.1737296)
- RATES Center. 2003. Maize market assessment and baseline study for Kenya. Nairobi, Kenya: Center for Regional Agricultural Trade Expansion Support. [http://tradeafrica.biz/downloads/kenya\\_report.pdf](http://tradeafrica.biz/downloads/kenya_report.pdf)
- USAID, 2016. Kenya Early Generation Seed Study, Country Report. Early Generation Seed Systems Study, Feed the Future: Building Capacity for African Agricultural Transformation (Africa Lead II).
- Wekesa, C. Ongugo, P. Ndalilo, L. Amur, A., Mwalewa, S. and Swiderska, T. 2017. Smallholder farming systems in coastal Kenya: Key trends and innovations for resilience. FAO Country Report.
- World Bank. 2017. *World Development Indicators*. Washington DC: World Bank. <http://databank.worldbank.org/data/source/world-development-indicators>



## CASE STUDY 3: SOLAR POWERED IRRIGATION ENHANCING AGRICULTURAL INTENSIFICATION IN PERI-URBAN AREAS OF KAJIADO

### What is the Innovation?

Enhancing agricultural intensification and food production through adoption of solar powered irrigation in a peri urban areas of Kajiado County.

**When:** From 2005 to 2021

**Where:** Kajiado County (peri-urban agriculture)

### The business Model

Facing water scarcity but with groundwater availability, small-scale peri-urban farmers adopting solar powered irrigation in response business pull and close proximity to food markets in nearby Nairobi city. At the same time, private-sector-led solar PV industry having developed affordable, durable, plug-and-play solar water pumps, marketed as a complete kits (solar panels, pump, irrigation gear) with innovative financing models to suit individual farmer needs. The rapid uptake of the technology enabling agricultural intensification and food production with clean energy.

### Background

Kajiado County is large, straddling from the edge of Nairobi city to the border with Tanzania at Loitokitok. Although the county is vastly used for pastoral grazing, areas nearer Nairobi are peri-urban. This zone, covers the Ngong hills, Ongata Rongai, Kiserian and the plains of Kitengela, Isinya, Oloolua, around Kajiado town mostly in Kajiad North sub-county. These peri-urban areas have seen rapid population growth due to emigration from Nairobi. There is however, a quiet revolution in these peri-urban areas as bastions of agricultural intensification and food production, both for local and export markets. This revolution has been marked mostly by widescale adoption of solar powered water pumping for irrigation. In the peri-urban areas, the average farm sizes are small-scale, ranging 0.5 ha to about 10 ha for the more commercial farming.

### *The Disconnect: Sourcing water for irrigation in Peri-urban Kajiado*

The peri-urban areas of Kajiado County are relatively dry, and other than around the Ngong hills, the rest of the sub-county has almost no permanent rivers. Thus, rainfed agriculture is constrained by prolonged dry spells, while there is little surface flows for irrigation. However, the peri-urban areas lying on the Athi-Kapiti plains have appreciable groundwater resources. But groundwater extraction, especially for irrigation requires energy, and the running costs can be prohibitive. Water pumping for irrigation relied on conventional energy sources, such as petrol or diesel pumps and in a few cases, electric pumps powered from the grid. These energy sources are generally expensive and they increase the costs of irrigation and thus reduce profit margins to the farmer. But solar powered water pumping was still not an option until around 2000. Since sunshine covers in every corner of the county, then applicability of solar powered irrigation systems (SPIS)<sup>7</sup> is possible almost everywhere, unless limited by water (un)availability. Energy was the missing link to upscale irrigation in Kajiado North, as farmlands tend to be far from grid electricity and thus would rely on petrol or diesel powered pumps.

### Evolution of solar powered irrigation systems (SPIS) in Kajiado

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<sup>7</sup> We define Solar powered irrigation system (SPIS) as: Irrigation system powered by solar energy. It typically consists of a photovoltaic array/solar panels, a pump with its controller unit, a water source and the irrigated field

Before the 1970s, use of solar power generation was almost negligible in Kajiado and indeed in Kenya. But as a response to the oil crisis of the 1970s, use of renewable energy was encouraged and solar energy for heating water and lighting homes were popularized. Towards the late 1970s, solar photovoltaic (PV) systems were installed in remote areas and solar pumps started to make their way into the Kenyan market. The early types of PV pumping systems used centrifugal pumps, usually driven by variable frequency AC motors. But these pumps had low hydraulic efficiencies ranging about 25 to 35 percent. The PV pumping systems had positive displacement pumps, progressive cavity pumps and diaphragm pumps for smaller water quantities, characterized by low PV input power requirements, lower capital costs and higher hydraulic efficiencies<sup>8</sup>. The early PV pumping models operated with batteries and a conventional inverter. This resulted in lower efficiencies and higher maintenance costs due to battery replacements.

### ***Disillusionment with past solar powered equipment***

The early solar pumps were fraught with problems. For instance, the cost of solar powered products (solar panels, battery, cables, wiring, inverters and pumps) were unaffordable to poor farmers. In addition, solar equipment produced weak energy outputs, and systems were fraught with problems. In addition, solar kits had short functional life, while other kits would malfunction or blow up, especially in hot areas. The management of solar energy and its storage in batteries was problematic, especially as local people did not know how to maintain the batteries and sometimes, solar panels were stolen or vandalized. These factors discouraged smallholder farmers from adopting solar powered pumps. In the 1980s, most efforts on solar PV went to lighting of schools, health centers and for water pumping funded by donors and NGOs and there was little

### **What caused the shift in adoption**

#### ***Advances in solar technology and demand pull for solar pumping***

Advances in science and technology have seen marked improvements in the design, types and functionality of solar powered pumping equipment available on the market. From around 2010, direct current (DC) pumping was introduced opening new impetus for solar powered irrigation, especially by smallholder and medium scale farmers. The price of solar panels decreased dramatically. Since then, PV water pumping systems have shown significant advancements, with the development of more powerful and efficient systems. Each year, the adoption of SPIS has been increasing albeit slowly, mostly due to lack of information. The market potential for both small-scale and large-scale solar powered pumping systems is great. The most common types of solar water pumping systems for irrigation in Kenya range from low head submersible pumps for shallow wells to heavy duty submersibles for borehole pumping. Boreholes can yield from 20 m<sup>3</sup>/hr to over 100 m<sup>3</sup>/hr thus requiring large solar panels, and these are available on the Kenyan market.

#### ***Solar powered irrigation kits have become affordable***

SPIS kits of today are affordable, with an array of products ranging from small portable kits to large-scale installations for scheme-level irrigation or community scale projects. For smallholder farm irrigating about 0.2 to 0.4 ha, a SPIS kit that includes a submersible pump and solar panels costs about US\$350-850, while those for heavy duty borehole pumping may cost about US\$30,000. As these are initial costs and there being low, if any running costs, then the investment is worthwhile. Also, the cost

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<sup>8</sup> Chandel S.S. et al. 2015. Review of solar photovoltaic water pumping system technology for irrigation and community drinking water supplies. *Renewable & Sustainable Energy Reviews* 49.

of solar modules has reduced by 80 percent in the last 10 years. Furthermore, the cost recovery of solar pumping investments can be attained within 1 to 3 years. This shows that solar power has come of age to plug the energy needs for irrigation.

### ***Solar solutions at farm level offer multiple use of energy***

Solar solutions at farm level offer multiple use of energy which is especially important in remote areas, and those not connected to the electricity grid. The solar energy can be used for post-harvest processing of crops, lighting up homes, charging mobile phones and other light industries. This eliminates the need to purchase fuels such as petrol and paraffin. Through improved access to energy and water, SPIS helps to stabilize, increase and diversify agricultural production (e.g. vegetables and fruits). The increased availability of food improves food and nutritional security, especially for smallholder farmers and their communities.

### ***Market penetration of solar systems***

There is a large-scale market-driven penetration of small photovoltaic systems with a capacity of 12 – 50 watts peak (Wp) consisting of low cost thin-film and both mono and polycrystalline silicon modules. It was estimated that by the end of 2014, more than 6 MW of solar PV System capacity would have been installed in the residential and commercial sectors through the private sector initiative. By the year 2020, it is projected that the installed capacity of solar photovoltaic systems will reach 100 megawatts electrical (MWe) generating 220 GWh annually<sup>9</sup>. There is a need for Solar-Powered Irrigation Systems (SPIS) to benefit from PV installations through proper planning and mainstreaming it into policy.

### ***Easy access to food markets in Nairobi***

The proximity of the county to Nairobi City and indeed location within the Metropolitan area provides easy market targeting for fresh produce. The irrigated farms of Kajiado provide fresh vegetables (kales, cabbage, tomato, onion) for the local market as well as French beans for the export market due to easy access to the international airport.

### ***Enabling Policy environment***

The Government of Kenya has zero-rated the import duty and removed Value Added Tax (VAT) on renewable energy equipment and accessories. The Energy Regulatory Commission has prepared and gazetted the Energy (Solar Water Heating) Regulations 2012 and The Energy (Solar Photovoltaic) Regulations 2012 to provide the much needed policy framework. Furthermore, the Government has been exempting imported solar equipment from excise duty (25 percent) and VAT (16 percent). This has really helped to lower the cost of solar panels and peripherals. However, the tax exemptions do not cover locally assembled parts, such as mountings or pumps. If tax exemptions were applied, costs of equipment would be reduced leading to more adoption thus creating employment.

## **Innovations in SPIS Services and Stakeholder engagement**

### ***Stakeholders and Value Chain Actors***

There is a wide stakeholder base engaged in the SPIS value chain, including: (i) users of solar products and equipment – mostly farmers, (ii) suppliers of either whole SPIS kits or components of solar powered equipment and associated services, such as importers, wholesalers, retailers and re-sellers, manufacturers and service providers across a wide spectrum (private companies, technicians, extension

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<sup>9</sup> National Energy and Petroleum Policy (2015)

workers, traders and transporters. There are also, (iii) development partners supporting SPIS (UN, multilateral, INGOs), (iv) banks and financial institutions, (v) marketing and farmer support organizations, including NGOs, (vi) institutions offering training on solar powered systems, and, (vii) policy and regulatory institutions at national and county levels (Government).

### ***The one-stop-shop for SPIS***

Several SPIS service providers and companies provide the layout and design of the whole system, including planning of agronomic aspects, and act as holistic service providers. Examples include; Sunculture, Kickstart International, Futurepump, Epicenter Kenya and Irrico etc. In Kenya, there is a general trend towards suppliers planning and designing the entire solar powered irrigation system (including pump and irrigation equipment), installing it and offering service contracts for its operation. This is especially true for the bigger systems, but there are also examples where this applies for smaller systems. In this case, the One-Stop-Shop business may also act as financier of the system.

### ***The IoT platforms***

The Internet of Things (IoT) are activities such as online purchasing, communicating, automated solar pumping, financing, marketing and all services that utilize the internet. Kenya is among the top countries in Africa in internet connectivity and use. Kenya's mobile phone penetration at almost 109% (many people have more than one SIM card) in January 2021 is one of the highest in Africa. Almost all farmers have a mobile phone resulting in a wide array of innovations targeting agriculture. As a result a number of ICT innovations are supporting agricultural intensification through SMS messaging and Apps that enable farmers to download extension messages, buy and sell goods, and improve the efficiency of the farming enterprise.

### ***FinTech innovations***

There are several innovative financial technology (FinTech)<sup>10</sup> solutions that address financing issues in agricultural supply chains using information and communication technologies (ICT). For example, Agri-wallet is a digital wallet (a mobile application) with M-pesa as the currency, providing farmers with a business account they can use to earn, buy and save money for agricultural inputs. Information and communication technologies (ICT) platforms have been adopted by service providers, banks and MFIs that reach farmers, as individuals or in groups with loans and credit.

### ***Innovative financing and credit schemes for SPIS***

There are many financial institutions providing grants, loans and credit for agriculture in Kenya including at village level. There are also private companies and NGOs offering innovative credit schemes targeting smallholder farmers engaged in irrigated agriculture. These include asset financing, such as providing in-kind soft loans for farmers to purchase SPIS equipment. The most common typologies of financing and credit models for SPIS include: Pay-as-you-grow (PAYG), Pay-as-you-go, micro-finance credit schemes, Mobile Layaways, Rent-to-own models, The Leasing Model, Aggregator Models and table-banking models. However, a number of these credit schemes have not been mainstreamed for SPIS, and thus opportunity for financing.

## **Scalability**

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<sup>10</sup> The term 'Fintech' refers to software and other modern technologies used by businesses that provide automated and improved financial services. Source: <https://www.fintechweekly.com/fintech-definition>

Solar powered irrigation is scalable across multiple scales as pumps come in a range of capacities and solar panels can be added for additional power as required, and can be implemented at individual farmer or community levels

### **SPIS is environmentally friendly**

Solar water pumping is a climate-smart choice, especially when compared with petrol, diesel or other fossil fuels. Overall, SPIS can play an important role in climate change mitigation, reducing GHG (CO<sub>2</sub>) emissions in irrigated agriculture by replacing fossil fuels with a renewable energy source. Solar being a renewable energy, solar irrigation facilitates attainment of SDGs that have a bearing on food security (SDG 2), water (SDG 6), energy (SDG 7), and climate change (SDG 13). The Government of Kenya has developed a Roadmap for SDGs – Kenya’s Transition Strategy<sup>11</sup> which describes how government plans to mainstream SDGs in all spheres of development.

### **Challenges that Still Remain**

A number of challenges face the sub-sector of solar powered irrigation, cutting across technological, policy, economic and social issues, to they include:

- a) **High initial costs:** Although Solar energy prices have drastically dropped, making the technology affordable to average farmers, the cost is still too high e.g. a small solar pumping kit for irrigation costs about US\$350-800, which is still too expensive for smallholder poor farmers. Moreover, most of the solar powered pumping equipment are imported from China, India, USA, Germany and other countries and finding spare parts can be a challenge.
- b) **Shortage of qualified technicians:** There are few qualified technical staff to handle design, installation, operation and maintenance of SPIS. According to the Kenya Renewable Energy Association (KEREAA)<sup>12</sup>, poor quality of products as well as design, installation and maintenance services has significantly hindered market growth for the sector.
- c) **Risk of over-pumping and groundwater depletion** – solar pumping has attractive features, such as low running costs, which may encourage over-pumping thus depleting groundwater resources. SPIS – if not adequately managed and regulated – bear the risk of fostering unsustainable water use as low energy costs can lead to wasteful water use, over-abstraction of groundwater, and low field application.
- d) **Policy challenges:** One problem is bureaucracy, arbitrariness and sometimes slow pace of getting clearances to get a project started<sup>13</sup>. Although there are tax exemptions for solar equipment, the costs of irrigation equipment are still fully taxed rendering SPIS expensive. County governments also charge levies, such as branding levy, which discourages distributors from advertising widely.
- e) **Shortage of land:** The peri-urban areas of Kajiado have been taken over by residential areas which occupy formerly fertile lands that could be irrigated. This means shrinking space for agriculture.

### **Reference Materials**

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<sup>11</sup> Ministry of Devolution and Planning (2017). Implementation of the Agenda 2030 for Sustainable Development in Kenya. <https://sustainabledevelopment.un.org/content/documents/15689Kenya.pdf>

<sup>12</sup> A voluntary accreditation framework for solar PV businesses in Kenya <http://kerea.org/voluntary-accreditation-of-solar-pv-businesses-in-kenya-2/> 24

<sup>13</sup> EED Advisory, 2018. Evaluation of the Sustainability of Solar Powered Water Supply Systems in Kenya. Global Solar and Water Initiative (GSWI), Nairobi

- County Government of Kajiado (2018). County Integrated Development Plan (2018-2022).
- FAO, 2018. The benefits and risks of solar-powered irrigation - a global overview. Food and Agriculture Organization of the United Nations and Deutsche Gesellschaft für Internationale Zusammenarbeit. <http://www.fao.org/3/i9047en/I9047EN.pdf>
- GoK, 2016. Policy on devolved system of government. Ministry of Devolution and planning. Government of Kenya
- GoK, 2017a. National Irrigation Policy. Ministry of Water and Irrigation. Republic of Kenya.
- GoK, 2017b. Kenya Climate Smart Agriculture Strategy (2017-2026). Government of the Republic of Kenya.
- GoK, 2019. Agricultural Sector Transformation and Growth Strategy (2019-2029). Government of Kenya.
- Government of Kenya (2018). National Climate Change Action Plan (Kenya) 2018-2022. Ministry of Environment and Forestry, Nairobi, Kenya. <https://www.kenyamarkets.org/wp-content/uploads/2019/02/NCCAP-2018-2022-Online-.pdf>
- Hlthaus, J., and Bikash P.R.F. (2017). Accelerating Solar Water Pump Sales in Kenya: Return on Investment Case Studies .
- Hornum, S.T. and Bolwig, S. 2020. The growth of small-scale irrigation in Kenya: The role of private firms in technology diffusion. UNEP-DTU Partnership. [https://backend.orbit.dtu.dk/ws/files/223530158/The\\_Growth\\_of\\_Small\\_Scale\\_Irrigation\\_in\\_Kenya1.pdf](https://backend.orbit.dtu.dk/ws/files/223530158/The_Growth_of_Small_Scale_Irrigation_in_Kenya1.pdf)
- <https://ledsgp.org/wp-content/uploads/2018/07/Smallholder-Solar-Pumps-101-7-17-18-002.pdf>
- Kenya Smallholder Solar Irrigation Project (KSSI) <https://winrock.org/wp-content/uploads/2017/03/Winrock-KSSI-Handout-for-Farmers-2-9-17.pdf>
- Mati, B.M. (2019). Country Assessment of Solar Powered Irrigation Systems in Kenya. Consultancy Report. Food and Agriculture Organization of the United Nations. Rome
- Mati, B.M. 2018. Innovations in Solar Water Pumping Systems: Taking Kenya's Development to the Next Level. 5<sup>th</sup> UNESCO Africa Engineering Week /3<sup>rd</sup> Africa Engineering Conference & 25<sup>th</sup> IEK International Conference 17<sup>th</sup> to 21<sup>st</sup> September 2018. <http://www.jkuat.ac.ke/departments/warrec/wp-content/uploads/2018/09/Innovations-in-Solar-Water-Pumping-in-Kenya-Prof.-Mati-3.pdf>
- Mercy Corps, JUNE 2020. Policy Brief: achieving food security in Kenya through smart solar irrigation. <https://www.mercycorpsagrifin.org/wp-content/uploads/2020/06/AgriFin-Solar-Irrigation-Report-Full-Length.pdf>
- MoALF. 2017. Climate Risk Profile for Kajiado County. Kenya County Climate Risk Profile Series. The Ministry of Agriculture, Livestock and Fisheries (MoALF), Nairobi, Kenya.
- MWS&I, 2020. Guidelines for Promotion, Development and Management of Irrigation in Kenya. Ministry of Water, Sanitation and Irrigation (MWS&I), State Department for Water. Government of Kenya
- Portia Crowe, 2014. Kenyan farmers profit from the sun to water crops. Thomson Reuters Foundation Wednesday, 12 November 2014. <https://news.trust.org/item/20141112092854-u3qln>
- Republic of Kenya, 2016. The Water Act. Kenya Gazette Supplement No. 164 (Acts No.43) of 2016. Government Printer.
- Republic of Kenya, 2019. The Irrigation Act. Kenya Gazette Supplement No. 136 (Acts No.14) of 2019. Government Printer.



Republic of Kenya, 2020. The Irrigation (General) Regulations. Government of the Republic of Kenya

Winrock International, 2018. Scaling Up Smallholder Solar Irrigation in Sub-Saharan Africa.  
<https://ledsgp.org/wp-content/uploads/2018/07/Smallholder-Solar-Pumps-101-7-17-18-002.pdf>

Netherlands Development Organization (SNV). (2019). *Accelerating Farmer-Led Irrigation Development-Theories and Practice of the Smart Water for Agriculture in Kenya Project.*

## **CASE STUDY 4: BLENDED FINANCE FROM DOWNSTREAM NAIROBI CITY SUPPORTING AGRICULTURE AND WATERSHED MANAGEMENT UPSTREAM**

### **What is the Innovation?**

A sustainable blended financing Trust set up and operationalized through Public-Private-Partnerships by engaging large water users in the City of Nairobi to support sustainable agriculture and watershed management activities implemented by land users in upstream catchments of Upper Tana River Basin.

**When:** From 2005 to 2020

**Where:** Upper Tana River catchment areas

### **Innovation Pathway**

Large water users in the city of Nairobi are companies having a generous CSR (Corporate Social Responsibility) fund and thus, willing to support conservation and other beneficial activities in upstream areas where the resource comes from. The Nairobi City Water and Sewerage Company would also like to see ecosystems preserved, agriculture practiced in a sustainable manner to enhance cleaner water flows from the catchments. The land owners/users who live upstream cultivate very steep, fragile lands prone to erosion, soil degradation and generally, are resource poor. They require support and motivation to afford the costs of conservations and sustainable agriculture. Rather than one-off projects, this innovation brought together the water users downstream (Nairobi based private and public institutions) who set up a long-term sustainable endowment fund – now registered as a Trust fund. It is a financing model combined with governance and having legal basis as a charitable public trust that creates a platform for participation of public, private and development actors and communities to provide support and a delivery mechanism for sustainable agriculture and watershed conservation, where downstream water users provide incentives (funds) for upstream communities to conserve the sources of water (see Figure 1).

### **Background**

The upper Tana basin covers an area of 17,000 km<sup>2</sup> and hydrologically here refers to three major sub-catchments, the Sagana-Gura, Maragua, and Thika Chania. The Tana river drains from two of Kenya's five water towers: the Aberdare Range and Mount Kenya, an area bearing national significance, in terms of protection of Kenya's water towers. It among the most important catchments for the people of Nairobi and Kenya in general, as it is the source of 95% of the city of Nairobi's water and 50% of Kenya's hydropower. The catchment areas are steep and occupied by some protected forest at the top, the rest of the land being under small-scale farming. For years, these cultivated lands suffered soil erosion which polluted the rivers, while low agricultural productivity was also a major problems.

The watershed's potential to provide water and other vital ecosystem services was declining due to overpopulation and farming methods that were unsustainable. Most of the unprotected forests and woodlands - including on steep hillsides, along rivers and wetlands - had been converted to agriculture such that most of the landscapes are covered in herbaceous vegetation and shrub, and farmlands by crops like tea, coffee, and maize. At the same time, local residents who farm the upper watershed had no outside investment or incentives to protect this critical resource by implementing measures that can ensure it provides abundant, safe water for everyone. The river was becoming increasingly polluted by sediments, while over-abstractions of water for irrigation was reducing river flows. All of these impacts exacerbated a declining productivity of farmland, water supplies, and water quality, while increasing the

costs of water distribution and energy production in the Upper Tana and downstream. At the same time, the unique biodiversity that depends on a healthy Tana river continued to be lost.

The **Water Fund model** is premised on observations that a well-conserved Upper Tana River basin with improved water quality and quantity for downstream users (public and private); maintaining regular flows of water throughout the year; enhancing ecosystem services, specifically food security, freshwater and terrestrial biodiversity, and improving human well-being and quality of life for upstream local communities.

### **Introducing the Water Fund Concept**

The concept of a water fund is based on the principle that it is cheaper to prevent some water problems at the source than it is to address them further downstream. Investments in green infrastructure using natural systems and its services to trap sediment and regulate water often provide a more cost-effective approach than relying solely on grey infrastructure such as reservoirs and treatment systems. Water funds have been successfully implemented elsewhere in the world to help secure the water quality and supply of major cities including New York, Quito, Rio de Janeiro, and Lima, among others.

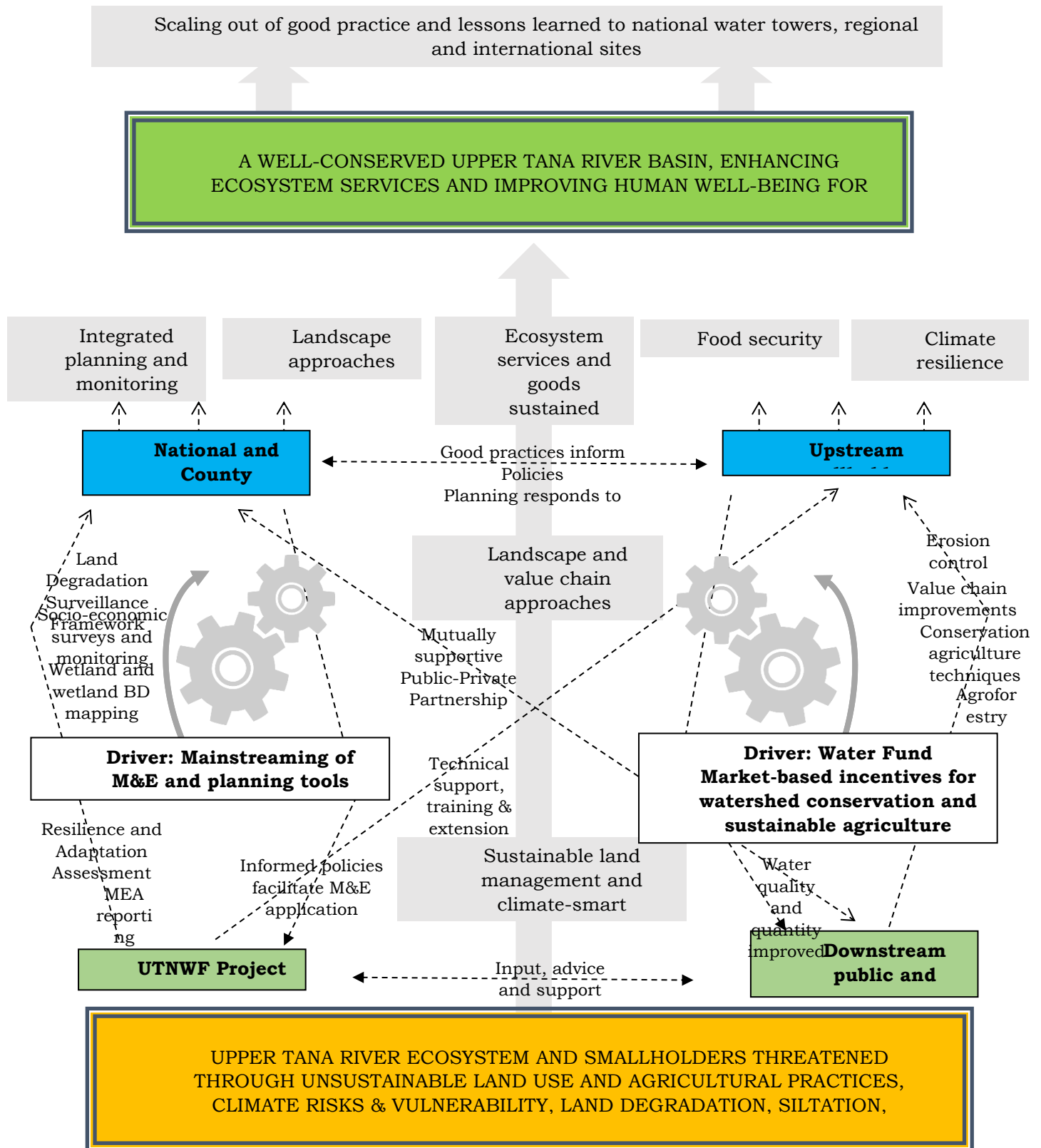
The Upper Tana Nairobi Water Fund (UTNWF) was the first of its kind in Kenya, and indeed in Africa. The UTNWF is a public-private-partnership of donors and major water consumers 'at the tap' who contribute to an endowment fund (now a Trust) of the Water Fund (WF) to support water and soil conservation measures 'at the top'. These measures benefit local farmers' livelihoods, food security and resilience through increasing agricultural yields and introducing climate-smart agricultural techniques, and thus reducing soil erosion that is so damaging both to crop production and to downstream water quality and supply. It was launched in 2012 through a three-year proof of concept phase which was used mostly for gathering baseline data, hydrological and economic modelling and developing a stakeholder base. A five year project phase from 2015 to 2020 actualized the Water Fund and implemented activities out of which successful outcomes (reduced erosion, increased tree cover, water harvesting, crop diversification, increased incomes for farmers, and investment flows from partners) were achieved. Throughout all this, a rigorous monitoring and evaluation system was inbuilt into the programme using scientific as well as socio-economic methods. There are robust databases supported by science to proof the concept was turned into reality with deliverables.

### **Main activities**

A number of activities have been implemented that culminated in the success of the UTNWF in mobilizing resources downstream, and using those resources prudently to achieve the intended watershed conservation and agricultural intensification upstream. These included:

- A proof of concept phase in which baseline data were collected and modelling tools used to determine where to target investments and the most opportune activities to implement as well as building partnerships;

Figure 1: Theory of change for the Water Fund Model



- Establishment and institutionalization of the Water Fund Management Platform. This involved identification of at least ten large private sector companies in Nairobi, and linking them with public sector institutions to create a public-private partnership to establish the Water Fund (WF) as a Charitable Trust registered under Kenyan law and governed by a Board of Trustees. The Board of Trustees was charged with the management of the WF, which worked through a set of advisory committees at both national and at county levels and a technical Secretariat, responsible for the day-to-day management of its activities;
- Mobilization of funds from both public and private sector institutions to support tangible activities in the upstream catchments;
- Investment flows to upstream catchment land users/land owners that supported sustainable land management and integrated natural resources management implemented by farmers and other land users in the upper Tana catchments;
- Capacity building of farmers, farmer groups, community, county and national institutions was done to facilitate adoption of best practices and creating communities of practice to upscale interventions; and
- Establishment of a robust knowledge capture, management and learning systems so as to track progress made and share lessons both at local and national levels. Strong emphasis was placed on M&E frameworks to support the WF in decision making and allowing for an adaptive management approach to the targeted incentive schemes, and also to allow for upscaling, policy integration and replication of lessons learned.

### **Achievements and Impacts**

The investment flows to land users in upper Tana catchments enabled upscaling the combination of biophysical and agricultural techniques and support for water management for diversified production and increased yield through improved soil retention; broadened adaptation potential and resilience through reduced erosion upstream, and stabilised catchment ecosystem services.

The farmers in the watershed have already yielded significant benefits and set the stage for rapid growth and much greater impact going forward. By end of 2019, the UTNWF had worked with over 29,391 farmers to apply soil and water conservation practices and was on course. UTNWF provided the skills, training, and resources they need to conserve water, reduce soil runoff, and improve productivity. The has been remarkable success which has been tracked to show that great milestones were achieved, including: Over 29,000 farming households (about 150,000 people) were applying soil conservation and water saving practices, and over 20,000 hectares were under sustainable management. At least 3.7 million trees were planted while some 14,000 water harvesting pans were installed that harvest 900 million litres annually. Others include at least 115 biogas digesters installed as local, renewable energy sources. This enabled increasing the resilience of the local population through improved food production, household incomes and diversified development options and livelihoods, with due reference, disaggregation of support and results by gender and age.

Downstream economic benefits include reduced water treatment costs through reduced sediment concentration and increased hydropower generation through higher water yield and reduced sedimentation. Moreover all of this impact has occurred using just 20% of the targeted US\$10 million total investment and the goal is to fully fund the Endowment. This target is also on course to be achieved.

By fostering multi-stakeholder alliances and partnerships, while also being a broad-based public private partnership, the UTNWF facilitated alliances incorporating beneficiary groups, NGO, private sector and public service providers along an innovative implementation strategy, and partnerships can be formed a even in the future. This is the underlying concept of water funds in providing financial sustainability; through payments for ecosystem services which require both a market for suppliers and the demand of recipients.

## Reference Materials

- FAO. (2017). Ex-ante carbon balance tool (EX-ACT). Rome: FAO.
- Hunink, J. E., Niadas, I. A., Antonaropoulos, P., Droogers, P., & de Vente, J. (2013). Targeting of intervention areas to reduce sedimentation in the Tana catchment (Kenya) using SWAT. *Hydrological Sciences Journal*, 58(3), 600–614.
- International Fund for Agricultural Development. (undated). Greenhouse Gas Assessment of the GEF IAP Establishment of the Upper Tana Nairobi Water Fund (UTNWF) in Kenya using the EX-Ante Carbon Balance Tool (EX-ACT).
- Kauffman, S., Droogers, P., Hunink, J., Mwaniki, B., Muchena, F., & Gicheru, P. (2014). Green water credits – Exploring its potential to enhance ecosystem services by reducing soil erosion in the upper Tana Basin, Kenya. *International Journal of Biodiversity Science, Ecosystem Services and Management*, 10(2), 133–143.
- Leisher, C. 2013. Maragua and Thika/Chania Baseline Survey for the Upper Tana Water Fund. The Nature Conservancy
- Schmitz, T. and Kihara, F. 2021. Investing in Ecosystems for Water Security: The Case of the Kenya Water Towers. Nature Switzerland AG 2021. R. Brears (ed.), *The Palgrave Handbook of Climate Resilient Societies*, [https://doi.org/10.1007/978-3-030-32811-5\\_23-2](https://doi.org/10.1007/978-3-030-32811-5_23-2)
- The Nature Conservancy (TNC) (2015): Upper Tana-Nairobi Water Fund Business Case. Version 2. The Nature Conservancy. (2019b). Protect source waters. Africa Business Plan 2019–2025. Nairobi: The Nature Conservancy
- WRMA (2011), Physiographical Baseline Survey for the Upper Tana Catchment Area, Nairobi, Kenya
- WRMA (2014), Catchment Management Strategy for Tana Catchment Area (2014-2022). Water Resources Management Authority.

## **CASE STUDY 5: INNOVATIVE ACCESS TO FINANCE SUPPORTING AGRICULTURAL INTENSIFICATION**

### **What is the innovation?**

Small-scale farmers accessing financial services (such as loan application, processing, cash withdrawals, savings, loan repayment, in-kind credit) through options that are timely, simple, user friendly, adaptive and versatile, thus enhancing financing of agricultural intensification.

**When:** From the year 2004 to 2021

**Where:** Kirinyaga County (actually, the whole country)

### **The Challenge**

Up to around the year 2004, the number of small-scale farmers in Kenya with a bank account or taking a loan to fund an agriculture were few. The banks in turn considered small-scale farmers too risky, low budget and not worthy of giving credit for agriculture. Lending by formal banking systems and financial institutions was very low. Banks would demand collateral such as land title deeds to process loans, while lending interest rates were high, rendering agricultural credit unaffordable and unprofitable to the average small-scale farmer. At the same time, credit processing required physical visits to the bank or MFI institutions, filling of incomprehensible application forms, review and evaluation of the farmer's account and financial history and sometimes including a visit to the farm. The turnaround time for credit processing and access was very slow and would sometimes be overtaken by important events such as cropping calendar or the loan would be made available when the farmer least needs it, having suffered losses or missed market targeting. In short, small scale farmers had few opportunities to access credit.

### **Growth of financial services for small-scale farmers**

The turn-around can be traced to around the year 2004, a number of microfinance institutions, relaxed the stringent requirements by small farmers to access credit. Among these were Equity Bank, the then K-REP bank (now Sidiya Bank), Faulu, Kenya *Women* Microfinance Trust (now a bank) among others. For instance, Equity Bank, previously a small building society, started giving small soft loans to small-scale farmers with a much simplified application process and requiring innovative collateral and repayment modes. The success of Equity's innovations saw their customer base grow exponentially and in particular, small-scale farmers were opening accounts making savings and taking loans. Other MFIs soon adopted similar models. This impetus was pushed by raft of policy reforms by the then newly elected (2003) Government such as the Economic Recovery Strategy for Wealth and Employment Creation (GoK, 2003) and the Strategy for Revitalization of Agriculture (GoK, 2004).

These changes saw Kenya's economy experience a boom and with it the expansion of the financing sector. The next great leap in financial services came when Safaricom's mobile money transfer platform M-Pesa was launched in Kenya in 2007. The success of the Equity model of lending to the poor coupled with the success of the M-Pesa platform produced a wide array of innovations in mobile banking among others. The number of financial institutions providing loans and credit to small-sale farmers has grown, the customer base has increased and a vibrant micro-finance sector emerged on financial services and Fintech open to farmers literally at the fingertips.



## Who and what (is involved)

### ***Commercial banks***

Kenya has a number of banks and financial institutions offering special products and services to smallholder farmers. These include Kenya Commercial Bank (KCB), Equity Bank, Co-operative Bank, Commercial Bank of Africa (NCBA), SBM Bank, Family Bora Bank, Sidian Bank, Jamii Bora Bank, Absa Bank and Stanbic Bank. Nearly all these banks require collateral from farmers, the most commonly accepted being land title deeds, logbooks, livestock, household assets and in some cases, crops. In some cases where development partners or government is supporting a specific smallholder project, the banks allow such grants as collateral. These banks allow lending to individual farmers or groups through cooperatives and self-help groups. Unlike lending to individuals, group lending works by way of farmers being guarantor to each other. There are other innovative products such as Sidian Bank's Kilimo loan, Kilimo Asset Financing and Jaza Stock. Kilimo Asset Financing is particularly designed for smallholder farmers investments in agricultural technologies. Kilimo Loan is often taken up by farmers for agricultural inputs like seeds, fertilizers, and agrochemicals. Some banks allow extending the grace period for loan repayment to coincide with the specific crop harvest time, thus enabling the farmer to pay later.

### ***Micro-Financial Institutions***

Micro-financial institutions (MFIs) are organizations that offer financial services to low income earners. MFIs are slowly filling the gap to address the challenges of access to finance that has been left by the commercial banks . MFIs target mainly the low-income earners, a niche amenable to small-scale majority of them being low- and irregular-income earners. MFIs are more flexible with application process, loan amount and repayment duration. Some of the MFIs that have been actively involved in financing small-scale farmers include: Musoni, Juhudi Kilimo, ECLOF Kenya, SMEP Microfinance Bank, Faulu Kenya and Unaitas SACCO, Kenya Women Finance Trust, Remu DTM Limited, Rafiki Microfinance, UWEZO Microfinance, Century Microfinance, and SUMAC Limited. MFIs are increasingly becoming more important to smallholder farmers due to their flexibility in providing group loans as well as individual loans. Group loans allow smallholder farmers to co-guarantee each other, thereby reducing the need for collaterals. In comparison to mainstream financial institutions, micro-financial institutions loan size is very flexible, sometimes as low as KES 500 (five hundred shillings). Comparatively, micro-financial institutions charge higher interest rates than mainstream financial institutions due to the risk factors involved in lending to the smallholder farmers. Unlike the commercial banks that charge interest per annum, MFIs charge interest on a monthly basis. Interest rate for loans from MFIs range from 1.6% to 2% per month.

### ***Digital banking and credit schemes***

Kenya's mobile phone penetration at about 109% (many people have more than one SIM card) as of January 2021, and is one of the highest in Africa. Almost all farmers have a mobile phone resulting in a wide array of innovations targeting agriculture. As a result a number of information and communication technologies (ICT) innovations are supporting agricultural intensification through SMS messaging and Apps that enable farmers to download extension messages, buy and sell goods, and improve the efficiency of the farming enterprise. Kenya has several innovative financial technology (FinTech)<sup>14</sup> solutions that address financing issues in agricultural supply chains using ICT.

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<sup>14</sup> The term 'Fintech' refers to software and other modern technologies used by businesses that provide automated and improved financial services. *Source: <https://www.fintechweek.com/fintech-definition>*

## **How they operate**

There are several digital finance technology platforms in Kenya that have ventured into quick financing for smallholder farmers and low-income earners. Kenya is considered a leader in the region with regards to financial technology, especially around mobile money and credit access. Led by Safaricom's Mshwari, there are several other digital platforms that provide mobile financing to low income earners and farmers alike. These technology platforms enable farmers quick access to finance directly into their phones, thereby providing flexibility and saves them time. Apart from the Mshwari, there are over forty other technology platforms operating in Kenya and lending quick cash to low income earners and small-scale farmers; Branch, Zidisha, Saidia, Tala Kenya, KCB Mpesa, iPesa, CreditHela, Haraka, Timiza from Barclays, Branch, Shika, Zenku, Okash, Jazika, Utunzi, Kopokash, HF Whizz, Kashway, Opesa, LCash, DigiFarm, Agri-Wallet, Apollo Agriculture and Cap ARGI. A survey by the Kenya credit bureaus has revealed that about 19 million Kenyans (38%) are active mobile loan borrowers, with at least 40% of these borrowers having loans from between 6 to 10 mobile money lending services.

The mobile lending technology is growing very fast in Kenya due to their accessibility, flexibility and efficiency in lending to low income earners. Unlike the financial institutions that require physical visit to the branch, mobile lending services are completed from the comfort of their phones. For instance, DigiFarm provides cash advances to farmers ahead of the season but also links the farmers to market for their produce in addition to providing customized information on best agricultural practices. Agri-Wallet uses block chain technology to enable farmers to save and earn points which can be used to acquire agri inputs for production, mainly seeds, fertilizers and crop protection products. Agri-Wallet does not have provision for irrigation equipment in the list of the financed products. Even though these financial technology platforms are becoming very popular in Kenya, they have some demerits that may not make them ideal for financing smallholder agriculture. Meanwhile, some of the mobile loan apps are unregulated, resulting in exorbitant interest rates.

## **Farmers' Contributions**

A number of mechanisms exist through which farmers raise funds and in-kind support for agriculture by themselves. These include savings and credit cooperative organizations (SACCOs), women groups, youth groups, commodity interest groups (CIGs) or table banking groups (chamas). In particular, SACCOs have played a key role in agricultural development by mobilizing savings schemes and providing credit to farmers and agri-businesses (GoK, 2010). The government recognizes SACCOs and other community-based lending organizations as important institutions for increasing funding to small-scale farmers. The groups donate money through a structured system e.g. monthly subscriptions. Some farmer groups charge themselves a fee for irrigation to raise funds (see Case study 3). The groups also raise collateral with which to borrow loans or attract grants from development partners, thereby creating some growth and financial sustainability.

## **Reference materials**

- Birch, I. (2018). Agricultural Productivity in Kenya, barriers and opportunities.
- CoG, 2020. Council of Governors Annual Statutory Report 2019/2020. Council of Governors, Nairobi, Kenya. <https://www.cog.go.ke/>
- Food and Agriculture Organization (FAO). (2014). Country Program Framework for Kenya (2014-2017).
- GoK, 2003. Economic Recovery Strategy for Wealth and Employment Creation (2003 – 2007). Ministry of Planning And National Development, Government of Kenya

- GoK, 2004. Strategy for Revitalising Agriculture (SRA) 2004-2014, Ministry of Agriculture and Ministry of Livestock and fisheries Development, Government of Kenya, Nairobi.
- GoK, 2007. Kenya Vision 2030. Government of the Republic of Kenya. Nairobi: Government Printer. [http://www.vision2030.go.ke/cms/vds/Popular\\_Version.pdf](http://www.vision2030.go.ke/cms/vds/Popular_Version.pdf)
- GoK, 2010. Agricultural Sector Development Strategy (ASDS) 2010-2020. Government of Kenya.
- GoK, 2012. National Agribusiness Strategy. Agricultural Sector Coordination Unit (ASCU) Kenya,
- Hall, A. Clark, N. and Frost, A. (2010). —Bottom-up, Bottom-line: Development-Relevant Enterprises in East Africa and their Significance for Agricultural Innovation. RIU Discussion Paper Series, 2010-02, July 2010, Research Into Use: UK.
- HCDA. (2014). National horticulture validated report. Kenya: Ministry of Agriculture, Department of Horticultural Crops Development Authority. Kenyan Government Printer. Retrieved from <http://www.agricultureauthority.go.ke/wpcontent/uploads/2016/05/Horticulture-Validated-Report2014-Final-copy.pdf>
- Hlthaus, J., & Bikash Pandey, R. F. (2017). Accelerating Solar Water Pump Sales in Kenya: Return on Investment Case Studies .
- Jayne, T., Muyanga, M., Wineman, A., Ghebru, H., Stevens, C., Stickler, M., Nyange, D. (2019). Are Medium Scale Farms driving agricultural transformation in Sub-Saharan Africa?
- Karina, F. Z., & Mwaniki, A. W. (2011). Irrigation Agriculture in Kenya. Impact of the Economic Stimulus Program and Long-Term Prospects for Food Security in an era of Climate Change.
- Kenya, A. (2020). Piloting a New Approach to Agricultural Credits for Productive Use Assets- Learnings from Amiran Kenya, Madaraka Project.
- KfW Development Bank. (2020). Ex Post Evaluation of Smallholder Irrigation Program Mount Kenya (SIPMK).
- Khan Z., Midega C., Pittchar J., Pickett J. and Bruce T. (2011). Push-pull technology: a conservation agriculture approach for integrated management insect pests, weeds and soil health in Africa. *International Journal of Agricultural Sustainability* 9(1): 162-170.
- Kiara J.K. (2011). Focal area approach: a participatory community planning approach to agricultural extension and market development in Kenya. *Int Journal of Agricultural Sustainability* 9(1): 248-257.
- Kiplimo, J.C., Ngenoh, E., Koech, W., and Bett, U.K. (2015). Determinants of Access to Credit Financial Services by Smallholder Farmers in Kenya.
- Muhanji G., Roothaert R.L., Webo C. and Stanley M. (2011). African indigenous vegetable enterprises and market access for small-scale farmers in East Africa. *International Journal of Agricultural Sustainability* 9(1): 194-202.
- Mutavi, S.K, Amwata, D.A (2018), Constraints and Opportunities Among Small Scale Peri-Urban Dairy Farmers in the South Eastern Kenya Rangelands
- Netherlands Development Organization (SNV). (2020). Inclusive Finance and Business Strategies for Farmer-Led Irrigation Development.
- Pretty J. Toulmin C. and Williams S. (2011). Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability* 9(1): 5-24.
- Republic of Kenya, 2013b. The Crops Act. Kenya Gazette Supplement No.28 (Acts No.16) of 2013. Government Printer.
- Stöber, S., Chepkoech, W., Neubert, S., Kurgat, B., Bett, H., & Lotze-Campen, H. (2017). Adaptation Pathways for African Indigenous Vegetables' Value Chains, 413–433. doi: 10.1007/978-3-319- 49520
- Wambugu C., Place F. and Franzel S. 2011. Research, development and scaling-up the adoption of fodder shrub innovations in East Africa. *International Journal of Agricultural Sustainability* 9(1): 100-109.

## CASE STUDY 6: SMALLHOLDER DAIRY SUPPORTING AGRICULTURAL INTENSIFICATION

### What is the Innovation?

Upscaling of smallholder dairy through improved breeds, capacity building and market thus enhancing agricultural intensification through products and by-products of tethered livestock keeping.

**When:** From 2006 to 2016

**Where:** Nakuru County

### Background

Improved dairy cattle production by indigenous Kenyans was not until after the Swynnerton Plan of 1954, which allowed them to engage in commercial agriculture (Conelly, 1998). By 1963, when Kenya attained independence, the dairy herd had increased to about 400,000 exotic cattle largely in the hands of the settlers. After independence, there was a rapid transfer of dairy cattle from the settler farms to the smallholders resulting in a decline in the cattle population on large-scale farms to 250,000 head by 1965. To encourage dairy production by smallholders, the government effected a number of changes in the provision of livestock production and marketing services, resulting in highly subsidized (Muriuki, H.G 2003) services. In 1971, and following the recommendations of the Dairy Commission of Inquiry, the government abolished the quota system of dairy marketing to Kenya Co-operative Creameries (KCC) to allow for the inclusion of smallholder producers. In 1993, the government published a dairy policy “A strategy towards Development of self-sustaining Dairy Sector “, aimed at giving direction to the industry’s liberalization. Parastatals and government institution that had dominated the sectors processing and marketing went down and with it other players emerged including private players and small community based processors anchored in cooperative movements. Several factors, which include the presence of significant dairy cattle populations, the importance of milk in the diets of most Kenyan communities, a suitable climate for dairy cattle and a conducive policy and institutional environment, have contributing factors to the success of dairy production by smallholders in Kenya (Conelly, 1998; Thorpe et al. 2000)

### Growth of smallholder Dairying

The growth of the dairying sector in Nakuru has been associated with the promotion of smallholder farming nationally. The organization of dairy farmers into cooperatives and other forms of producer groups, has seen dairy farmers benefiting from subsidies in breeding, animal health, and extension and training services. In addition favourable government policies liberalization of the sector in the 1990s, interest and investment in the dairy sector by development partners and private sector, and the multiple benefits of dairy animals when stall fed (milk, manure and cattle as a social-economic resource. Kenya’s dairy sector account for 6-8% of the country’s GDP. It is a major activity in the livestock sector and an important source of livelihood to approximately 1 million small scale farmers. It is the most rapidly expanding dairy sub sector in sub-Sahara Africa with over 85% of the dairy cattle population in Eastern Africa. Kenya is one of the largest producers of dairy products in Africa with a dairy herd of about 3.5 million exotic cattle, 14.1million indigenous cattle, 27.7 million goats, and 2.97 million camels (NDDP 2013). Dairy production in Kenya is mainly practiced by smallholder dairy farmers keeping one to three cows who account for over 80% of domestic milk production (ILRI, 2008). Dairying is an attractive livestock enterprise in Kenya for income generation and food security in addition to contributing to the sustainability of smallholder crop-dairy systems through nutrient cycling to fertilize soil,

employment creation and provision of farm household nutrition. Dairying supports an estimated 625,000 smallholder producer households. Smallholders retain approximately 40% of milk produced mainly for household consumption (70%) and calf feeding (30%), while the rest is marketed via informal markets, cooperatives, self-help groups and processors.

### **Improved breeds**

Milk production is largely undertaken by smallholder dairy farmers. The production systems include open grazing, zero grazing, and semi zero-grazing. This consists of Friesians, Ayrshires, Jerseys, Sahiwals, and their crosses. Improvement of breeds, improved animal health, improve dairy groups' access to financial services by promoting competitive investment grants designed to improve dairy business activities and techniques protection activities. reduce transaction and input costs. Link groups to processing services and markets. Adoption of the market oriented dairy enterprise approach. resourcing the dairy groups, cooperatives and apex organization to strengthen the market linkages. Artificial insemination, animal disease prevention and disease management, fodder production, silage preparation.

### **Milk Marketing**

Cooperatives have played a big part in the dairy industry in most cases being engaged in the collection, consolidation, transportation and processing of milk. It is estimated that from every 100 litres of milk marketed by small scale producers, 1.2 jobs (formal and informal) are created along the dairy value chain (Murage and Ilatsia, 2011). These attributes have made dairying a preferred choice for addressing rural poverty. According to ILRI, the Dairy sector employs about 15% of the labour force. The small scale dairy is mainly implemented by farmers, majority of whom have been enrolled in the cooperatives or self-help groups. Dairy cooperatives provide the market for their milk with some of them providing inputs, extension and credit. This is mainly the impetus for the high enrolment. The participation of the farmers in the approval of the activities provides ownership of their dairy.

### **Integrated small holder production systems**

Dairy farming fits well in the smaller holder farming system. There is interdependency with almost all the activities including the recycling of resources. The zero grazing adopted in most of the farms enables the farmer to recycle nutrients through collection manures and application to his fodder together with the production of bio-gas. Dairy farming fits well in the highly populated highlands of Kenya where majority of farmers own less than 3 acres of land.

### **Reforms and policy changes**

The initial reforms and policy supported the establishment of the dairy sector. Government policies on the transfer of the cattle dips to the community in 1989 ensured the ownership of such infrastructure was handed to the farmers. The privatization of the AI services & clinical services and the decontrolling of milk prices were major accelerators in the development of the small holder dairy farming. The policy enabled farmers to form community groups to plan and implement their own activities. It enabled the farmers to seek high quality services including credit to develop their dairy. Farmers felt liberated from the government control and as such they could invest in the industry. One of the impact of these policy changes was the development of proliferation of sale of raw milk (hawking). This has been popular with the farmers as they are paid promptly by the consumers (NDDS, 2013). Consequently, it is estimated 80 percent of marketed milk in Kenya is handled by the informal traders who deal with the unprocessed whole milk. Due to lack of restrictions, starter farmers are attracted to dairy as you can

make money quite fast. Though undesirable by the Government due to quality concerns, the number of processor is too low to handle all milk while the prices maybe restrictive.

### **Employment, gender and inclusion**

Lack of access to productive resources such as land, credit, technical skills and extension services has limited participation of women and youth in farming. Dairy farming remains one enterprises that may not require much capital as a start-up. Women through the support of women groups have been able to start the enterprise as it requires small area for zero grazing. Value adding of milk into milk product has attracted the youths ensuring the creation of the employment. The milk value chain engages a lot of players therefore employing more people in the chain.

### **Multi-stakeholder Partnerships**

The milk value chain has many player wh include Government Ministries (Agriculture, Cooperatives), County Governments. The Dairy Training Institute is based at Naivasha in Nakuru and plays an dedicated role of building capacity for the sub-sector. The Kenya Animal Genetic Resource Centre (KAGRIC), Parastatals (KDB), International organizations IFAD,SNV, ILRI, Cooperatives, Various milk processors such as (KCC, and Brokeside), DCS, farmers,

### **Impacts**

There is high demand of milk which is fueled by the increase in population majority of them in the urban areas. In 2012, milk consumption in Kenya was about 4 billion liters. The consumption is estimated to rise by 3 to 4% annually driven by increases in population, urbanization and income. It is anticipated that by the year 2018, the consumption will rise to 4.7 billion litres. Currently, it is estimated that the annual per capita milk consumption is 120 litres (NDDP 2013). This is a sustainable market which is pushing a lot of people into dairy farming. This lead to the essence of formation of Dairy marketing groups to market the milk through producers. Also target the communities in the appropriate environment for dairy and they have not been farming dairy.

### **Reference materials**

- Agro-industrialization through institutional innovation transaction costs, cooperatives and milk-market development in the East- African highlands, *Agricultural Economics*, 23(3):279-288.
- Bebe, B. O., Udo, H. M. J., Rowlands, G. J. and Thorpe, W. 2003. Smallholder dairy systems in the Kenya highlands: cattle population dynamics under increasing intensification, *Livestock Production Science*, 82 (2–3):211-221.
- Conelly W.T. 1998. Colonial era livestock development policy: Introduction of improved dairy cattle in high-potential farming areas of Kenya. *World Development* 26:
- IFAD (International Fund for Agricultural Development), 2006. Small Holder Dairy Commercialization Programme- Appraisal Report: Africa Division 11, Programme management Department. Rome, Italy.
- IFAD/GoK. 2020: Smallholder Dairy Commercialization Programme Project Completion Report
- ILRI (International Livestock Research Institute) 2000. Handbook of livestock statistics for developing countries: socio-economics and policy research Working Paper 26. International Livestock Research Institute, Nairobi, Kenya.
- Kenduiwa, A. A, Mwonya R. A and Kinuthia L. N. 2016. Influence of smallholder dairy farmers participation in microfinance on breed improvement in dairy farming in Longisa Sub County, Bomet County, Kenya. *Journal of Agriculture and Veterinary Science*, 9(7):66-75.

- Kenya Dairy Board (KDB). 2020. Kenya Dairy Board website. Available at: <http://kdb.co.ke> accessed on 21<sup>st</sup> August 2020.
- Kenya National Bureau of Statistics (KNBS) 2019. Kenya Population and Housing Census 2019, Volume IV: distribution of population by socio-economic characteristics. KNBS, Nairobi, Kenya.
- Kilelu, C. W., Klerkx, L. and Leeuwis, C. 2017. Supporting smallholder commercialization by enhancing integrated coordination in agrifood value chains: experiences with dairy hubs in Kenya. *Experimental Agriculture*, 53(2):269-287.
- Mburu L. M., Gachui C. K., Wanyoike M. M., Mande J. D. and Badamana M. S. (2016). Production resources and performance in small-scale dairy cattle farms in coastal lowlands of Kenya. *Journal of animal science advances*, 6(8):1696-1708.
- Murage AW, Ilatsia ED (2011). Factors that Determine use of Breeding Services by Smallholder Dairy Farmers in Central Kenya. *Trop. A.Health Prod.* 43.
- Mutavi S K, Kanui T I, Njarui D M, Musimba N R and Amwata D A 2016 Innovativeness and Adaptations: The way forward for Small scale Peri- Urban Dairy Farmers in semi-arid Regions of South Eastern Kenya. *International Journal of scientific research and innovative technology*.
- Muthui J.N., Mshenga P.M., and Bebe B.O., 2014, The influence of livestock market structure conduct and performance on herd productivity among smallholder dairy farmers in Western Kenya. <http://academeresearchjournals.org/journal/jaed>.
- Ndambi, A., Kilelu, C. W., Lee, J. Van Der, Njiru, R. and Koge, J. 2019. Making milk quality assurance work on an unlevel playing field. *3R Research Report 008 WLR*. Nairobi. Available at: <https://edepot.wur.nl/476559>
- Nyeri CIDP (2018). Nyeri County Integrated Development Plan 2018- 2022: towards a competitive and prosperous county. department of finance and economic planning January, 2018. County Government of Nyeri. Available at: <https://www.cog.go.ke/downloads/category/106-county-integrated-development-plans-2018-2022>. Accessed on 17 December 2020.
- Nyokabi, S., Oosting, S., Bebe, B, Phelan, L., Bett, B, Lindahl, J. and Boer, I. 2018. The Kenyan dairy sector: stakeholder roles and relationships, and their impact on milk quality: theme 5 – sustainable agri food systems, value chains and power structures. 13th European IFSA Symposium, 1-5 July 2018, Chania (Greece).
- Odero-Waitituh J A 2017: Smallholder dairy production in Kenya; a review. *Livestock Research for Rural Development*. Volume 29, Article #139. <http://www.lrrd.org/lrrd29/7/atiw29139.html>.
- Odero-Waitituh, J A. 2017. Smallholder dairy production in Kenya: a review. *Livestock Research for Rural Development* 29 (7) 2017. <http://www.lrrd.org/lrrd29/7/atiw29139.html>
- Odero-Waitituh, J. 2017. Smallholder dairy production in Kenya: a review. *Livestock Research for Rural Development*, 29(7):1-9.
- Omondi, I., Rao, E. J., Karimov, A. A. and Baltenweck, I. 2017. Processor linkages & farm household productivity: evidence from dairy hubs in East Africa. *Agribusiness*, 00:1-14.
- Omunyin, M. E., Ruto, J., Yegon, M. K. and Bü, A. 2014. Dairy production constraints in Kericho and Bomet counties of Kenya: evidence from farmers fields. *International Journal of Science and Research*, 3(12):1241-1246.
- Rademaker C J, Bebe B O, Lee J V, Kilelu C and Tonui C 2016 Sustainable growth of the Kenyan dairy sector. A quick scan of robustness, reliability and resilience. Report 3R Kenya/WLR 979
- Rademaker I. F, Reuben, K. K, Jansen, A. and Lee, J. V. 2016. Smallholder dairy value chain interventions. The Kenya Marketled Dairy Programme (KMDP) Status report. SNV Kenya/Wageningen UR CDI.



- Richards, S., Vanleeuwen, J. Peter, S. G., Wichtel, J., Kamunde, C., Uehlinger, F. and Gitau, G. 2019. Impact of mineral feeding on reproductive efficiency on smallholder dairy farms in Kenya. *Livestock Research for Rural Development*, 31(6):80. 2020, from <http://www.lrrd.org/lrrd31/6/srich31080.html>
- Richards, S., VanLeeuwen, J., Shepelo, G., Gitau, G. K., Collins, C. K., Uehlinger, F. and Wichtel, J. 2015. Associations of farm management practices with annual milk sales so smallholder dairy farms in Kenya. *Veterinary World*, 8(1):88–96.
- Thorpe W., Muriuki H.G., Omore A., Owango M.O. and Staal S. 2000 (a). Dairy development in Kenya: The past, the present and the future. Paper presented at the annual symposium of the Animal Production Society of Kenya, Nairobi, Kenya, 22–23 March 2000
- USAID (United States Aid for international development) and GoK (Government of Kenya) 2009 Dairy value chain competitive assessment and action plan development. Final report
- Van Leeuwen, J., Mellish, T., Walton, C., Kaniaru, A., Gitau, R., Mellish, K., Maina, B. and Wichtel, J. 2012. Management, productivity and livelihood effects on Kenyan smallholder dairy farms from interventions addressing animal health and nutrition and milk quality. *Tropical Animal Health and Production*, 44(2):231–238.
- Wambugu, C., Place, F. and Franzel, S. 2011. Research, development and scaling-up the adoption of fodder shrub innovation in East Africa. *International Journal of Agricultural Sustainability*, 109.

## CASE STUDY 7: COMBATING STRIGA IN MAIZE PRODUCTION IN WESTERN KENYA

### What is the Innovation?

Solving the Striga problem affecting maize production in Western Kenya.

**Location of innovation:** Nyanza and Western Kenya areas including Kisumu and Busia counties.

**When:** From 2000 to 2018

**Where:** Western Kenya, (Kisumu and Busia Counties)

### Background

Striga is a very old problem in Kenya whose reports can be traced in the 1930s. It is a parasitic plant that originates from African grasslands but has now invaded vast areas of its cropland (Woomer et al, undated). Native grasses and traditional African cereals have some resistance, but most domesticated cereals have little or no ability to fight off the parasite. Germinated striga seeds infect host roots, feeding on the plant below-ground for several weeks, and then a fast growing shoot emerges that produces prolific flowers and thousands of tiny seeds (Odhiambo and Woomer, 2005). Host plants exhibit a range of symptoms including severe stunting, twisted growth and bronzing, and severely infested plants produce little or no yield (Woomer et al, undated).

Several management options are available to partially manage Striga including resistant varieties (Ejeta and Butler 1993, Woomer et al., 2005), intercropping with suppressive legumes (Carsky et al., 1994, Khan et al., 2005) and the use of herbicide (imazapyr) resistance (Kanampiu et al., 2002). Findings by Andersson and Halvarsson, 2011 found the most economically beneficial maize farming system to be where resistant maize was intercropped with legumes. However other farming systems found in literature were not present in the study area. They found the reason for farmers not using the recommended systems to be lack of information and insufficient supply of agro commodities. Major Cause of Striga is the market of seed (Bernel et al., 1995) as seeds from a large area are normally sold at market and striga seeds are often mixed with the crops seeds. Consequently farmers in areas with no striga can get weed from seed purchases.

### Status of the Innovation

Striga was reported by Woomer and Savala, 2009 to be infecting about 217ha in Kenya causing annual crop loss of US\$ 53 Million. *S. Hermothica* considered to be the most lethal strain affecting maize, rice, sorghum, pearl millet, sugar cane and wild grasses is found in Nyanza and western areas (Alupe, Churaimbo, Miwani, Bungoma, Kendu, Migori, Kuria, Nyamira, Siaya and Homabay) (Atera et al., 2013). The Key organizations involved in combating striga together with their roles is presented in the table below.

Key organization	Role
CIMMYT	Developed imazapyr-resistant (IR) maize as a means to overcome Striga
Forum for Organic Resource Management and Agricultural Technology (FORMAT)	NGO working with farmers to combat Striga in Western Kenya.
The International Centre for Insect Physiology (ICIPE)	Push and Pull technology that suppresses Striga

Kenya Agricultural and Livestock Research Organization (KALRO)	KALRO Kakamega developed a Striga tolerant OPV KSTP 94). KALRO Kibos and hosts a Striga ecology laboratory.
Maseno University	Researchers and Students investigating on Striga management.
Resource Projects Kenya	Assists farmer organisations to better access farm inputs and market surplus in Striga affected areas of Kenya
SCODP	Improving farm input supplies in West Kenya particularly blended fertilizer and improved varieties of maize and legumes
TSBF-CIAT	Works with Legumes that suppress Striga
Western Seed Company	Produces both Striga tolerant WH502 and imazapyr-resistant (ua Kayongo) maize varieties
BioInnovate Africa	Partnership to deliver to market Striga weed resistant maize and finger millet varieties
AATF	StriAway Maize initiative to eradicate Striga weed for increased yields and farm productivity
Rockefeller Foundation	Financing research into Striga Management technologies
BASF	Provision of imazapyr resistance (IR) maize seed for research and

*Source: AATF, 2006; FAO, 2013;*

Striga causes severe yield losses, sometimes the farmers lose 100% of their harvest (Berner et al., 1995). Therefore it has a major economic impact for the smallholders as it decreases the income significantly. The weed also lowers the food supply for many households as it causes major damages on the staple food and affects families whose food consumption is dependent on the harvest, so called subsistence farmers (Andersson and Halvarsson, 2011).

To overcome the adverse effects of Striga infestation, the Striga eradication initiative StrigAway came into effect in 2006 (FAO, 2013). The initiative involved a well-coordinated public-private partnership with the different partners working together towards the common goal. Thus the partners provided farmers with incentives to apply the interventions. New expertise was required regarding Striga biology, IR maize technology, seed production and dressing processes, understanding the product, product handling, business management and entrepreneurship (FAO, 2013). Expertise was provided by Ministry of agriculture, Maseno University, Kenya Seed Company and KARI (now KALRO) Kibos. Rockefeller foundation provided funding while farmers, Seed Company, agro-dealers, extension officers, and technical assistants were trained to implement the interventions.

### **Main interventions**

Methods to combat Striga include intercropping with legumes, resistant maize, fallow, suicidal germination and pesticides (Andersson and Halvarsson, 2011) as well as use of fertilizers and manure. Vanlauwe et al., 2008 found use of IR-maize integrated in a push-pull system to be the most promising option to reduce Striga. The IR maize technology, marketed as StriAway®, involves herbicide coated maize seed which provide chemical protection against Striga infestation (FAO, 2013). The outcomes of the StrigAway project are presented in Box 1.

A combination of the use of tolerant or resistant maize varieties coated with either Foxy FK3 or Gro plus, and the maize grown in MBILI maize legume intercrop system is a viable option recommended by Wycliff, 2014.

### **Box 1 StrigAway project outcomes**

During 2008, the project delivered technology packages and extension services to 51 280 farm households, established 107 roadside demonstrations for \$56 each, and conducted 30 farmer field days for US\$0.45 per participant. 23 600 STEP\* packages and 800 FIST\*\* packages were distributed. Striga control technologies were established onto 655 ha resulting in about 1 108 tons of additional maize worth US\$367 120 with an estimated farmers' benefit to cost ratio of 2.8. Public awareness of Striga was promoted through several actions (Striga management instructions were provided in both English and Kiswahili, 200 posters, one video documentary, media broadcast on KBC, exhibition at the Nairobi International Show).

In 2008, the demand for IR maize was estimated to be 1.6 tons (Ksh 256 Million) while that of Imazapyr herbicide was 2.4 tons (Ksh 25 Million). The IR maize seed generated an additional production of 82 000 tons of maize with an incremental value of Ksh 1.44 billion.

*Source:* Compiled by authors from AATF annual report, 2009 and Woomer and Savala

\*A STEP package is comprised of 250g IR maize seed (Ua kayongo), 1.5 kg fertilizer (1.0 kg of DAP and 0.5 kg of CAN) and user instructions. The package was intended for 100m<sup>2</sup> of Striga infested crop land.

\*\* A FIST package consisted of 2.5 kg of IR maize seed (Ua kayongo), 10-20 kg of fertilizer.

The package was intended for 1 000m<sup>2</sup> of Striga infested crop land and distributed through a credit model.

*Source: FAO 2013*

### **Main Activities at grassroots level**

At the grassroots level activities include capacity building of farmers on Striga management. Farmers are also involved in Striga technology selection for testing and in the demonstration; to assess the different technologies for best performing. Farmers and extension staff on the ground are involved in data and information gathering during the implementation of the initiatives.

### **Policy and Governance**

Atera et al., 2013 records as urgent the need for the establishment of policies to promote, implement, and ensure a long-term sustainable Striga control programme. Third Medium Term Plan 2018 – 2022 identified flagship PPP projects approach, like that was used in the StrigAway initiative, as a way to address the productivity, land use, markets and value addition challenges in agriculture (Government of Kenya, 2018).

### **Main Outputs**

There is evidence that long-term repeated application of appropriate packages was required to confirm their cumulative benefit (Esilaba 2006).

Monitoring and evaluation depended on individual organizations involved in the initiative.

### **Impacts**

FAO, 2013 reports the impact of the StrigAway initiative to have reached 51 280 farmers who received technology packages and extension services. The increased output due to Striga control technologies was 1,108 tons of additional maize. Striga resistant maize seed generated additional production of 82

000 tons). Farmers increased maize yields from 2 bags/acre to 4-6bags per acre hence increasing household food security. There was also decreased cost of production

### **Lessons Learnt**

Lessons include the realization that PPP success depended on the partners bringing in their interventions without excessive costs and proper coordination of the partners (FAO, 2013)

### **Challenges faced**

The adaptation of the new methods is often slow; one reason for this is that the farmers doubt them. Another reason is that the return of new methods in terms of higher yield do not appear immediately but the cost do (Khan et al, 2008). Furthermore, rumours are spread on how these new methods do not work and therefore unwilling to test them.

Esilaba, 2006 suggests use of integrated management strategies suitable for the existing farming systems to control Striga. One reason for limited adoption of recommended technologies is the mismatch between technologies and the farmers' socioeconomic conditions, particularly the non-availability of economically feasible and effective technologies There is need therefore to adopt a farming systems approach for the development and implementation of integrated Striga management strategies suitable for the various agro ecosystems (Esilaba, 2006).

### **Reference Materials**

- AATF (2006) Empowering African farmers to eradicate Striga from maize croplands. The African Agricultural Technology Foundation. Nairobi, Kenya. 17 pp.  
<https://conservationagriculture.org/app/uploads/2019/02/STRIGA-ERADICATION-OPTIONS-AATF-2006.pdf>
- Atera EA, T. Ishii, J.C. Onyango, K. Itoh & T. Azuma, 2013. Striga Infestation in Kenya: Status, Distribution and Management Options. Sustainable Agriculture Research; Vol. 2, No. 2; 2013.  
[https://www.researchgate.net/publication/257417711\\_Striga\\_Infestation\\_in\\_Kenya\\_Status\\_Distribution\\_and\\_Management\\_Options](https://www.researchgate.net/publication/257417711_Striga_Infestation_in_Kenya_Status_Distribution_and_Management_Options).
- Berner D., Kling J., Singh B., 1995. Striga Research and Control a perspective from Africa. Plant disease Vol 79 Nr 7.
- Carsky, R.J., Singh, L., Ndikawa, R. 1994. "Suppression of Striga hermonthica on sorghum using a cowpea intercrop" Experimental Agriculture 30: 349-358.
- Ejeta, G. and Butler, L.G. 1993. "Host-parasite interactions throughout the Striga life cycle and their contributions to Striga resistance". African Crop Science Journal 1: 75-80.
- Esilaba A. O., 2006. Options for Striga management in Kenya. Kenya Agricultural Research Institute. KARI Technical Note No. 19, March 2006.  
[https://www.kalro.org/fileadmin/publications/tech\\_notes/TecNote19\\_20060810.pdf](https://www.kalro.org/fileadmin/publications/tech_notes/TecNote19_20060810.pdf)
- FAO, 2013. Agribusiness public-private partnerships – A country report of Kenya.  
<http://www.fao.org/3/aq232e/aq232e.pdf>;
- Government of the Republic of Kenya, 2018. Third Medium Term Plan 2018 – 2022. Transforming Lives: Advancing socio-economic development through the "Big Four".
- Jenny Andersson and Marcus Halvarsson, 2011. The economic consequences of Striga hermonthica in maize production in Western Kenya. Degree project, Swedish University of Agricultural Sciences, Uppsala.
- Kanampiu, F.K., Ransom, J.K., Friesen, D. and Gressel, J. (2002), 'Imazapyr and pyriithiobac movement in soil and from maize seed coats to control Striga in legume intercropping', Crop

Protection 21: 611-619.

- Khan Z., Midega C., Njuguna E., Wanyama J. and Pickett J., 2008. Economic performance of the push-pull technology for stemborer and Striga control in smallholder farming system in Western Kenya. Esevier, Kenya.
- Khan, Z.R., Muyekho, F.N., Njuguna, E., Pickett, J.A., Wadhams, L.J., Dibogo, N., Ndiege, A., Gemga, G. and Lusweti, C. 2005. A Primer on Planting and Managing Push-Pull Fields for Stemborer and Striga Control in Maize: A Step-by-Step Guide for Farmers. ICIPE Science Press, Nairobi.
- Odhiambo, G. and Woomer, P.L. 2005. "Striga emergence and seed bank dynamics under different maize management practices in western Kenya". African Crop Science Conference Proceedings 7:473-477.
- Woomer Paul L., George D. Odhiambo and Canon N. Savala (undated). Striga Infestation and Management in East Africa. [https://www.kalro.org/sssea24/Theme1/STRIGA\\_INFESTATION\\_AND\\_MANAGEMENT.pdf](https://www.kalro.org/sssea24/Theme1/STRIGA_INFESTATION_AND_MANAGEMENT.pdf)
- Woomer, P.L., Tungani, J., Odhiambo, G. and Mwaura, F.M. 2005. Striga management options in western Kenya. African Crop Science Conference Proceedings 7:
- Woomer, P. L., and Savala, C. E. N. (2009). Mobilizing Striga control technologies in Kenya. African Crop Science Conference Proceedings, 9, 677-681.

## ANNEX 8: POSSIBLE INSTITUTIONS FOR KEY INFORMANT INTERVIEWS

The following are the possible sources of data through Key Informant interviews, for each of the seven SAI Innovations

Case study No.	Title	Sources of data and KII
1.	Water harvesting farm ponds enabling agricultural intensification and climate change resilience	County Governments of Machakos, Makeni, Kitui Caritas, WVK, ICRAF, SNV, Inades Formation, Action Aid, WFP, FAO, ADRA
2.	Improved availability and access to agri-inputs by small-scale farmers	County Government of Meru AGRA, Frigoken, KFA, Kenya Seed, Yara, Bayer, Syngenta,
3.	Solar powered irrigation enhancing agricultural intensification	County Government of Kajiado Sunculture, Future Pump, Kickstart, Davis & Shirtliff,
4.	Blended finance from downstream Nairobi City for sustainable agriculture and watershed management in upstream	County Governments of Nyandarua, Nyeri and Muranga NCWSC, TNC, WRA, MWSI, GBM, NDEKA,
5.	Solar powered irrigation enhancing agricultural intensification	County Government of Kajiado Sunculture, Future Pump, Kickstart, Davis & Shirtliff,
6.	Innovative access to finance supporting agricultural intensification	County Government of Kirinyaga Juhudi Kilimo, Equity Bank, KCB, Coop Bank, Faulu, Musoni, Family Bank, Sidian Bank, Safaricom,
7.	Smallholder dairy supporting agricultural intensification and circular economy	County Government of Nakuru, DTI, KDB, KCC, Brokeside, KALRO,
8.	Combating striga in maize production in western Kenya for food security	County Government of Kisumu and Busia KALRO, CMYTT, ACRE project,

Note:

Government Ministries and private sector organizations based in Nairobi will be included in the KII across all innovations