



Agricultural Transformation of Kenya's Makueni Drylands



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Agricultural Transformation of Kenya's Makueni Drylands

A Report by the Technologies for African Agricultural
Transformation Clearinghouse Office, January 2020

Background

The Clearinghouse recently submitted a strategy to the Rockefeller Foundation "Food Systems Vision 2050 Prize". It describes a process of agricultural transformation in Makueni, Kenya and includes the roles of several technologies promoted by the Technologies for Africa Agricultural Transformation (TAAT) program. While the awards are relatively small, its 10 winners form an international panel of experts to advise on the future of agriculture. The TAAT Clearinghouse is participating in this initiative to increase awareness of the program's approach toward transforming African agriculture and to examine this process in a more holistic manner.

There are five main goals of the Food System Vision 2050 program: 1) to build a network of food system movements; 2) to infuse more hope into people's view of the future; 3) to stimulate new innovations and patents that strengthen food system performance; 4) to forge new multi-stakeholder partnerships between industry, policy, academia, and civil society; and 5) to generate Visions that become futuristic food systems projects to scale and positively impact upon large numbers of Places and People (Rockefeller Foundation 2019).

The conceptual relationship between TAAT and the Food System Vision 2050 raise exciting possibilities. Indeed, TAAT operates as a network of its Commodity and Enabler Compacts to raise awareness of the African Development Bank's Feed Africa Strategy, in part through fostering technology-product linkages to the private sector (TAAT 2019). It seeks to infuse hope and action toward Africa's food self-sufficiency, agro-processing capacities and its future role in global trade (TAAT 2019). But as TAAT's name implies, it is strongly oriented toward technologies and partnerships built around them, whereas Vision 2050 embraces a more balanced, six-themed approach consisting of equal parts environment, diets, economics, culture, policy and technology (Rockefeller Foundation 2019). Each strategic Vision must meet exacting requirements concerning its content around these themes and beneficiary coverage, being applicable to a single country and no more than an area of 100,000 km².



Figure 1. The Kibwezi Plain seen from Mount Mbui Nzau (upper left), maize failure during a drought (upper right), an innovative water delivery system (lower left), and maize harvest under irrigation (lower right).

In accordance with Vision 2050 requirements, we prepared a strategy for Makueni County in east Kenya. Makueni is a critical test ground for agricultural transformation within African drylands (Figure 1). This farming area faces serious environmental and agricultural challenges, but at the same time offers developmental promise. Poverty is widespread across this community; and our Vision is committed to improving the livelihood of its people through the transition to more diversified, market-oriented agriculture. Climate change exacerbates this situation as more erratic and episodic weather leads to greater risk adversity, a situation that in turn prompts opportunity for innovation. Our Vision team represents the knowledge and technology holders needed for this transformation, but recognizes that access to needed inputs and investment remains limiting. The situation is particularly acute for youth, who have access to online information and set ambitious targets for their lives but find little opportunity to achieve their goals despite completing their education. Our team regards directing these marginalized youth to productive agricultural career pathways as crucial to the Place's economic future.

This description sets the stage for the Vision 2050 team’s close relationship to the Place. For the most part, our team members were raised, live, work or do business there. Our team understands that modern agriculture is the mechanism that drives economic growth across Africa, including Kenya’s agricultural drylands, and gains are dependent upon the adoption of new, increasingly commercialized farm technologies. Our team sees itself as able to catalyze agricultural transformation through its understanding of these modernizing technologies, how they can become better accessed, and the food systems and wider rural economic changes that this transformation evokes.

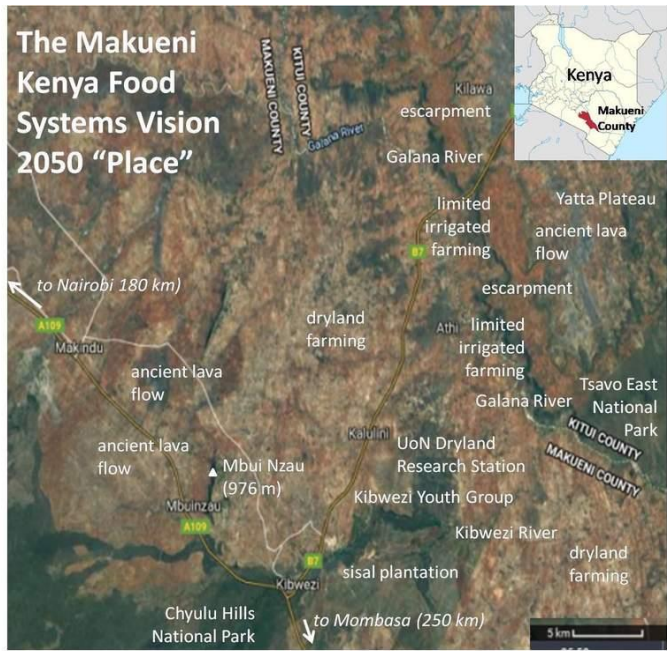


Figure 2. A satellite image of the Vision 2050 Place showing the Galana River, major roads, farming systems and other important features.

Makueni’s People and Place

Makueni County is located in a semi-arid area of east Kenya covering 8,008 km², with specific attention paid in this Vision to its under-utilized, potentially irrigable agricultural lands (Figure 2). The current population of Makueni County is estimated to be 988,586 persons (481,380 males and 507,206 females) based upon a projection of the 2017 census (Government of Makueni County 2017). Its growth rate is about 1.4% per year. The proportion of persons dependent upon agriculture is 78%, or about 771,097 persons. Youth aged 15 to 35 account for 30% of the population (about 276,576 youth). At the same time, the lessons learned from this Vision are widely applicable to other dryland farming areas and food systems across Kenya and East Africa.

Makueni is mainly populated by the Akamba people who settled the semi-arid plains of eastern Kenya. They are derived from a late wave of the Bantu migration, discovering that the sub-humid highlands were securely occupied by the Kikuyu and closely related tribes and instead settled the drier lands to the east. While the area

is dry for much of the year, it receives short bimodal rains that allow traditional small grains and maize to be produced and livestock to be fed. It is situated in a transition zone, to the north is semi-humid croplands; to the east is Yatta, a massive volcanic remnant; to the west are pastoralist Maasai; and to the south is the famed Tsavo wildlife refuge and semi-desert unsuited for farming.

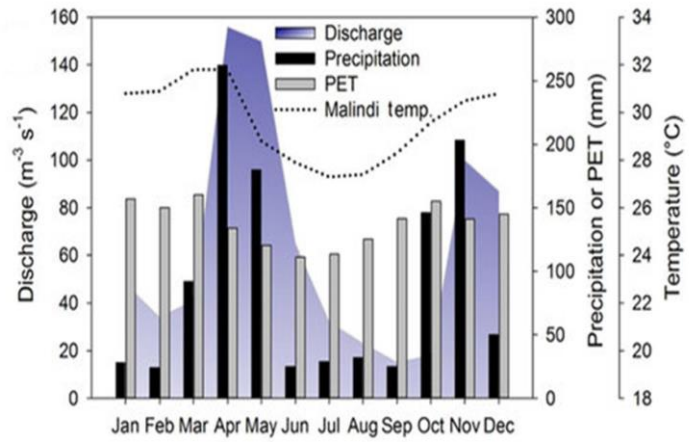


Figure 3. Discharge, precipitation and pan evaporation of the Athi-Galana-Sabaki River catchment. Note the strong seasonal discharge and that average precipitation only exceeds evaporation three month per year (from Ng'ang'a et al. 2015).

An outsider's impression of Makueni is tempered by time of year and how well the most recent rains have performed (Figure 3). Its midland plains occupy an elevation of 700 to 900 MASL and are punctuated by rounded hills and ancient volcanoes. The temperature is neither cool nor hot. Arrive during the late rains and find green bushy grasslands, well-fed livestock and fields of maize and legumes. Arrive in the dry season and find bare fields and hungry animals driven to remaining pockets of vegetation. Arrive during a drought and find desperate people, starving animals, and women and children carrying water long distances. Another feature is its equidistant position along the trade corridor between Mombasa and Nairobi. A stream of trucks plies this route, so that transient customers and distant markets are accessible through trading centers. These customers include tourists visiting Tsavo Park, but most of their commerce is directed to the lodges to the south. And while these tourists are confined within the park, its wildlife is not, and can cause much crop damage, creating mixed feelings toward wildlife conservation among farmers.

To understand Makueni, one must visit its farming families because 78% of the people are engaged in agriculture. Houses are made of clay, roofs are iron sheets rather than thatch, and the floor is dirt or concrete. Animals include cattle, sheep, goats and chickens. Many households have oxen for plowing and granaries for food storage but few have wells. Almost none have piped water or electricity. Granaries harbor mycotoxic fungi that pose risk to health. The poorest households have only a hoe and machete as tools for farming, and are inured to hard labor. Termites are

ubiquitous, consuming all wooden structures. Families value education so that their children may escape poverty. They walk the roads to and from school in worn uniforms during the morning and afternoon. To understand Makueni, one also must know its youth, particularly recent, disappointed school leavers. There are just no good jobs despite their education, so they weigh futures as poor farmers against the hazards of urban migration. Here is Makueni, land of spatial and temporal variability, a place of both hardship and opportunity!

The Challenges before Makueni's Agricultural Community

Challenges before Makueni include widespread poverty, food and nutritional insecurity, and resource degradation. These challenges are manifest across six Themes: Environment, Diet, Economics, Culture, Technology and Policy. Rainfall has grown more erratic as a consequence of climate change, and the adoption of climate-smart technologies must be accelerated. These practices include innovative water harvesting and soil protection (Ghebremariam and Steenbergen 2007; Sanginga and Woomer 2009) common in the Horn of Africa and Sahel, but not well understood in semi-arid Kenya. The diets of Makueni's people vary greatly with season; well-balanced meals are enjoyed during the wet seasons but poorer nutrition is suffered throughout the dry one. Drought poses threat of famine to the poorest households. Its local economy is only as strong as its most recent rains. Irregular food production has a huge negative impact upon economic growth because of insufficient supply for value-added and marketing enterprises. Following bumper harvests, commodity prices are depressed from oversupply and during dry seasons and droughts farmers have too little money to spend, affecting the economy as a whole. At the same time, more resilient rural enterprises are known, such as cultivation of drought tolerant cereals and legumes, mango and citrus growing, and beekeeping that serve to reduce household economic risk. Other households practice artisan handicrafts, particularly sisal weaving and woodcarving, for which the Akamba people are renowned.

A great challenge before this community is the economic marginalization of youth and its far-reaching social consequences. Education is valued as a means to escape poverty, but the lack of local employment opportunities places this commitment at risk. This is especially true for girls. Fortunately, primary school education is free in Kenya, but education at secondary and higher levels requires financial commitment by families. School leavers find a paucity of opportunities and are either forced into resigned laxity or adopt dangerous lifestyles. This challenge also drains local human resources as talented youth migrate away or its recent university graduates are reluctant to return to their home areas for lack of employment prospects.

It is suffice to state that agricultural production cannot improve without the adoption of several modern farm technologies. Agrodealers are plentiful in market centers but demand for needed input products and labor-saving equipment remains weak. So too, the local policy dimensions require careful attention. The county government appears to understand the challenges before it but has limited ability to evoke improvements at the required scale. It is one thing to plan yet another to achieve those plans in a timely, cost-effective manner; especially given the limited investment potential among stakeholders. In an optimistic sense, let us assume that today's humanitarian challenges are met through planned agricultural transformation, and in 2050 concerns are more related to how best to sustain these gains among a growing population, and to progressively transition to stronger performing, more diversified commercial production and agro-industries.

An Approach toward Agricultural Modernization

Our Vision for food systems transformation is both realistic and paced. It departs from the rhetoric of unkempt promises and rather focuses upon introduction of proven agricultural technologies and dependable support services, many of them supplied through farmer organizations and the private sector. It builds upon the Makueni County Development Plan, particularly its plans for youth empowerment and infrastructure improvement. All of the aforementioned challenges as they relate to Vision 2050's Environment, Diet, Economics, Culture, Technology and Policy Themes are addressed in systematic manner and are ultimately linked through improved and equitable water resource management. Within the scope of climate change, dryland farmers are not carbon emitters, but their lands have potential to sequester organic matter. Rewards for carbon gain must be considered, perhaps as subsidized tree planting and cover cropping, measures that also counteract soil degradation and erosion. Rural households with irrigation can operate year-round kitchen gardens that better diversify and balance diets, and little more than water is required to seize this opportunity. Expanding these gardens creates marketable surpluses and generates income, and enlarging them further leads to horticultural industry. Stronger rural economies result from increased productivity and greater market intelligence; goals best achieved through commodity associations; but there is little incentive for farmers to join groups unless reliable production surpluses are achieved.

The year 2020 appears to be one of bumper harvests due to the strong ongoing "short rains" but moreover it should be viewed as the year where technology-led agricultural transformation gained traction. These technologies are too many to fully present in detail within this report but consist of improved crop varieties exhibiting stress tolerance and biofortified nutritive properties, integrated soil fertility management that balances fertilizer use with recycling of crop residues and

manures, integrated pest and disease management where producers respond quickly and effectively to outbreaks, and improved animal rearing reliant upon better breeds, feeds and veterinary care (TAAT Clearinghouse 2018). Small-scale mechanization and value-added processing technologies must become increasingly available as well. These technologies are best bundled into toolkits for commercial distribution by well-informed agrodealers, and linked to ICT-led extension services. As economic benefits accrue, let culture adapt to opportunities for change

while recognizing that traditional values are strong and well-founded. But let the culture of democracy grow, and voters must elect those who best represent their interests, particularly candidates advancing public investment in better rural infrastructure. In addition, investor’s forums must be organized that combine public and private sector assets. Lastly, women and youth must lead this transformation as innovators, new business operators and empowered citizens.

Advancing the Interests of Youth

Youth are the true stakeholders of Makueni’s agricultural transformation and have much to do to achieve this Vision. The County recognizes this role in terms of what it describes as a demographic dividend given its slightly reduced birth rate and a “window of opportunity for rapid economic growth if the right social and economic policies are developed and investments made” (Government of Makueni County 2017). This dividend includes mainstreaming youth in agriculture through “tailor made products targeting youth in irrigated agriculture, poultry production, micro-processing, service provision and marketing.” This governmental planning approach is clearly in line with this Vision.



Figure 4. Members of the Kibwezi Hortipreneur Youth Group, an ENABLE TAAT cooperator, participate in many agricultural events and planning exercises across Makueni County.

Table 1. TAAT Commodity Compacts under development in Makueni.

TAAT Compact	Actions	Comment
Aquaculture	produce feed, catfish and tilapia	linked to water storage
Cassava	test and multiply golden variety	need greater virus control
High Iron Bean	promote cvs. Nyota and MAC 44	seed multiplied and distributed
Maize	promote dryland cv. 1101	extensive wildlife damage
Rice	none	potential along Galana River
Small Animals	test and promote goat fattening	integrated farm approach
Sorghum-Millet	test dwarf white varieties	extensive wildlife damage
Sweet potato	promote cv. Irene and others	profitable OFSP operations
Wheat	none	potential for heat-tolerant varieties

The Government of Makueni County (2017) is rehabilitating its Agricultural Training Centre at Kwa Kathoka (near the County HQ in Wote) with offices, internet, hostel and field facilities; the role of youth within this Center must be reinforced through opportunity and investment. So too, the county is improving its agriculture extension program by re-equipping six sub-county agriculture offices, and it is important that each have an active youth program. Currently the county plan intends to train 10 youth per sub-ward per year to offer support services to farmers in grafting fruit trees, soil conservation, nursery establishment, commercial horticulture, animal health care and other skills. Across Makueni’s 30 wards this is 300 youth to be trained as service providers per year, a growing cadre that can be readily tracked as an indicator of steady success. How those trained manifest their skill as successful agribusiness service providers, and what additional support is required for them to do so is of critical importance.

The main implementer of TAAT in Makueni is the IITA Youth Agripreneur (IYA) group known as the Kibwezi Hortipreneur Youth Group (KHYG) (Woomer and Mulindi 2016). The group is hosted by the University of Nairobi at its Kibwezi Dryland Research Station and its actions are conducted in conjunction with TAAT’s youth enabler known as ENABLE TAAT (TAAT 2019). It conducts advocacy actions, registers youth as an interest group, and conducts agribusiness incubations within diverse pilot enterprises at its farm near Kalulini (Figure 2), many aligned to the TAAT priority value chains (TAAT Clearinghouse 2018). The group is engaged in technology outreach, particularly through collaboration with schools, youth groups and farmer associations (Figure 4). On several occasions the County has recognized KHYG as a leading youth group in Makueni, and their expertise should be incorporated into future training and agribusiness support operations, including those within the revitalized Kwa Kathoka Agricultural Training Center. KHYG’s expertise includes

several TAAT technologies their toolkits, and their incorporation into profitable enterprise through IYA's proven approach to agribusiness incubation (Woomer and Mulindi 2016).

The Role for TAAT Technologies and Compacts

Seven of the nine TAAT Commodity Compact toolkits (TAAT Clearinghouse 2018) were tested in Makueni through the efforts of the Kibwezi Hortipreneur Youth Group (Table 1). Success has been mixed, but of these seven promotional actions, four have resulted in ongoing, youth-led enterprises.

Aquaculture. The group's activities in Aquaculture predated the establishment of TAAT and it was the first of the IITA Youth Agripreneur network to install pond liners and aerators (Figure 6), and to make its own floating fish feed. Its attempts to link formally to the Aquaculture Compact were rejected for reasons that are not understood, but nonetheless fish farming is an important enterprise within the KHYG farm and is included within its outreach activities. One KHYG intern has started an independent fish farm based upon production approached developed by the group.

Cassava. While the Cassava Compact is not active within Kenya, KHYG obtained golden cassava (+Vitamin A) cuttings from national partners through ENABLE TAAT. Despite being drought tolerant, cassava is not widely grown in Makueni. A field was placed under sprinkler irrigation and performed well until it was affected by the Cassava Mosaic Virus (Figure 5). Cassava tuber production was prolific prior to this disease, but plans to distribute cuttings were curtailed by it. Claims that the Cassava Compact offers virus tolerant varieties should be tested in the near future.



Figure 5. Learning enterprises conducted by ENABLE TAAT in Makueni include fish farming (upper left), cassava production (upper right), propagation of sweet potatoes (lower left) and goat fattening (lower right).

High Iron Bean. KHYG was provided a small quantity of High Iron Bean seed from its Compact and were quick to multiply and promote it. Cv. Nyota performed particularly well and is now grown in an innovative intercrop with sweet potato. MAC 44, a climbing variety, did not perform as well as hoped under greenhouse conditions and abandoned. Seeds of cv. Nyota were distributed to other youth groups and promoted through a series of county events. This variety is quick cooking and has excellent culinary characteristics.

Maize. Makueni farmers prefer maize despite its poor rains that limit its performance, opening the door for the Maize Compacts water efficient varieties. The Clearinghouse arranged for a large quantity of WEMA 1101 to be delivered to the group for testing and distribution, including seed purchased from Dryland Seed Company. Unfortunately, baboons destroyed the large field established at the KHYG farm, but seed distributed through its outreach activities and marketed through the KHYG depot in Kibwezi town were well received.

Rice. At present there are no TAAT activities in Makueni involving rice, and its dryland conditions preclude its entry until irrigation resources are available. Developing a network of rice paddies along the Galana River is a realizable goal in the future and the cost of this objective should be weighed against other targets.

Small Animals. Makueni's drylands are widely used to raise livestock, particularly goats and sheep, and the Livestock Compact has special relevance there. KHYG is working in two Compact areas, goat fattening and poultry. A pilot goat fattening operation using the Gala breed at the KHYG farm was initiated and a feeding and veterinary regime established (Figure 6). This approach is ready for outreach actions. Goat fattening responded well to regular rations of sweet potato vines. So too, potential exists for poultry raising and KHYG interns have established two independent chicken farms.

Sorghum-Millet. KHYG was encouraged to raise dwarf white sorghum (cv. Sila) for use as a carrier material for the new AflaSafe factory in adjacent Machakos county. The crop performed well until it reached early heading and was destroyed by wildlife, mostly troops of primates. Nonetheless, there is potential for expanded sorghum production in Makueni in areas less affected by hungry wild animals. The Sorghum-Millet Compact is not currently active in Kenya but its leader, ICRISAT, has a strong presence there and future collaboration should be forged with Makueni County Extension.

Orange Fleshed Sweet Potato. KHYG has worked in close conjunction with the OFSP Compact to bring improved sweet potatoes to Makueni. First, improved varieties Delvia, Irene and Sumaia were obtained from the Kenya Plant Health Inspection Service as soon as they were released; and then multiplied under greenhouse

conditions (Figure 5). A market for cuttings and vines was quickly established. Potatoes found a ready market. To date, production is irrigated and the ability to produce the new drought-tolerant lines under rainfed conditions is not yet established. The innovative bean-sweet potato intercrop offers combined opportunity for both of these TAAT Compact commodities because as the beans are ready for harvest, the sweet potato cuttings are well rooted and ready to quickly establish a new crop canopy.



Figure 6. The Galana River running along Makueni County during December 2019 at a discharge rate of about 80 m³ per second.

Wheat. Wheat is not presently grown in Makueni but given the claims of the Wheat Compact concerning its new heat-tolerant varieties perhaps it could be. Transforming abundant semi-arid grassy bush in Makueni into wheat would have a profound impact upon the county and Kenya’s agriculture, and ENABLE TAAT is prepared to take a lead in this area. The Wheat Compact is active in the Kenyan Highlands, but not its semi-arid east, and overtures should be made for expansion of its activities into Makueni.

A Higher Level Vision

The ability of Makueni to develop a dynamic agro-industrial economy in the future depends upon the success of actions taken over the near-term. Foremost among these actions is the harnessing of diverse water resources in order to modernize its agricultural technologies (Figure 6). The massive, seasonal discharge of the Galana River must be captured and widely distributed (Figure 3 from Ng’ang’a et al. 2015) in a manner that results in production corridors producing grains, fruits and fish. Consumer trends and global demand must be considered in the design of these corridors. Clean energy technologies must be employed to lift and distribute this water including siphon systems, inline hydroelectric turbines, and solar power

arrays. Situated within these corridors will be agro-industrial parks where food processing creates both profitable products and decent employment.

This economic growth must factor in the massive visitor appeal of the Indian Ocean coast and wildlife tourism; indeed, Makueni is well positioned to become its food and flower basket. Commercialized handicrafts add to this advantage. In the meanwhile, Makueni must overcome its widespread poverty and food and nutritional insecurity. Grand irrigation schemes are fine but more modest approaches to water management are also needed. Climate-smart technologies must be continuously identified and mobilized. Agricultural extension must be reoriented toward mobile information technologies and working through increasingly larger farmer organizations. Moreover, youth must be attracted to agricultural career pathways. An important step is the establishment of Youth Agribusiness Hubs where workspace and centralized services are provided to young Agripreneurs. Another important element is to strengthen agricultural training within secondary and vocational schools in a way that glamorizes rural lifestyles rather than presents farming as drudgery and servitude. Let the process of rural renaissance in Makueni gain momentum and provide an example across other African drylands.

Moving Ahead toward Agricultural Modernization

Much can be done to improve food and nutritional security among Makueni's small-scale farmers today; starting with the distribution of improved crop varieties. These improved varieties include drought-tolerant maize and sorghum, biofortified cassava and sweet potatoes, high iron beans, drought tolerant grain legumes (e.g. green gram, pigeon pea and soybean), even the new wheat varieties that are adapted to higher temperatures and rust disease (TAAT Clearinghouse 2018, 2019). Some of these crops can be grown twice a year under rain fed conditions, but production is much greater under irrigation. Production toolkits are available for each of these crops that address different levels of investment. The best adapted crops also provide business opportunity for local seed producers. So too, specialized fertilizer blends may be produced and marketed. Maize-based technologies include the release of non-toxicogenic fungi to inhibit the presence of aflatoxin, reducing a persistent and ominous risk to public health. Cassava and sweet potato are vegetatively propagated; providing cuttings of improved varieties to producers represents a business opportunity in its own right. Grain legumes balance cereal-based diets but also result in nitrogen recycling through increased symbiotic fixation facilitated by the application of rhizobial inoculants. Consumption of these crops diversifies household diets and they are readily incorporated into traditional and widely accepted foods. At the same time, these commodities are readily marketed and processed through small- and medium scale agro-industry. Reliable supply of

these commodities at reasonable prices throughout the year and the profits and demand generated by their value-added products stimulate further investment and lending to commercial producers and processors alike.

This vision includes strong elements of agricultural extension reform, reliance upon information and communication technologies (ICT), and opportunities for greater mechanization and automation. The current agricultural extension agents are both under-resourced and overwhelmed by the tasks necessary to modernize agriculture. The model requiring agricultural extension agents to visit and advise individual farmers is impractical and outdated. Because of the ICT revolution, and the availability of handheld devices in even the remotest locations, producers can now directly access information needed for farm planning, problem diagnostics and market intelligence. As a result, extension agents are now better positioned to work directly with farmer organizations, rather than individuals, while focusing their attention upon the poorest of the poor in a manner that strengthens safety nets and eases suffering. To achieve this end, these agents must be properly versed with ICT devices and their applications in order to transmit these advantages to others.

Mechanization is a key to eliminating the stigma of hard work for too little returns that is associated with small-scale farming. Hand tractors, paddle weeders, power sprayers, land augers and other labor-saving devices are now available at affordable prices in Kenya, and distribution channels to Makueni ought to be strengthened. Scope exists for the design and commercialization of more ergonomic hand tools; the days of using heavy hoes and ineffectively swinging machetes are numbered. Drip irrigation is by far the most water efficient irrigation system, but needed expertise in its installation and equipment are in too short supply. Agrodealers should expand their services in this area, and be assisted to do so. Better transportation also becomes within the reach of farmers as they shift toward market production, whether it is through trailer attachments to hand tractors for local, heavy loads; or by operating a tricycle tuk-tuk suited to passengers or cargo. As the first of these farmers mechanize, they are able to provide contract services to their neighbors.

Mobilizing waters from the Galana River is an essential driver of this vision. Discharge from this river varies between 20 and 160 cubic meters per second depending on the season, and is barely being utilized (Ng'ang'a et al. 2015) . The river enters Makueni at an elevation of 950 MASL with large areas of farmland below that, so there is scope for downward water delivery. Field irrigation technologies are in place but improvements are needed in water lifting, sediment removal and distribution. The county development plan embraces expanded irrigation. Transition to irrigated agriculture offers interrelated benefits toward environmental protection, improved

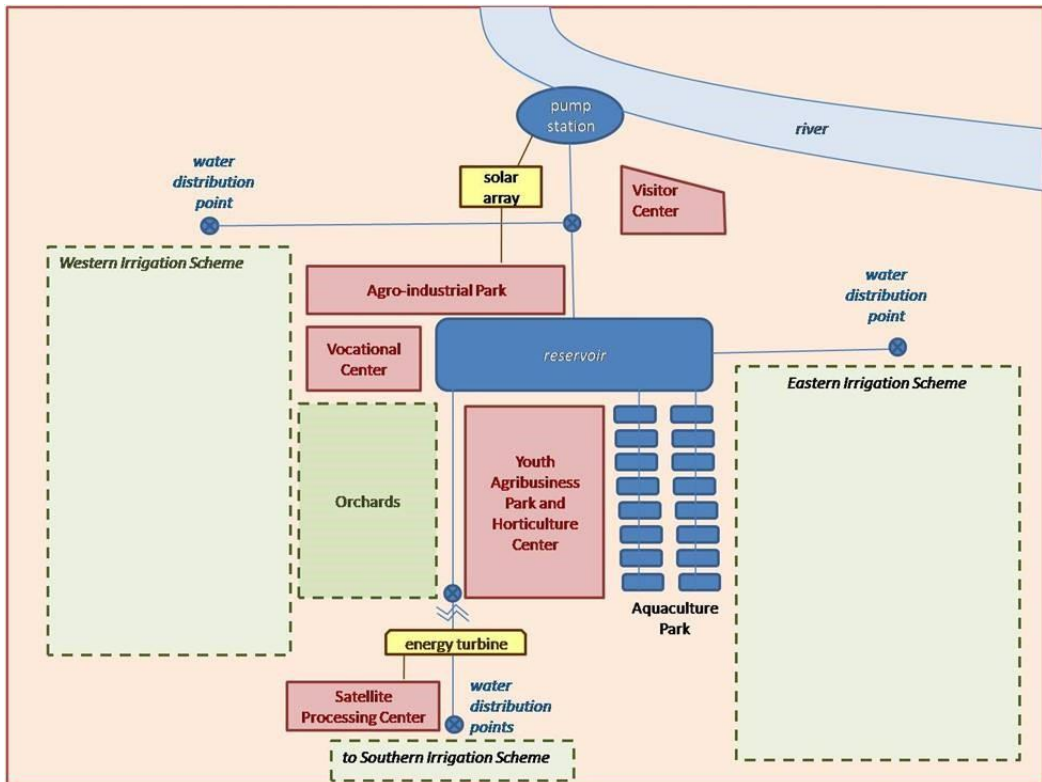


Figure 7. A generalized design for an Integrated Agribusiness Cluster based upon improved water delivery to dryland farming systems and future needs for enterprise diversification. Elements of this design are not necessarily drawn to scale but it depicts a wide range of enterprise opportunities and agribusiness support services.

diets, stronger local economies, technology adoption and policy-led infrastructural development.

The pathway toward this Vision is within reach. Imagine a series of agribusiness development clusters located along the Galana River that advance irrigated farming and accompanying agro-industry. Each cluster contains a solar powered pump that feeds a reservoir, and includes an agribusiness park that supports orchards, horticulture and aquaculture. Additional value is produced through nearby agro-industries (Figure 7). Skill sets are provided through a vocational center. From this cluster, water distribution points supply community-led irrigation schemes. Each cluster provides agricultural, employment and entrepreneurial opportunities for the local community and those attracted to it. A visitor and recreation center complements these activities and further contributes to improving the quality of lives (Figure 8). This approach is essentially an expansion of the Integrated



Figure 8. A composite photographic depiction of an Integrated Agribusiness Center superimposed upon a satellite image of the Makueni Place and based upon water delivery from the Galana River.

Agribusiness Hub model recently developed by the International Fund for Agricultural Development (IFAD 2019).

A possible design considers that each agribusiness cluster would extract only 5% of the river volume at its lowest discharge, or 86,000 m³ per day. This water is sufficient to maintain a two km² reservoir and irrigate about 8,000 ha of surrounding farmland, providing year-round benefits to about 16,000 farms producing two or three crops per year. Food production increases at least 48,000 tons per year. In combination, improved farming, horticulture, and aquaculture generate over \$60 million in revenue annually, and value-added processing contributes at least another \$15 million. One such industry is the production of blended animal and fish feeds that in turn stimulates modern livestock, poultry and aquaculture industries. Over 12,000 decent jobs are created. The facility serves as a magnet to enterprise and innovation, and is replicated by others. Environmental impacts are monitored to ensure that downstream impacts are minimized, including those on the adjacent Tsavo Park's habitats and wildlife.

While the establishment of water delivery is critical to this Vision, it is not the only infrastructure requirement. Better roads are needed adjacent to the Galana River to

open the area's potential. The current roads servicing this area are unpaved, tortuous, not interconnected and may be impassible following heavy rains. Expected improvements in electricity and domestic water services as described in the current Makueni Development Plan ought to be completed. A fence along the northern boundary of Tsavo Park and other ecological deterrents should be contemplated if the invasion of wildlife compromises the gains from irrigated farming.

This plan relies heavily upon the engagement of the people of Makueni at many levels. The identification of where irrigation facilities are best targeted depends heavily upon initial stakeholder participation. Infrastructure development by government will determine how irrigation water will become available, but community groups shall determine how it is used. Community groups should be prepared to contribute their time and effort toward this end, including their labor within public works. At the same time, these infrastructure projects should hire locally wherever possible. Wages can then be used in part to make the farm-level investments needed to connect with and benefit from transition to irrigated agriculture. Women and youth must be provided special consideration as stakeholders but at the same time, we recognize that neither women nor youth represent homogeneous factions, particularly with regard to their preferred career pathways. For this reason, opportunities for innovation must remain open as agro-industries grow and diversify. One such course is the development of textile industry around the production of sisal and harvest of baobab, and other artisan occupations such as leatherworks and woodcarving. Another is related to the recognition that as farms commercialize, they become more dependent upon specialized service providers, who in turn require training and technical backstopping.

This leads us to a brief consideration of the next steps forward. Due attention was paid to the current Makueni County Development Plan, its targets for 2025, and this Vision assists in its completion and trajectory for an additional quarter century. However, neither plan considers how to raise revenues for its public works or to better attract the private sector as investors. Technically, the current county biennial plan published in August 2017 has expired, and it is important that this Vision be considered within whatever follows. Moreover, the need for private investment and commitment of public financial institutions should be formalized for the required water delivery infrastructure to be secured. This may be achieved in large part by operating a Makueni County Agriculture Investment Office. Major events that showcase investment opportunity are needed, and attractive mechanisms developed for those who respond positively. Similar forums should be held at the annual Makueni Agricultural Show and the county-level International Youth Day and World Food Day events. Too often, these events are dominated by politicians rather than stakeholders, experienced planners and agribusiness champions. Indeed, the

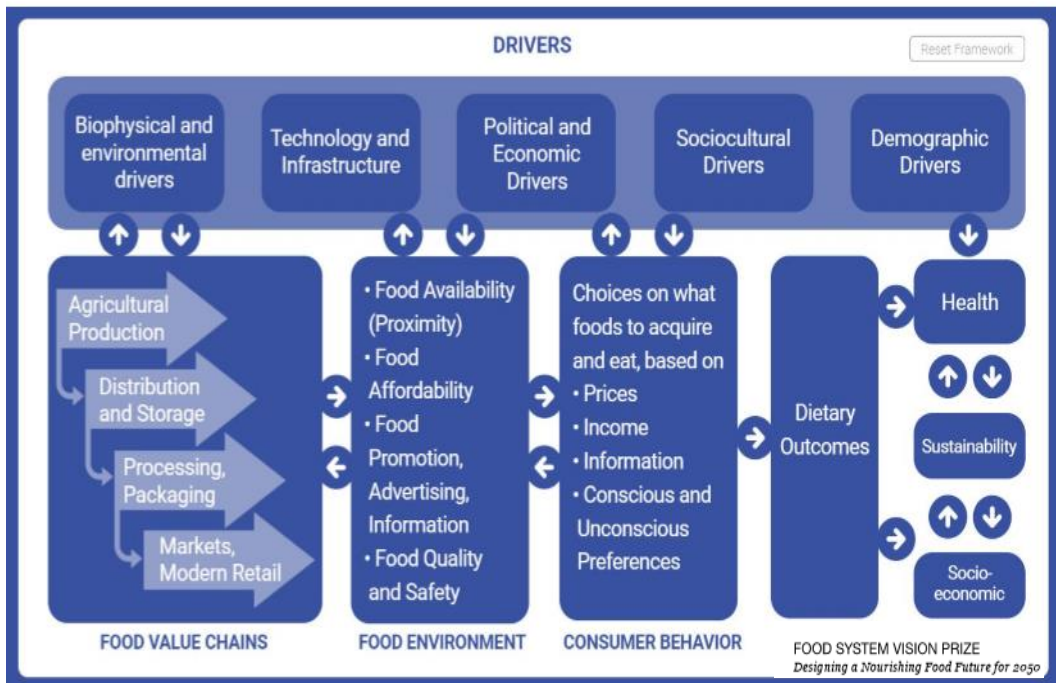


Figure 9. A conceptual diagram for systemic change advanced by Food System Vision 2050 that connects drivers to food value chains and dietary outcomes.

content of future forums must be more representative and impactful so that 2020 becomes recognized as the year that agricultural transformation in Makueni gained critical momentum, achieving food and nutritional security by 2025, and that by 2050 Makueni achieves a fully agro-industrialized food system.

Conclusion

This Technical Report seeks to reconcile the practical, technology-led approaches of TAAT with the more holistic and futuristic ones of the Food Systems Vision 2050. Clearly, both have merit and can contribute to one another, but they are inherently different. On one hand, TAAT sees agriculture as the engine for economic growth in Africa, and technical modernization as central to that growth while Vision 2050 regards dietary healthfulness as the fundamental role of agriculture. Africa must achieve food security in the short run and a greater role in global trade in the mid-term, but its people must also eat better and live healthier lives for that potential to become realized. So too, TAAT is focused upon specific, sequential, and site appropriate technical solutions while Vision 2050 is ultimately intended to inspire forward thinking movements. Indeed, must be paid to TAAT’s detailed processes and tools, but it is also the time to think big and brave in a manner that inspires rigorously designed, longer-term visions for Africa’s larger agricultural and economic future.

This report attempts to shape a positive, progressive Vision for a dryland farming system and its rural community beyond its technical dimensions. It is based upon multiple perspectives in a manner that builds upon but extends beyond available data and short-term planning horizons. It envisages innovation along several dimensions of food systems: social, cultural, political, and market-based, while holding upon a central tenet, that dryland farming must take full advantage of water resources, and wherever possible evolve into irrigated systems for the wellbeing and aspirations of this and future generations to become achieved. The challenges before this Vision are large but the opportunities it offers are profound; and with shared direction, collective effort and time, a modern food system and rural economy designed around ambitious future needs will result.

Vision 2050 relies upon “futurecasting” (Rockefeller Foundation 2019), and so should TAAT. This report proposes a future that redirects current trends and creates a new trajectory. It imagines a long-term agricultural outcome and shapes a path toward it, but is admittedly short on many important details. It assumes that less bad is not good enough for tomorrow in a way that learns from the past but extrapolates well into the future. Mark Lundy of CIAT (Colombia) offers Vision 2050 an interactive conceptual framework that considers food system drivers, value chains, and dietary outcomes (Figure 9). Note that technology and infrastructure serve as only one of five key drivers and that value chains are not viewed as an end but rather as a means to influence the larger food environment and consumer behavior (and its related producer practices). This framework is useful in exploring food systems and their actors and to define entry points that affect the operations of the agricultural sector. Furthermore, interactive arrows earmark key trade-offs that can ultimately influence dietary outcomes. Within the context of this diagram, it remains for the TAAT Clearinghouse to document lessons learned by TAAT, refine theories of change, better connect actors, and to identify public and private policies that influence change at scale considered by TAAT and the larger Feed Africa Strategy of the African Development Bank (AfDB 2016).



Figure 10. The CLEAR framework for systems change; an approach with relevance to the TAAT Clearinghouse.

This framework can also serve as a model for planned country-level assessment of agricultural and food systems in support of developmental loans intended to secure African economic advancement.

In accordance with Vision 2050, Dr. Lisa Drier, Founder of FutureTable and formerly with the World Economic Forum, offers the CLEAR framework as a means of pursuing systems change (Figure 10). This framework recognizes that systemic challenges are complex and evolving, and require collective, adaptive approaches (Drier et al. 2019). In this case, successful food systems change involves combining elements in creative, iterative and non-sequential ways. Visioning for systems change grapples with the redesign of incentive structures, and so too should the TAAT Clearinghouse. Finally, this approach recognizes that mindsets matter and that new styles of leadership are needed to enable food systems change. All of these lessons appear very applicable to the Clearinghouse and its operations within the TAAT Program!

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Technologies for African Agricultural Transformation (TAAT) and its Clearinghouse Office

The developmental objective of TAAT is to rapidly expand access of smallholder farmers to high yielding agricultural technologies that improve their food production, assure food security and raise rural incomes. This goal is achieved by delivering regional public goods for rapidly scaling up agricultural technologies across similar agro-ecological zones. This result is achieved through three principal mechanisms; 1) creating an enabling environment for technology adoption by farmers, 2) facilitating effective delivery of these technologies to farmers through a structured Regional Technology Delivery Infrastructure and 3) raising agricultural production and productivity through strategic interventions that include improved crop varieties and animal breeds, accompanying good management practices and vigorous farmer outreach campaigns at the Regional Member Country (RMC) level. The important roles of sound policies, empowering women and youth, strengthening extension systems and engaging with the private sector is implicit within this strategy. The Clearinghouse is the body within TAAT that decides which technologies should be disseminated. Moreover, it is tasked with the responsibility to guide the deployment of proven agricultural technologies to scale in a commercially sustainable fashion through the establishment of partnerships that provide access to expertise required to design, implement, and monitor the progress of technology dissemination campaigns. In this way, the Clearinghouse is essentially an agricultural transformation incubation platform, aimed at facilitating partnerships and strengthening national agricultural development programs to reach millions of farmers with appropriate agricultural technologies.

Dr. Mpoko Bokanga, Head of the TAAT Clearinghouse

Back cover photographic credit: Members of the Kibwezi Hortipreneur Youth Group participating in an agricultural show in Makueni County submitted by Ms. Elizabeth Muema of the Kibwezi Hortipreneur Youth Group.



Agricultural Transformation of Kenya's Makueni Drylands



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