FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Partnering for Innovation

The Market for Small-Scale Drip Irrigation in East and Southern Africa

Opportunities and challenges to commercialization

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AUGUST 2016

ABOUT FEED THE FUTURE PARTNERING FOR INNOVATION

Feed the Future Partnering for Innovation is a USAID-funded program that helps the private sector to scale and market agricultural technologies for smallholder farmers through investing in technology commercialization and knowledge exchange. The program also facilitates partnerships between USAID Missions and the private sector and provides business acceleration tools and services.

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This publication was made possible with support by the American people through the United States Agency for International Development, under the terms of Cooperative Agreement No. OAA-A-12-00051, and managed by Fintrac Inc. The opinions expressed herein are those of the author(s) and do not necessarily reflect the view of the United States government.

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Executive Summary

Drip irrigation can be a transformational technology for smallholder producers. It has many advantages over rainfed production and traditional furrow irrigation methods, such as increased on-farm yields, year-round production, efficient use of scarce water resources, and reductions in waterlogging, salinization, and pest and disease pressures. The commercial potential for the private sector to expand this technology to smallholder farmers is enormous, given the sheer volume of potential customers at the smallholder level, and the area of arable land yet to be irrigated.

Despite these opportunities, drip technology remains woefully underutilized in East and Southern Africa among smallholder farmers, and to date it has failed to reach its commercial potential for both suppliers and users. Estimates suggest that drip technology adoption in many food insecure countries has been negligible or less than 1 percent of total cultivated land.[i]

The practical reality is that despite its transformational qualities, drip irrigation may not be commercially viable for all smallholders in all geographic areas for all crops being produced at all times. To expand uptake of the technology, it is necessary for both development partners and private sector suppliers to appropriately target the farmers, regions, and crops that present positive returns on investment, and to address underlying constraints to the sustained adoption of the technology.

Feed the Future Partnering for Innovation has undertaken this research to identify the market segment characteristics which present high potential for the sustained adoption of small-scale drip irrigation in eight countries across East and Southern Africa – including Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Zambia, and Zimbabwe.

Each country is unique in many respects, such as the distribution of land holdings, agro-ecological characteristics, water availability, smallholder target crops, input and output market access, prevailing public sector policies influencing the drip irrigation industry, and priorities of the development community. Recognizing the diversity across and within countries, this research segments the market for drip irrigation to assist private sector distributors and development partners to appropriately target the commercial introduction of the technology.

While this research provides deep, country-specific analyses of the market segment characteristics seen to increase the probability of drip irrigation adoption, the consistent overarching messages across the region include:

- Drip irrigation is most appropriate for farmers operating as a business, regardless of size.
- High-value agriculture, particularly horticulture and seed production, is more likely to support investments in drip than staple food production.
- Areas of marginal land, limited water, and extended distances from markets are unlikely to support the commercial expansion of drip irrigation, without significant donor/government resources.
- The enabling environment, including government subsidies, duties, and regulations, influences commercial incentives for suppliers to target small-scale producers.
- Drip irrigation is only a tool. If farmers do not apply good agriculture practices and modern inputs such as improved seeds, fertilizers, and crop protection, then returns from drip irrigation will be restrained, thereby limiting its continued adoption.

Commercializing Drip Irrigation in Smallholder Markets

Benefits of drip irrigation:

110% yield increase per harvest

45% less water used

38% labor savings

Opportunities and Challenges to commercialization:

- Drip irrigation's return on investment is high enough for smallholder horticulture producers to pay off the investment in a year.
- Farmers growing high-value crops, such as tomatoes, are better suited to drip irrigation than farmers growing only staple crops.
- Many governments have prioritized drip irrigation as an agricultural development strategy, but in practice, the ease of importing drip equipment varies.
- Affordability and access to credit are main barriers to smallholders wanting to purchase drip irrigation systems.
- Farmers who already produce at a commercial level are most likely to benefit from drip irrigation.
- Youth farmers may present an interesting market for drip irrigation, since they tend to be more open to using new technologies.
- Some farmers in water-abundant areas may not understand the many benefits of using water-efficient methods of irrigation such as drip.

Sources: Feed the Future Partnering for Innovation, "The Market for Small-Scale Drip Irrigation in East and Southern Africa" and "Drip Irrigation in Smallholder Markets," partneringforinnovation.org; CGIAR, "Optimizing Crop Production with Drip Irrigation," https://cgspace.cgiar.org; and IFC, "Impact of Efficient Irrigation Technology on Small Farmers," http://www.ifc.org

Overview of the Research

This research examines countries across East and Southern Africa to identify local-level constraints to smallholder adoption of drip irrigation and highlight opportunities for commercial drip irrigation suppliers to more effectively penetrate the small-scale market segment. The following characteristics of the market for drip irrigation are presented in country-level analyses:

Smallholder segmentation: Understanding the heterogeneity of smallholders across and within countries is key to identifying and targeting the smallholders with the greatest potential to adopt and sustain their utilization of drip technology. We present household characteristics in terms of landholdings, assets and capabilities, primary crops cultivated, and geographic locations.

Geographic segmentation: Geographic targeting is necessary for commercial suppliers to identify the areas with the greatest opportunity for drip irrigation uptake. We identify the locations with favorable agro-ecological conditions, including the necessary land and water resources, and the locations of high-value agricultural production by smallholders that are expected to support the uptake of drip technology.

Enabling environment profile: Assessing the business enabling environment concerning drip irrigation and the input market generally is important for commercial suppliers to understand the support provided or barriers erected by local governments. We present relevant policies, taxes and duties, procedures, and supporting services that impact the import and marketing of drip equipment.

High-value agriculture dynamics: Market oriented production systems, particularly those focused on high-value crop production such as horticulture and/or seed production, are widely recognized to deliver output market returns to farmers that have a greater potential to support the upfront investment and ongoing operating costs of drip irrigation. We present the dynamics of smallholder farmer participation in the horticulture, seed, and other high-value sectors.

Key drip irrigation actors: Knowledge of relevant commercial actors provides a sense of the supply of drip irrigation equipment available for smallholder farmers, and also provides a sense of the competition in the small-scale market segment. We present the leading drip irrigation manufacturers and distributors currently targeting the smallholder market in each country with a brief overview of their products/services.

Challenges for smallholder uptake: Understanding the constraints for smallholder farmers to adopt drip technology is an important step to determining what actions are necessary to increase supply and demand. We present several of the major barriers for suppliers to profitably deliver drip irrigation to farmers, for farmers to invest in and operate drip irrigation systems, to benefit from drip irrigation, and to maintain their investments in drip irrigation.

Development initiatives: Public sector, private sector, and donor-funded initiatives may present opportunities for collaboration to improve the commercial delivery of drip irrigation to smallholder farmers. We present the key in-country initiatives focused on commercialization in smallholder markets, particularly those with the objectives of expanding high-value agriculture and/or access to micro-irrigation.

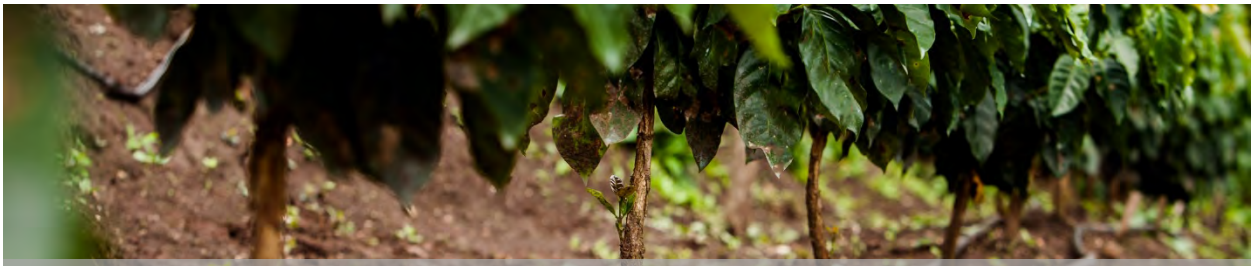
Recommendations for future opportunities: Considering all of the above characteristics of the local market, certain opportunities are evident for commercial suppliers to target the small-scale market for drip irrigation. We summarize a few of these recommendations for drip irrigation manufacturers and distributors to expand sales and impact at the smallholder farmer level.

Description of Methodology

This analysis was carried out from April 19 to May 9, 2016 through the following methods:

Secondary data collection: Quantitative data was gathered from the International Commission on Irrigation and Drainage to ascertain arable and permanent cropping area for each country, and the percent of cropping area known to be irrigated. Additional quantitative data was gathered from the UN FAOStat database to determine national area cultivated of staple crops versus horticulture crops. Together these data sets are intended to present the scope for commercial expansion of drip irrigation in each country. Additionally, qualitative data was collected through a literature review to identify country-level characteristics, including smallholder demographics, available natural resources, and high-value agriculture market dynamics.

Primary data collection: Semi-structured interviews were conducted with key stakeholders identified in each target country, including commercial drip irrigation distributors, manufacturers, and development partners. Interviews provided open-ended questions for stakeholders to convey their knowledge on drip market competition, relevant enabling environment factors, financial sector challenges, natural resource availability, commercial smallholder segmentation, support services available to farmers, and perceived challenges and opportunities to expand drip irrigation uptake in the country. The list of stakeholders consulted can be found in Annex I.



Ethiopia: The Market for Drip Irrigation

Market Overview

Ethiopia's economy is primarily agricultural. The agriculture sector accounts for 43 percent of GDP and 90 percent of exports[ii], and more than 80 percent of the population are employed in the sector[iii]. Several regions of Ethiopia are suitable for the production of a wide range of high-value agricultural products because of favorable agro-climatic conditions, abundant land, and water resources. Major high-value exports include several vegetables, fruits, and cut flowers. While production is primarily rainfed, furrow irrigation is practiced across the Rift Valley. To promote efficient use of water resources and expand commercial agricultural potential for smallholders, the government has recently placed a high priority on expanding small-scale irrigation nationwide. This initiative presents a potential opportunity for commercial providers of drip irrigation equipment.

Smallholder Market Segmentation

There are approximately 12 million smallholder households across Ethiopia accounting for an estimated 95 percent of agricultural production. It is estimated that 4.3 million farmers (36 percent of total) cultivate less than 0.5 hectare of land and 2.8 million farmers (24 percent of total) cultivate between 0.5 and 1 hectare of land[iv]. Stakeholders in Ethiopia have indicated that smallholder production systems are commercially viable (producing surplus for sale) at a minimum of .25 ha (2500 m^2).

South of Addis Ababa in the Rift Valley, smallholder farmers cultivate small-scale farms ranging in size from 2 to 5 ha. These are considered to be quite profitable production systems; however, the land tenure system constrains their investment incentives. Many of the commercially oriented producers using traditional irrigation practices in the Rift Valley tend to rent their land on an annual basis. As there is no guarantee they can secure the land with the landlord the next year, these producers are reluctant to install permanent infrastructure on the land. Instead, they prefer the flexibility of labor intensive (rather than capital intensive) land preparation and irrigation systems such as furrow practices. Furrow methods only require pump and energy costs to lift the water, and are therefore inexpensive relative to drip irrigation. Smallholder land renters are unconcerned about the salinization issues caused by furrow methods, so the perceived value proposition of drip irrigation is somewhat limited.

Geographic Market Segmentation

Ethiopia possesses approximately 110 million hectares of land, 14.5 million of which are arable, permanent cropping area. The International Commission on Irrigation and Drainage estimates that only 3.7 percent of the arable cropping area is irrigated, reflecting approximately 540,000 ha of irrigated land. The majority of farmers therefore rely on the rainy season from June to August for a harvest season from September to November. Water resource availability is spatially heterogeneous across the

country, with the Rift Valley benefiting from an abundance of water resources, while the Afar and Somali regions suffer from water scarcity.

The main source of irrigation water for smallholders is from open water bodies, including lakes, rivers, and *wadis* (seasonal riverbeds) where water is lifted with electric or diesel pumps to gravity tanks. There is currently little use of shallow hand-dug wells in areas of water abundance; however, the Ethiopian government through the Agricultural Transformation Agency is promoting the expansion of hand-dug wells (up to 30 meters) and more capital intensive boreholes to access groundwater aquifers.

> Vegetable production is booming in some regions, and although these farmers are employing relatively sophisticated production practices, they are also overwhelmingly using furrow irrigation.

In the central Rift Valley, studies suggest that 37 percent of vegetable growers divert water from rivers (typically along the Awash River), while 35 percent access water from hand-dug wells and boreholes. In these areas, an overwhelming 99 percent of vegetable growers practice furrow irrigation. Nearly 65 percent of growers in the central Rift Valley indicate that water availability is not a problem, but, competition among water users is common where communal schemes are utilized. [v]

The primary geographies practicing high-value irrigated agriculture are the three hour stretch south of Addis towards the city of Nazareth; and the Awash River basin west of Addis that stretches to Djibouti. Additionally, there are significant efforts underway by the government to introduce efficient water saving technologies in the water scarce areas of Afar and Somali regions, although irrigation practices in these areas are uncommon given the limited water resources.

Enabling Environment

Since 1991, the Ethiopian government has made agriculture its primary priority through its Agricultural Development Led Industrialization (ADLI) strategy, an export-led development initiative[vi]. More recently, a national effort to promote small-scale irrigation has been put into action to expand year round high-value agricultural production through the efficient use of water resources. These efforts include transitioning from traditional furrow irrigation practices to reverse soil salinization and addressing pest disease challenges, as well as introducing water saving technologies in areas of water scarcity.

> The Ethiopian government has enacted a national effort to promote small-scale irrigation, and importing drip irrigation equipment is VAT and duty exempt both in policy and practice.

Representatives from the Small Scale Irrigation Development Expansion Directorate within the Ministry of Agriculture and Natural Resources have indicated that they have put about 2.4 million hectares of land under small-scale irrigation schemes with 1.6 million smallholder farmers, and that over 5.3 million hectares of land could be further developed under small-scale irrigation schemes for a total of 10.4 million small-scale farmers[vii]. These figures are not to suggest that the current market for drip irrigation is 10.4 million smallholders, but instead reflects the commitment level of government towards small-scale irrigation efforts.

This support can be seen through importing procedures as well. All stakeholders interviewed indicated that there were no burdensome regulations or taxes/duties to importing drip irrigation equipment. On the contrary, as this is a priority area for the government, importing drip irrigation equipment is VAT and duty exempt in both policy and practice. The main challenge identified for importing agricultural equipment is periodically limited foreign currency availability.

High-Value Agriculture Dynamics

Ethiopia has a favorable climate and conditions for the production of tropical, sub-tropical, and temperate high-value horticulture in the lowlands (<1,500 meters above sea level), midlands (1,500-2,200 meters), and highlands (>2,200 meters).[viii] Small-scale commercially oriented producers cultivate a range of economically important vegetables for both export and domestic markets, while large scale enterprises focus on cut flowers and orchard crops for export. Over the past 10 years, high-value vegetable production has grown in large part because of institutional support from government for small-scale irrigation, and booming domestic demand as a result of urbanization and economic growth[ix].

The table below[x] illustrates the national area harvested for staples versus fruits and vegetables from 2010-2013. While the ratio of fruits and vegetables has not grown relative to staples over this period, there has been an increase of over 35,000 ha of land dedicated to fruits and vegetables over this period, and there are a total of over 500,000 ha allocated to fruits and vegetables, reflecting promising potential for the introduction of drip irrigation on commercially oriented farms. Additionally, compared to neighboring countries in East and Southern Africa, Ethiopia has more land allocated to fruits and vegetables than Kenya, Zambia, Malawi, Mozambique, and Zimbabwe.

ETHIOPIA: AREAS HARVESTED (HA)		2010	2011	2012	2013
Area harvested (ha)	Cereals, Roots/Tubers	10,538,710	10,445,533	10,473,946	10,710,822
Area harvested (ha)	Fruits & Vegetables	467,919	476,560	509,217	503,990
	Staples to FFV	**22.5**	**21.9**	**20.6**	**21.3**

Commercial vegetable production by small-scale producers is concentrated in the Rift Valley areas of Ethiopia, primarily because of availability of irrigation water, accessibility, and closeness to agro-processing facilities. Vegetable production is booming in the area, and hundreds of thousands of farmers are estimated to be involved. These producers employ relatively sophisticated practices including high density planting and intensive use of fertilizers and agrochemicals; however, they are also overwhelmingly practicing furrow irrigation.

Despite its growth, there are several factors constraining smallholder horticulture production systems in Ethiopia. A study of irrigation practices indicates that 100 percent of farmers surveyed face problems related to their irrigation method, particularly soil salinity, waterlogging, soil erosion, and an increase of pests and disease pressures[xi]. Extension services for irrigation practices are extremely limited and rural access to inputs also remains a bottleneck. While fertilizer access is improving it has yet to be fully liberalized. The private sector input distribution network is improving, but the 'last mile' remains a challenge. Inputs such as seeds, agrochemicals, and machinery are typically supplied by village level cooperatives.

Key Drip Irrigation Actors

Stakeholders have indicated that there are estimated to be up to 20 suppliers of drip irrigation in Ethiopia; however, the majority are construction equipment and engineering companies that focus on drip irrigation only peripherally, with a greater emphasis on the large-scale floriculture producers. There are five known companies that are dedicated to drip irrigation with an effort to target the small-scale farmer market segment: Tecmod Water Works, Netafim Ethiopia, Astu Naet, Schoteb Engineering, and Bruh. Drip irrigation suppliers targeting the small-scale market segment indicate that distribution directly to farmers is not feasible. Instead, many sell equipment wholesale to farmer associations and cooperatives with whom they have established relationships, and provide agro-inputs such as seed and fertilizer to farmer members.

COMPANY	DESCRIPTION	CONTACT
Netafim Ethiopia	Widely regarded as a market leader because of their high-quality product line featuring small-scale kits and rural demonstration efforts; however, stakeholders also indicated that Netafim operations in Ethiopia prioritize the large-scale consumer and government segments over the small-scale segment given the difficulty of justifying higher overhead costs for a lower margin market segment. Netafim recently landed a deal to drip irrigate 7,000 hectares of sugarcane in a project with the Ethiopian government, financed by Israeli bank Bank Hapoalim.	+251 11 618 5713
Tecmod Water Works	Has identified small-scale plots as a large market opportunity particularly given the institutional support for these efforts from the government. Tecmod provides installation and maintenance services from in-house technicians, as well as training in Amharic and regional languages, for 250m² systems and up. Tecmod is actively targeting the Afar and Somali regions given the water scarcity in these areas. Smallholders in these areas reportedly are quick to see the value of drip irrigation given its water saving features, compared to areas of water abundance where other forms of less efficient irrigation are viewed as cheaper and easier by smallholders. Government has also prioritized these areas for development, presenting an opportunity for pioneering firms like Tecmod.	Dawit Tefera +251 911 176 559 dawitef@yahoo.com

Key Challenges for Smallholder Drip Irrigation Uptake

Finance: Commercial financial institutions are generally unwilling to lend to the smallholder agriculture sector, particularly for rapidly depreciating equipment like drip irrigation. Many microfinance institutions have been active lenders to rainfed production systems, and some have begun providing credit for water pumps. The Bureau of Agriculture has been known to provide lender guarantees for water saving technologies, but in practice this has been limited, and varies from region to region. Another option is the Cooperative Finance Bank which is widely seen as the main source of finance for rural cooperatives. And finally, the Addis Credit Association, a government initiative, is intended to provide favorable terms including appropriate cost recovery/repayment periods compared to private lenders, but in practice, there is little evidence of lending for smallholder drip.

Farmer awareness: On the positive side, irrigation is widely practiced by smallholders, particularly in the Rift Valley along the Awash River. However, traditional furrow irrigation practices dominate, and transitioning to drip where water resources are abundant may prove challenging. Farmers have no knowledge of drip irrigation, and given the area's water abundance, may fail to see the relative value of

water efficiency. Where first movers do transition to drip irrigation, they need extension support to properly operate and maintain their system. Development agents from the Ministry of Agriculture's regional offices are mandated to provide production guidance to farmers, but they have insufficient resources and require capacity building to fully understand the technical operation of drip systems.

Land tenure: While larger scale floriculture producers are reported to have renewable land leases of up to 50 years, smaller-scale horticulture producers in the Rift Valley overwhelmingly rent their farm plots on an annual basis. Without secure land tenure from year to year, they are unlikely to manage water and land resources efficiently, or invest in irrigation infrastructure on their land. The target market for commercial drip distributors is likely limited to those small-scale commercially oriented producers with secure long term land tenure; however, the number of farmers meeting these characteristics is currently not quantified.

Key Development Initiatives

Project	Description	Contact
Agricultural Transformation Agency	The government of Ethiopia established the Agricultural Transformation Agency (ATA) by federal regulation in 2010 as a catalyst to promote transformational, sustainable change in the smallholder agriculture sector. ATA is currently piloting energy efficient small-scale irrigation, such as solar pumps for drip systems, in eight districts where water is readily available over three years, and then plan to scale up to 100 districts nationwide. ATA is also currently undertaking groundwater mapping, borehole drilling, and well digging in areas of water scarcity.	Seyoum Getachew Seyoum.Getachew@ata.gov.et 091-114-2495 093-009-8873
Agricultural Growth Program II	This is a large scale umbrella development initiative funded by USAID, the World Bank, UNDP, FAO, CIDA, and AECID that encompasses several smallholder commercialization projects. AGP II commenced in November 2015, and its project components include agricultural support services, agricultural research, small scale irrigation, agricultural marketing, and value chain development. Nonetheless, high-value horticulture is not currently a target value chain for AGP II, suggesting limited opportunity for the introduction of drip irrigation within target value chains.	http://ethioagp.org/ Headquarters Yeka Sub-city, K. 13/14, H. No. New Marathon Building, 4th Floor Addis Ababa
DFID Land Investment for Transformation (LIFT) program	This project is focused on land tenure issues, particularly registration and issuance of second level land certificates to farmers which runs from 2014-2019 implemented by DAI. Drip equipment distributors may find opportunity by targeting production areas where farmers have been issued land titles thereby increasing their incentives to invest in drip systems on their land.	http://dai.com/our-work/projects/ethiopia percentE2 percent80 percent94land-investment-transformation-lift-0 John Leckie John_leckie@dai.com
Feed the Future Ethiopia Value Chain Activity	This project has not yet been awarded but is scheduled to begin in late 2016. The predecessor to this project was USAID/Ethiopia's Feed the Future AGP Agribusiness and Market Development (AMDe) project. Target value chains include maize, coffee, chickpea, dairy, and livestock, presenting limited opportunity for drip irrigation commercialization.	TBD

Recommendations for Future Market Opportunities

Geographic targeting: There were two divergent recommendations from stakeholders interviewed. Conventional wisdom, along with the majority of stakeholders interviewed, suggests that the appropriate geographic target for expanding sales of drip irrigation would be areas of high-value horticulture production where water resources are readily available. The area most in line with this strategy include the Central Rift Valley, including the stretch of land south of Addis Ababa towards the city of Nazareth, and the Awash River basin west of Addis Ababa stretching to Djibouti. These areas have significant numbers of small-scale vegetable farmers; the challenge lies in generating farmer demand by conveying the value of drip relative to furrow. Alternative wisdom, and one particular drip stakeholder in Ethiopia, has suggested that the greatest geographic targeting opportunity for drip is in the water scarce regions of Somali and Afar. Here boreholes and/or wells are necessary; however, farmers instantly recognize the water saving efficiency of drip irrigation. The government has prioritized development initiatives in these areas, particularly Afar. It is noteworthy that the Somali region presents additional challenges such as conflict and limited access to output markets.

Farmers in water-abundant areas may not see the relative value of water-efficient irrigation methods.

Distribution and extension: Stakeholders suggested that the most opportunistic distribution strategy for drip suppliers is to wholesale through village level farmer associations and cooperatives. These organizations have established relationships with farmers, and they are already providing a range of agro-inputs. Nonetheless, they will need to be trained in proper installation, operation, and maintenance. Distributors of small-scale drip would be well served by in-house technicians holding demonstration events in tandem with cooperative/association agents to raise awareness and build a customer base.

Labor saving qualities: In the Rift Valley, drip irrigation distributors targeting the small-scale commercially viable market segment would benefit from highlighting the labor saving qualities over the water saving qualities of drip irrigation technology. Given the water availability and limited land tenure, these farmers see little value in good land and water management practices – after all, they have not internalized the costs of the water, or long term externalities like soil salinization. But they do often face labor shortages on the farm, and will recognize the value of the time saved irrigating land under drip irrigation.

Kenya: The Market for Drip Irrigation

Market Overview

Agriculture accounts for more than 25 percent of Kenya's GDP, and more than 75 percent of the population is economically engaged in the sector[xii]. In 2015, the agriculture sector grew by 6.2 percent, driven in large part by an impressive 7.5 percent year over year growth in the value of horticulture produce, including cut flowers, fruits, and vegetables[xiii], and nearly 80 percent of Kenya's horticulture is grown by smallholder producers. Still, Kenyan farmers largely depend on rainfed production despite inadequate rainfall to meet basic crop water requirements in more than 80 percent of the country. In 2014, the government of Kenya launched its National Water Master Plan 2030, which aims to increase irrigated areas from approximately 100,000 ha to 970,000 ha. Conservatively assuming that only 1/3 of the government's targets were met, the drip irrigation market would be worth an estimated $100 million.[xiv]

Smallholder Market Segmentation

The FAO provides a useful demographic and economic portrait of the smallholder farmer market segment in Kenya, their economic condition, and general agricultural capabilities[xv]:

- There are estimated to be approximately 3.2 million small farm land holdings in Kenya, ranging from .04 ha up to 1.2 ha with an average of .47 ha. For regional reference, this about the same as Malawi, but about half the size of small-scale plots in Ethiopia and Tanzania.
- The average smallholder household income is estimated to be $2,645/year, 40 percent of which is earned from crop production. Despite smaller landholdings, average smallholder income in Kenya is nearly twice that in Ethiopia.
- Only 24 percent of smallholder farmer production is sold; however, this is more than 2x the share of production sold by smallholders in Ethiopia and Malawi.
- Only 2.5 percent of smallholder land is irrigated, and 2.8 percent of households use motorized equipment.
- Approximately 30 percent of smallholders utilize improved seeds.

Although 97 percent of smallholders grow maize[xvi], commercial drip irrigation suppliers must recognize the heterogeneity of the smallholder farmer market segment. Commercially oriented smallholders in Kenya are increasingly cultivating higher value crops alongside staple crops, particularly in Central and Western Kenya. Despite low levels of smallholder commercialization (24 percent of smallholder production is sold), the data above suggests Kenyan smallholders are, on average, more commercially oriented than those in Ethiopia and Malawi, suggesting an active segment of the population expected to be receptive to investments in drip irrigation.

Stakeholders in Kenya have suggested that those farmers at or above approximately 0.5 ha of land are the most suitable for producing a surplus of higher value crops, and therefore are expected to be the

most appropriate target for small-scale drip irrigation technology, although there are currently no estimates available of the number of farmers within this particular sub-segment.

Additionally, stakeholders in Kenya have suggested that the youth demographic represents a compelling opportunity for commercializing small-scale drip irrigation. Approximately 10.8 million people are between 15-30 years of age, and unemployment is estimated to be nearly 70 percent[xvii]. Nonetheless, nearly 86 percent of Kenyan youth are literate[xviii] and commercial drip stakeholders in Kenya have indicated that youth farmers are relatively innovative, technologically minded, and have exhibited higher rates of drip irrigation adoption than the average smallholder.

Geographic Market Segmentation

Kenya has a total land area of approximately 58 million ha, only 10 percent of which (5.8 million ha) is arable and permanent cropping area. Further, only 17 percent is classified as medium to high potential, with more than 700mm of rainfall per year - the rest of the land is classified as arid and semiarid lands (ASAL) and cannot support rainfed agriculture without irrigation[xix]. The International Commission on Irrigation and Drainage estimates that only 1.8 percent of the arable and permanent cropping area is irrigated (approximately 103,000 ha). Most smallholders therefore rely on two distinct rainy seasons, the 'long rains' from April to June, and the 'short rains' from November to December.

Land resources in Kenya can be generally classified by the following agro-ecological regions[xx]:

- Humid regions: this includes highlands to the east and west of the Rift Valley as well as the lowlands along the coast. These areas exhibit annual rainfall of 1,100mm-2,700mm/year.
- Sub-humid regions: this includes the area around Lake Victoria and western Kenya with annual rainfall of 1,000-1,600mm/year.
- Semi-arid/Arid regions: this includes primarily northern and north-eastern Kenya with rainfall ranging from 150mm-900mm/year.

The humid and sub-humid regions are considered to be the medium to high potential production areas, and the areas where fruit and vegetable production is practiced. Overall, stakeholders in Kenya indicated that the most opportunistic geographic target for high-value crop production under drip by smallholders is in western Kenya around Lake Victoria, and Central Kenya around Mount Kenya. Small-scale producers in the vicinity of the lake region naturally have greater access to water resources, as do producers in the rift valley where there are numerous springs and rivers that can be tapped for irrigation with a diesel, electric, or solar water pump. On the coast, boreholes (170m) and shallow wells (20-30m) become the main source of water for irrigation. In many areas of western Kenya where rainfall is more than 1,100mm/year, building water catchment ponds also becomes a feasible source of irrigation water.

Although most farmers in Kenya primarily grow staple crops, there is also a significant potential opportunity for high-value agriculture, for which there is both a domestic and export market.

While most stakeholders in Kenya say that Western and Central Kenya have the most opportunity for the expansion of small-scale drip irrigation because of proximity to markets and water availability, one stakeholder interviewed indicated that the coastal areas with seasonal water shortages also present a viable market opportunity, primarily because the perception of drip will be more valuable where water

is scarcer. Nonetheless, this stakeholder also acknowledged that drilling boreholes is often not financially feasible for smallholders and this approach would likely require additional donor-funded support.

Enabling Environment

In 2014, the Government of Kenya launched its National Water Master Plan 2030, which targets an increase in areas under irrigation of 970,000 ha – a more than nine fold increase from current irrigation estimates. Despite the high level of commitment to expanding irrigation, in practice, stakeholders report confusing and inconsistently enforced policies for importing and selling drip irrigation equipment.

One stakeholder reported that drip equipment is not VAT exempt, and is subject to a mandatory 16 percent VAT payment, whereas duties are a "gray area". The formal policy is that drip is duty-free on import, but the distinction of what is subject to payment versus duty free is less clear. Another stakeholder reported that if a drip irrigation supplier imports an entire "project" then they are not charged VAT or duties, whereas kits are often charged both VAT and duties. Yet another stakeholder reported that the rules around customs inspections are becoming more onerous, and that all shipments must be inspected or they are subject to an additional 25 percent fine. All stakeholders indicated that getting shipments out of customs often requires informal payments to avoid their equipment being stuck in customs for extended periods of time; however, the size of these payments was not reported. Overall, these findings suggest that the import and distribution of drip equipment is not as efficient as government policy intends.

High-Value Agriculture Dynamics

Stakeholders indicate that the fruits and vegetables sector represents a significant opportunity for smallholder production of high-value products. Nonetheless, Kenyan farmers focus primarily on the production of staple crops, particularly maize, relative to high-value horticulture. As the table below illustrates, the land area allocated to staples has actually grown since 2010, and by 2013 was 8.8 times that allocated to fruits and vegetables. Nonetheless, with more than 340,000 ha of land estimated to be allocated to fruits and vegetables nationwide, this can be considered a key metric for quantifying the potential size of the market for drip irrigation. Additionally, compared to other countries in East and Southern Africa, particularly Zambia, Zimbabwe, Mozambique, and Malawi, Kenya has more land area allocated to fruits and vegetables.

KENYA: AREA HARVESTED (HA)		2010	2011	2012	2013
	Cereals, Roots, Tubers	2,811,270	2,928,620	2,986,905	3,010,010
	Fruits and Vegetables	346,936	327,709	319,604	340,602
Staples to FFV		**8.1**	**8.9**	**9.3**	**8.8**

Global demand for fruits and vegetables, particularly from Europe, has accelerated the growth of the high-value fruit and vegetable sector in Kenya[xxi]. European supermarkets exhibit year-round demand, increasing the need for drip to enable suppliers to meet demand during dry seasons. Significant domestic demand also exists for fruits and vegetables in the main population centers including the Nairobi, Thika, and Mount Kenya regions.

The horticulture sector employs approximately 4.5 million people countrywide directly in production, processing, and marketing, while another 3.5 million people benefit indirectly through trade and other activities. Horticulture is a major source of livelihood to farmers generating in excess of $1 billion in

foreign earnings annually.[xxii] Perhaps most importantly, up to 80 percent of horticultural production in Kenya is undertaken by smallholder farmers.

There is significant scope to expand drip irrigation technology among small-scale horticulture producers. While 71 percent of rice production in Kenya is currently irrigated, only 20 percent of vegetable production is irrigated.[xxiii] Large-scale export oriented horticulture producers are estimated to account for 85 percent of overall drip technology used in Kenya; however, given that 80 percent of Kenyan horticulture is grown by smallholders, the opportunity to dramatically expand the use of small-scale drip technologies is evident.

In addition to open field production systems, there has been a major push in Kenya to introduce small-scale greenhouses to smallholders. Geographically, findings indicate that greenhouse production is spatially heterogeneous, with clusters around the central highlands, and spreading towards marginal semi-arid zones.[xxiv] From 2004, there was a major push by the government to expand small-scale greenhouses (15x30 meters on average); and to date there are an estimated 150-200 ha of land under smallholder greenhouse production[xxv]; however, stakeholders in Kenya indicate that now nearly 70 percent of the small-scale greenhouses (15x30 meters on average) have been abandoned by farmers because of production and pest and disease challenges faced by smallholders.

Youth farmers may represent an interesting potential market for drip irrigation products due to their relative openness to innovation and technology.

Farmers generally have good access to modern agro-inputs such as hybrid seeds, fertilizer, and crop protection products, as all major suppliers (Monsanto, Bayer, Syngenta, etc.) distribute through rural sellers in smallholder production areas. Most sellers in major towns are licensed agricultural professionals with sufficient capacity to provide information to farmers; however, dealers at the village level have less professional knowledge to extend to farmers on proper input utilization.

Key Drip Irrigation Actors

There are four main drip irrigation distributors currently targeting the small-scale producer market segment: Amiran Kenya, Hortipro, Green Zone Agencies, and G. North and Sons. These companies are not exclusively focused on drip irrigation, nor are they exclusively targeting the smallholder farmer. They also provide a range of agro-inputs and equipment, and they earn the majority of their sales from the larger scale export oriented producers in Kenya. An overview of some of the dedicated products and services as explained by stakeholders interviewed are as follows:

Company	Description	Contact
Amiran Kenya	Will sell individual components of a drip system, but their primary focus is on providing a 'package' of products and services for farmers. Amiran sells Netafim branded drip systems bundled with hybrid seeds, fertilizer, and crop protection products. Small-scale drip systems start as small as 90 m^2 ($180), which are believed to enable smallholders to grow into a range of open field products including the 150 m^2 system, 500 m^2 system, 1,000 m^2 system, and 1 acre system. Amiran provides farmer training through a team of 38 field agronomists and a dedicated phone support service.	Yariv Kedar yariv@amirankenya.com +254 (0) 719 09 5211 +254 (0) 733 88 0000
Green Zone Agencies	Provides small-scale drip irrigation for open field as well as protected production systems. It markets the Netafim and Azud brand equipment, and offers a ¼ acre and ½ acre kit to smallholder farmers. It has nine technicians on staff to follow up with farmers to properly manage their drip systems. Green Zone also partners with rural sellers and pays a share of their overhead to keep drip inventory in stock.	Bernard Otieno bernard.otieno@gmail.com +254 (0) 703 727 565
Hortipro	Provides both small-scale kits as well as customized systems to smallholders. It markets the Rivulus (formerly John Deere Water) brand of drip equipment, and is active in Kenya, Tanzania, Ethiopia, and now Uganda through a strategic partnership with AgroMax U Ltd. Hortipro will also sell small-scale individual components, whereas some suppliers require that farmers buy a full drip kit, or a full 1,000 meter roll of drip tape, which they believe is a distinguishing factor with the competition. Hortipro also delivers technical training on drip irrigation to farmers by partnering with the Ministry of Agriculture through farmer field days.	Jay Dave jay@hortiprolimited.com +254 (0) 722 366 319
G. North and Sons	Active in Kenya for more than 13 years, it currently markets the Eurodrip brand drip equipment. They provide irrigation solutions of all types including drip, sprinkler, and center pivot with a focus on both small- and large-scale clientele. Additionally, G. North provides a range of agricultural equipment including tractors, plows, planters, etc. For the small-scale drip market segment they provide products ranging from 'bucket scale" (40-60 meter) up to one ha, which reportedly represents about 15-20 percent of their sales.	Elijah Mugah mugah@gnorth.co.ke +254 (0) 733 930 766

Key Challenges for Smallholder Drip Irrigation Uptake

Finance: All stakeholders interviewed indicated access to equipment credit as a major constraint that is tangibly limiting initial investment in drip systems by smallholder farmers. Several private sector distributors have entered into partnerships with financial institutions to facilitate credit disbursement. Currently, formal financial institutions required a formal lending history, and collateral for equipment credit. Drip irrigation equipment does not qualify as collateral and farmers are generally unwilling to provide the title to their land as collateral for an investment they themselves view as potentially risky, and they rarely have the cash to pay deposit requirements. Green Zone, Hortipro, and Amiran have all offered a buy-back guarantee to lenders to reduce default risks, but banks remain unwilling to lend. The financial sector is seen to be in a period of crisis in Kenya with many financial institutions falling into receivership, so small-scale agricultural lending is not viewed as a priority. In the absence of credit, those farmers with access to water choose to practice furrow irrigation despite its comparative drawbacks.

Technical knowledge: Several stakeholders highlighted that drip irrigation is a tool, not a solution. Without the application of good agricultural practices, including proper land preparation, and the utilization of hybrid seeds, water soluble fertilizer, and crop protection products, the returns from drip irrigation will never meet their potential. Comprehensive extension services across the country are weak, with government extension services under-resourced and lacking technical capacity themselves. Select development projects, including the USAID-KAVES project, are widely viewed as the only viable source of comprehensive extension for smallholder horticulture producers in the country. Additionally, without practical knowledge on drip operation and maintenance, farmers who invest in drip often abandon the system if it becomes clogged and inoperable because of poor management.

Protected production systems: The promotion of small-scale greenhouses was previously seen as the most opportunistic entry point to introduce drip irrigation to smallholders, resulting in the majority of drip irrigation being practiced in conjunction with greenhouses. Small-scale greenhouses were billed as a panacea of sorts for smallholders to achieve year round production of high-value vegetables, particularly tomatoes. But now an estimated 70 percent of the small-scale greenhouses across the country have been abandoned because of inappropriate greenhouse designs for varied agro-ecological zones (poor ventilation, etc.), and the emergence of bacterial wilt disease in tomatoes, the dominant crop produced under protected structures. Now, small-scale drip irrigation under protected production systems is increasingly understood as an option only for the more sophisticated producers who can afford the additional upfront investment of the greenhouse ($2,000-$3,000), access disease resistant seeds, and manage the system appropriately, whereas open field production is now seen as potentially more viable for smallholders.

Availability of recycled drip equipment: Many of the entrepreneurial small-scale producers currently practicing drip irrigation are also employees of large floriculture or horticulture operations. This enables them to see the productivity of drip irrigation, as well as the market windows for producing horticulture products off-season. On the other hand, they often recycle used drip equipment, including drip tape and filters, from the large commercial operations that replace their drip equipment every 12-18 months. While this is an opportunity for smallholders to obtain drip components at little or no cost, it also reduces their incentive to buy these components, thereby reducing market opportunity for commercial suppliers of drip equipment.

Key Development Initiatives

There are several relevant development projects across Kenya that may present promising opportunities for collaboration with private sector drip stakeholders to expand sales to the commercially oriented smallholder producer market segment:

Project	Description	Contact
USAID Kenya Agricultural Value Chain Enterprises (KAVES)	KAVES is a $40 million project that runs from 2012 to 2018, supporting the commercialization of small farmers in the horticulture, maize, and dairy value chains. The lead implementer, Fintrac Inc., works closely with local NGOs, government agencies, and nucleus farms to deliver farm-level extension for production-level technology uptake and to facilitate access to output markets. The project is active in 22 counties in the western and eastern regions of Kenya.	Steve New snew@fintrac.com
FARM Africa	Several active projects in Central and Western Kenya. The Youth Empowerment in Sustainable Agriculture (YESA) project is working with 2,300 youth through 87 groups in Trans Nzoia County to start small agribusinesses growing high-value vegetables and introducing new production technologies on demonstration plots and establishing outgrower schemes with buyers such as Keitt Exporters and Kenya Fresh for French beans, and Mace Foods for chilies. The project also facilitates access to credit from the Youth Enterprise Development Fund for investments in new production technologies. They are also supporting 3,000 women smallholders in Kwale County for improved passion fruit production and marketing in collaboration with the Kenya Agricultural Research Institute.	Nairobi, Kenya +254 20 273 1664 www.farmafrica.org
One Acre Fund	One Acre Fund is a social enterprise engaged in the supply of inputs to smallholder farmers, with headquarters in Bungoma, Western Kenya. One Acre Fund primarily focuses on inputs for the production of staple food crops, particularly maize, so their target beneficiaries may not be the most commercially viable market segment for drip irrigation; however, they have a broad network of smallholder customers with 136,500 farmers served across Western and Nyanza provinces and they have experimented with drip modestly in East Africa.	Bungoma, Kenya www.oneacrefund.org
GiZ	GiZ implements several agriculture sector projects in Kenya. The Food Security and Drought Resilience project runs from 2014 through 2016 and is implemented in partnership with the Ministry of Agriculture in Western Kenya, Northern Kenya, and the Mount Kenya area. Possible activities include establishing training systems that focus on agricultural intensification, such as how to increase soil fertility, control erosion, conserve water, and implement small-scale irrigation systems. And the GiZ funded Green Innovation Center in Kenya runs from 2015-2017, and seeks to support innovations in the agriculture sector to increase the incomes of small-scale farming enterprises.	Nairobi, Kenya Hendrik Linneweber giz-kenia@giz.de

JICA Smallholder Horticulture Empowerment Project	In collaboration with the Ministry of Agriculture and the Horticulture Crops Development Authority, this project runs from 2009-2018 with the objective of promoting farming as a business to transform 13,000 commercially oriented smallholder production systems.	Nairobi, Kenya +254 20 2775000 ky_oso_rep@jica.go.jp

Recommendations for Future Market Opportunities

Geographic targeting: Based on agro-ecological analysis and feedback from stakeholders interviewed, the most opportunistic geographic area for expanding sales of drip irrigation equipment to small-scale producers is in the humid and sub-humid zones in Western Kenya around Lake Victoria, as well as Central Kenya around Mount Kenya. These areas experience favorable soil conditions, abundant water access, and stable output market opportunities, all of which are necessary to incentivize smallholder investment in high-value agriculture.

Farmer targeting: All stakeholders interviewed suggest that commercially oriented farmers currently producing a surplus of fruits and vegetables present an immediate opportunity; however, there are divergent views on the most opportunistic land size for targeting. Generally, those farmers possessing at least one acre (.4 ha) are viewed as those who have the potential to be commercially viable. One commercial stakeholder indicated that the best approach is to introduce very small systems (90 meters) to commercially oriented farmers who have water access and support them to properly manage this system before moving up the scale to 150 meter systems, 500 meter systems, and eventually one acre systems. This approach allows farmers to get on the "drip ladder" to experience success, and for commercial suppliers to upsell a range of products including seeds, fertilizers, agrochemicals, larger drip systems, and additional mechanization over time. Additionally, youth farmers (aged 15-30) present a particularly attractive market sub-segment for drip irrigation given their literacy, entrepreneurial attitudes, and technological aptitude.

Revolving credit fund: The financial sector's unwillingness to lend to smallholders is a major challenge for commercial suppliers to expand sales of small-scale drip equipment. One stakeholder recommended that drip irrigation suppliers need to partner with donor-funded initiatives to provide a revolving credit fund to provide liquidity to the system and buy down risk for financial institutions.

Supermarkets: Participation in supermarket channels is estimated to increase farm productivity in terms of technology utilization by 45 percent.[xxvi] Fruit and vegetable procurement from smallholders in Kenya is growing among both domestic and European supermarkets, although this is typically structured through outgrower schemes or local buyer agents. Given the need for year round supply of fruits and vegetables, there is a distinct incentive for supermarkets to promote the adoption of drip irrigation among their suppliers. Further, a stable output market provides incentives for farmers to invest in drip, and also reduces risks for financial institutions to lend. Drip irrigation suppliers may find opportunity in collaborating with supermarkets, and other structured buyers, to introduce drip irrigation to their smallholder suppliers.

Solar pumps: The emergence of commercial solar equipment providers in Kenya presents strategic partnership opportunities for drip irrigation suppliers to bundle solar pumps with their existing drip irrigation products. Solar pumps have the potential to bring farmer operating costs down, making investments in drip more palatable for smallholders. Leading solar pump providers in Kenya include Sun Culture (which also offers a small-scale drip kit) and Future Pump (which does not currently have a drip irrigation product line).

Malawi: The Market for Drip Irrigation

Market Overview

The economy in Malawi is highly dependent on agriculture. More than 90 percent of the population relies on agriculture for their livelihood, and the sector contributes more than 75 percent of total national exports[xxvii]. The agriculture sector relies heavily on traditional cash crops like tobacco, tea, and sugar for its export earnings. The country is considered to possess favorable agro-ecological areas for several high-value crops including vegetables, cassava (for industrial use), paprika, citrus fruits, and bananas.

Smallholder Market Segmentation

Smallholder agriculture is estimated to contribute 84 percent of total agricultural output, while production from the estate sub-sector contributes the remaining 16 percent[xxviii]. The estate sector employs commercially oriented capital intensive production systems for tea, tobacco, coffee, sugar, and cut flowers, while smallholder production systems are primarily subsistence oriented. Smallholder farmers are heavily concentrated in rainfed production of maize, groundnuts, and select cash crops like tobacco and tea.

It is estimated that 2.8 million smallholder households cultivate approximately 4.4 million ha of land under customary land tenure. Smallholders can be classified into four different segments[xxix]:

- Chronically food deficit farmers: approximately 700,000 smallholders (25 percent of total) cultivating less than ½ ha.
- Sporadically food deficit farmers: approximately 840,000 smallholders (30 percent of total) cultivating from ½ ha to 1 ha.
- Potential surplus farmers: approximately 868,000 smallholders (31 percent of total) cultivating between 1 and 2 ha.
- Surplus farmers: approximately 392,000 smallholders (14 percent of total) cultivating more than 2 ha.

For drip irrigation, commercial providers may be best suited to targeting the potential surplus, and surplus farmers, indicating a potential market segment size of between 390,000 and 1.25 million farmers.

Geographic Market Segmentation

Malawi has a total land area of 11.8 million ha, 33 percent of which (3.62 million ha) are arable and permanent cropping area. Under the SADC Regional Indicative Strategy Development Plan (RISDP), Malawi aims to increase cropland under irrigation to 7 percent of total arable land and double the

adoption rate of proven technologies for water and land management[xxx]. Although the area irrigated in Malawi has seen a steady increase since the 1990s, the proportion of irrigated land to the total arable land remains well below the 7 percent target. The International Commission on Irrigation and Drainage indicate that only 1.5 percent, or 56,114 ha of permanent and arable cropping area is irrigated. Achieving the 7 percent target would equate to an additional 197,286 ha of land under irrigation – a substantial opportunity for irrigation equipment providers.

Past studies have identified 57 potential large-scale irrigation projects in the country, 38 of which are in the Southern region (25 of which in the Southern region are in the lower Shire), indicating that the Southern region, particularly the lower Shire offers comparative benefits for irrigation potential vs. other areas of the country[xxxi]. The majority of farmers who lack irrigation rely on rains during the wet season which generally falls from December to March.

The main districts producing high-value commercially oriented horticulture products, particularly tomato, include Mzuzu, Mzimba, Nkhatabay, Salima, Lilongwe, Dedza, Ntcheu, and Thyolo.[xxxii]

Enabling Environment

Following the Maputo declaration, the Malawi agriculture sector has seen a dramatic increase in public spending. In 2013, agriculture was reported to have received a relatively overwhelming 21 percent of the national budget[xxxiii]. However, transfers were widely seen to be in recurrent and variable costs rather than capital investments. Productivity of staple crops, particularly maize, was supported through the provision of input subsidies under the Farm Input Subsidy Program (FISP). In fact, maize attracted 71 percent of public expenditures[xxxiv]. The subsidies were provided in the form of coupons provided to farmers that were used to buy inputs from commercial suppliers, which was intended to incentivize the ag-input industry. But in recent years the program has faced difficulty – the government has been late to pay out on coupons to the private sector, and most recently, stakeholders report that they may not receive full payment for agro-inputs distributed. While the FISP program was widely lauded by the international development community for many years for its potential to address rural poverty and food insecurity, it is evident that this program has counteracted the government's objective of diversifying agricultural production, distorted private input markets by establishing farmer dependency input subsidies, and disincentivized private input suppliers from participating in the subsidy program because of late and/or insufficient payments by the government.

Agricultural production in Malawi is highly concentrated in maize, and challenges exist from the policy level to the household level in incentivizing famers to diversify.

Additionally, the FAO concludes that the policy environment in Malawi has not support producers of the key export commodities (cotton, groundnuts, tobacco, tea, and sugar) despite stated objectives of diversifying from maize and promoting agricultural exports. Market inefficiencies and exchange rates are estimated to have depressed producer prices by 30 percent in 2013.[xxxv]

High-Value Agriculture Dynamics

The average land productivity in Malawi stands at about $155/ha, which is significantly lower than the SADC average of approximately $270/ha.[xxxvi] It is therefore critical for Malawi to improve land productivity, which can be accomplished through increased yields and high-value crop diversification.

A transition to high-value crops presents a market opportunity for drip irrigation providers because smallholder farmer investment in drip irrigation can rarely be justified for staple crops intended for household consumption. Despite the obvious potential, the sector remains small and unexploited because of a lack of essential market infrastructure and support services such as credit and extension. Nonetheless, smallholder farmers account for more than 80 percent of total horticultural production, which mainly includes cabbage, tomatoes, leafy vegetables, and onions.

Smallholder horticultural land is typically less than 0.1 hectare per household and usually located along riverbeds and *dambos* (seasonal flood plains). Notable vegetable production areas include Dedza, Ntcheu, Mulanje, Thyolo, and Mzimba. Production potential is high in Rumphi, Ntchisi, Dowa, Mchinji, Zomba, and Mwanza. Vegetable export development potential exists in Kasungu, Lilongwe, and Blantyre because of their proximity to international airports.[xxxvii]

Because of a lack of year round irrigation and technical know-how, smallholder horticulture production is highly seasonal in nature – revolving around the rainy season, which generally runs from December to March. The production period for vegetables is limited to when the floods recede, before the water table drops below a level reached by shallow hand-dug wells. This results in most vegetable producers coming to market in the dry season, and failing to meet peak demand in the rainy season when supply is low. An additional challenge for horticulture production is the competition for labor between staples and horticulture during the rainy season, limiting the number of farmers that choose to produce higher value vegetables in favor of lower value maize.

The table below illustrates the ratio of staple production to high-value fruit and vegetable production in Malawi. Despite stated objectives to diversify to higher value agriculture, the period of 2010-2013 saw little relative change in staples to horticulture production, with an average ratio of staples to flowers, fruit, and vegetables of over 12.5 (meaning 12.5 times as much area is allocated to staples as fruit and vegetable)[xxxviii]. Despite the failure to diversify nationally, commercial drip distributors may in the near term identify the areas currently allocated to fruits and vegetable as the highest potential for introduction of drip irrigation technology, with a target area of over 190,000 ha in 2013.

MALAWI: AREA HARVESTED (HA)		2010	2011	2012	2013
	Cereals, Roots, Tubers	2,317,872	2,297,772	2,287,342	2,351,131
	Fruits & Vegetables	181,585	177,088	179,497	190,284
Staples to FFV		**12.8**	**13.0**	**12.7**	**12.4**

Key Drip Irrigation Actors

There are very few dedicated drip irrigation equipment distributors active in the country. One drip irrigation manufacturer was identified along with two key national agro-input providers whose extensive rural input supply network can be leveraged by stocking drip equipment in locations where high-value smallholder agriculture is common.

COMPANY	DESCRIPTION	CONTACT INFO
PipeCo Ltd	PipeCo Ltd. engages in their own molding and assembly of piping for several uses, including both large- and small-scale irrigation and construction. It specializes in small-scale drip systems ranging from 100m², 200m², 250m², and up. It is headquartered in Gabarone, Botswana with a sister company (Polytech Limitada) based in Mozambique.	Isaac Kamwendo Blantyre +265 888 821 282 +265 1 684 391 Vbs-pipeco@globemw.net
Farmers World	Farmers World carries a wide range of agricultural inputs for smallholders, including to a very small degree drip irrigation components. It operates 110 permanent stores with up to 600 "pop up" stores in key growing periods.	PO Box 1631, Lilongwe Chris Gianakis cgianakis@farmersworld.net +265 (0) 1 710 180/518
Kulima Gold	Kulima Gold is the national agro-input supplier arm of the Rab Group of companies, with 85 rural outlets across the country. Its current line of drip products is unknown but may present opportunities to expand this product offering to its smallholder customer base.	Rab Group of Companies Bashir Sama +265 (0) 888 824 703 gmc@rabmw.com

Key Challenges for Smallholder Drip Irrigation Uptake

Finance: Financial service providers tend to lend only to controlled value chains like tobacco and cotton, and only for working capital and primary inputs like seed and fertilizer. Additionally, a major constraint to credit markets in Malawi is that farmers do not have any unique identification system, so lenders have no way to track outstanding loans/defaults. Generally, financial institutions require relatively substantial risk buy-downs from donors before they will engage with smallholders. Opportunity Bank is the only bank lending to smallholder farmers outside of tobacco and cotton. They have partnered with CRS to deliver direct extension services to farmers, so this model could be expanded to include equipment loans for drip irrigation.

Willingness to pay: Farmers in Malawi have become accustomed to their inputs being subsidized through FISP and receiving handouts from donor-funded projects. With this dynamic in mind, convincing smallholders to make large capital outlays for investments in drip may prove challenging at scale.

Crop diversification: To maximize the potential of drip irrigation, farmers producing maize will need to diversify into high-value horticulture. There are significant social barriers to this shift, given the labor trade-off that producing horticulture would require. Drip irrigation offers the possibility for farmers to intensively cultivate a portion of their land year round for higher value horticulture, but this will require increasing yields on maize plots to make this land allocation palatable for farmers. Increasing maize yields and successfully transitioning to year round vegetable production will require significant farmer capacity building efforts.

Extension: Access to farm-level technical capacity building across Malawi is severely limited. Government extension services are overstretched and under-resourced. Farmer cooperatives provide basic extension, but the quality and consistency is seen to be lacking. The National Association of Smallholder Farmers of Malawi (NASFAM) provides extension approximately once a month to smallholder members growing groundnuts, soy, and maize. These services are heavily subsidized by donor efforts but the quality and consistency of the service leaves much to be desired. The Farmers Union of Malawi is focused on national level advocacy rather than practical farm-level capacity building. In all, the opportunity for commercial drip distributors to leverage existing extension services to expand uptake of drip irrigation is limited.

Key Development Initiatives

Generally, development programs have very little focus on high-value agriculture. Instead, most donor funded initiatives are currently focused on household food security, nutrition, and subsistence farming, including the production of maize, groundnut, soya, and sweet potato.

Project	Description	Contact
Feed the Future Malawi Agriculture Diversification Project	In Malawi, Feed the Future is focusing on improving the nutritional status of women and children, increasing the production and consumption of groundnuts, soy, and orange-fleshed sweet potato, and engaging the Government of Malawi to improve the policy environment. Target regions include Dedza, Mchinji, Lilongwe, Ntcheu, Mangochi, Balaka, and Machinga districts in the Central and Southern regions. A particularly relevant activity funded by Feed the Future in Malawi is expected to be the Malawi Agriculture Diversification Project (expected start late 2016, implementer TBD) – focused on transitioning to orange-fleshed sweet potato, legumes, and two other crops. There could be an opportunity for high-value horticulture, primarily in backyard gardens, to be a focus of this project, in which case drip irrigation could become a critical technology.	TBD
The Clinton Development Initiative (CDI)	The Anchor Farm Project in Malawi is working with more than 56,000 smallholder farmers to integrate commercial farming at the smallholder level. Project activities include smallholder farmer outreach, access to agro-inputs, provision of agronomic knowledge, and access to markets. Tukula Farming Company was established by CDI to manage operations of commercial farms, and provides access to low cost, high-quality inputs to more than 56,000 farmers. CDI Field Officers, with the help of lead farmers in CDI's farmer groups and associations, illustrate the benefits of using certified seed, implementing conservation climate-smart agriculture practices, investing in fertilizer and agro-chemicals, and practicing other advanced agronomic techniques. There may be opportunity for drip irrigation distributors to access the network of outgrowers to introduce drip technology.	https://www.clintonfoundation.org/about/contact-us
DfID Malawi Oilseeds Sector Transformation (MOST)	MOST is a £6 million, four-year (2013-2017) program funded by the UK Department for International Development that aims to increase the incomes of 60,000 farmers and entrepreneurs in Malawi's cotton, groundnut, soybean, and sunflower markets. MOST's portfolio of interventions focuses on facilitating improved access to farm inputs, including better quality seed and pesticides, and improved access to agronomic information. MOST is also marketing and distribution systems in farm input and crop output markets. While oilseeds are not ideal crops for smallholder drip irrigation, the production systems would undoubtedly benefit from year round production and efficient water use. Additionally, the MOST project is committed to introducing transformational technologies to smallholders through the private sector, so this could be a compelling opportunity for commercial distributors to explore partnership opportunities.	http://www.most.mw/ 2nd Floor, Nedbank Building, City Centre, Lilongwe, Malawi POSTAL: Private Bag 382, Lilongwe, Malawi +265 1 775 787, +265 1 775 691

Recommendations for Future Market Opportunities

The most immediately compelling opportunity for commercial drip distributors interested in entering or expanding operations in the Malawi market is to explore partnership opportunities with entrenched national-level agro-input suppliers like Farmers World and Kulima Gold. These companies have a significant rural presence and established relationships with smallholders in key production zones, enabling rapid access to a potential customer base. Additionally, these input supply shops have expressed interest in expanding the technical services they provide to smallholders, so cost-sharing a drip technician in key rural depots could prove a promising investment.

Based on the key vegetable production areas, drip distributors would be best served targeting the Southern region, particularly the lower Shire. The smallholder market segment with the greatest potential opportunity appears to be surplus or potential surplus producers cultivating one hectare or more.

Mozambique: The Market for Drip Irrigation

Market Overview

Agriculture contributes about 31 percent of Mozambique's GDP, and more than 80 percent of the population derives its livelihood from agriculture. Crop production accounts for 78 percent of agricultural GDP, and food crops account for 90 percent of total crop production. Agricultural production is almost entirely dominated by smallholders, with more than 95 percent of the total farming area cultivated by an estimated 3.8 million small-scale farms, with a national average cultivated area per household of only 1.4 hectares.[xxxix] The vast majority of crop production, particularly for staple foods, is rainfed. Only 2.5 percent of arable land in Mozambique is irrigated, and the World Bank has estimated that more than 3 million hectares have the potential to be irrigated, with groundwater and major river systems largely unexploited. Irrigation is mainly undertaken for sugarcane production and rice, with a smaller proportion utilized for horticulture production. Although cash crops like sugarcane, cashew, tobacco, and cotton are commonly grown by smallholders, more than two-thirds of agricultural production is for home consumption. Smallholders account for 99 percent of national horticulture production, focused primarily in the areas of the Beira Corridor in central Mozambique, and the Nacala Corridor in northern Mozambique.

Smallholder Market Segmentation

There are estimated to be 3.8 million smallholder farms with an average cultivated area across the country of approximately 1.4 hectares. Smallholder farmers account for more than 96 percent of the cultivated land across the country. While 84 percent of smallholder production area is allocated to food crops for household consumption, an estimated 16 percent of smallholder land is allocated to cash crop production, particularly cashew, cotton, tobacco, and horticulture.[xl] It is estimated that approximately 50 percent of smallholder farmers who grow horticulture sell their surplus produce, but potentially only 8 percent of horticulture grown by smallholders is marketed.[xli] Below is a table outlining farm size segmentation nationally[xlii]:

	Small-scale farms	Medium-scale farms	Large-scale farms
# of farms	3,801,259	25,654	841
Total cultivated land (ha)	5,428,571	130,651	73,565
Avg cultivated land/farm (ha)	1.43	5.09	87.47

The small and medium scale farming sector can be further segmented as follows[xliii]:

Cultivated land holdings	Percent of total segment	# of farm households
<1 ha	34	1.3 million
1-2 ha	37	1.4 million
2-5 ha	25	950,000
>5ha	3	115,000

Smallholder land tenure systems typically vary by region, as illustrated by a CGAP survey seeking to segment the smallholder market for financial service, illustrating the potential bankability of smallholders geographically[xliv]:

Land tenure type	Northern region	Central region	Southern region
Individual lease/certificate	25 percent	23 percent	24 percent
Individual customary tenure	50 percent	42 percent	38 percent
Communal land	6 percent	22 percent	2 percent
State, other, or don't know	13 percent	6 percent	11 percent

These efforts to segment the market suggest that those farmers growing cash crops and/or market oriented horticulture on >1 ha of land with individual land certificates are likely the most commercially viable farmers to invest in drip irrigation technology.

Geographic Segmentation

Drip irrigation is most appropriate in geographies suitable for high-value agriculture. Mozambique is a very large country with diverse crop production by region, because of geographic variations in rainfall, temperature, soil type, and market access. The country can generally be divided into three geographic regions as follows, with corresponding administrative provinces, agro-climatic conditions, and primary cropping patterns:

Region	Provinces	Agro-climatic conditions	Main Food Crops	Main cash crops
North	Niassa, Cabo Delgado, Nampula	Sub-humid, 1,000-1,800mm/yr	Cassava, maize, rice, sorghum, beans	Tobacco, cotton, cashew, groundnut
Central	Zambezia, Tete, Manica, Sofala	Sub-humid, humid 1,000-1,200mm/yr	Cassava, maize, rice, beans, sorghum, millet	Tobacco, cotton, horticulture
South	Inhambane, Gaza, Maputo	Semi-arid, arid 400-1,000mm/yr	Cassava, maize	Limited/none

The most fertile areas are in the northern and central provinces. The majority of agricultural production takes place in the north, although market access is more limited north of the Zambezi River. The central region also has good potential for high-value agriculture with relatively fertile soils and many river bodies available for irrigation water. The central region, across the Beira Corridor, and in the northern region, across the Nacala Corridor, particularly around Nampula, are the most important areas for several horticultural products, particularly fresh vegetables.

Currently irrigated areas lie mainly in the central and northern regions, with the Zambezi river basin accounting for nearly 60 percent of the total area irrigated. Irrigation infrastructure is mainly found in Gaza, Zambezia, Tete, and Manica.[xlv] Although the International Commission on Irrigation and Drainage estimates that about 117,000 ha of land are currently irrigated, the World Bank reports that only about 37,000 ha are actually irrigated, mainly through large-scale public, donor-funded small-scale, and farmer-led micro-irrigation schemes. The main crops grown under irrigation are sugarcane, rice, and vegetables. The remainder of the farms in the country are reliant on rainfall during the wet season, which runs from December to April.

Most smallholder horticulture producers do not sell their produce through formal channels, but those that are connected to existing outgrower schemes present a market opportunity for drip irrigation.

The Beira corridor (Tete, Manica, and Sofala) has the largest area of horticulture production with more than 220,000 ha, followed by the Nacala corridor (Nampula) which has approximately 99,000 ha of land allocated to horticulture, and the Maputo corridor, which has approximately 65,000 ha allocated to horticulture.[xlvi] In the Nacala corridor specifically, there are an estimated 200,000 semi-commercial smallholders, cultivating an average area less than 1 ha each. At least 10 percent of these smallholders (20,000) are reported to be market oriented, and on average cultivating .25 ha of vegetables.[xlvii]

Enabling Environment

Mozambican drip distributors are faced with similar regulatory burdens as seen in other East and Southern African countries. Namely, importing drip equipment is meant to be VAT and duty free given the government's support of small-scale infrastructure development; however, the reality often differs in practice. Stakeholders interviewed indicated that if they import individual irrigation components then they are almost certain to be charged VAT and import duties. Bringing a full irrigation scheme in will not be subject to VAT or duties. Nonetheless, for those distributors importing equipment from South Africa, where the Netafim brand of equipment has manufacturing and warehousing facilities, then imports should be duty free according to the SADC regional trade agreement.

Additionally, drip stakeholders in Mozambique highlighted the challenges caused by major foreign exchange deficits and the restrictions on foreign currencies. It has been reported that the government is confiscating US dollars to assist in covering their foreign exchange deficit, which places undue burdens on trade in imported equipment and other agro-inputs.

High-Value Agriculture Dynamics

The Mozambican agriculture sector is dominated by staple food production, with more than 3.1 million ha dedicated to cereals, roots, and tubers; however, as the table below illustrates, land allocated to higher value fruits and vegetables has risen by 10 percent since 2010, and now reflects a total size of nearly 220,000 ha nationwide.[xlviii]

		2010	2011	2012	2013
	Cereals, Roots, Tubers	4,123,043	4,242,991	3,164,385	3,162,531
	Fruits & Vegetables	199,640	204,558	229,795	219,609
	Staples to FFV	**20.7**	**20.7**	**13.8**	**14.4**

The horticulture sector is dominated by smallholders, with 83 percent of the total area under production in small-scale production systems.[xlix] The World Bank estimates that about 36 percent of all farming households produce vegetables, but only 8 percent of smallholder vegetable produce is sold. Further, more than 90 percent of smallholder horticulture that is sold channels through informal markets, as smallholder farmers are unable to meet the quality, quantity, and consistency requirements of higher value buyers like domestic supermarkets, hotels, and restaurants[l].

During the rainy season surplus production floods the market causing volatile prices and low farmer returns. Smallholder vegetable production is usually irrigated during the dry winter season, as 52 percent of horticulture producers report that they use some form of irrigation system, although the majority use manual (buckets, watering cans) irrigation in lowlands and gravity fed furrow methods in hilly areas.[li] In the Nacala Corridor, only 49 percent of horticulture smallholders have access to year round water, as the rivers dry up in the hot season, and only 15 percent of these smallholders are estimated to have the capacity to buy or rent a pump for mechanized irrigation – the remainder rely on

gravity irrigation in hilly districts (Malema, Ribaue), and buckets or watering cans in the Eastern Lowlands.

Surplus horticulture producers in the Nacala Corridor are reported to generate an annual gross income of only $272[lii], far below the economic potential that year-round intensive horticulture production should return. These producers are focused on a limited range of vegetables including onion, tomato, cabbage, pepper, kale, and lettuce. Despite the majority of smallholder horticulture producers reporting that they use improved inputs (seeds, fertilizers, and crop protection), average yields remain well below potential.

Key horticulture processing companies across Mozambique include: Companhia de Vanduzi in Manica, Farm Fresh in Tete Province, Bananalandia in Maputo province and Matanuska in Nampula Province. Commercial drip irrigation providers should explore collaboration with these companies to extend drip equipment to their smallholder outgrowers and suppliers.

In addition to horticulture production, stakeholders have indicated that there are latent opportunities to introduce drip irrigation to smallholder outgrowers of cowpea seed in the Nacala Corridor. This output market has the potential to yield significantly higher farm-gate prices for farmers than grain, but requires consistent and predictable water application in an area that is prone to occasional drought. Importantly, domestic seed buyers have high quality standards that farmers must meet, and smallholders have been known to engage in side-selling in circumstances of rising grain prices relative to seed prices. Nonetheless, this is a compelling market segment for small-scale drip irrigation distributors to consider.

Key Drip Irrigation Actors

There are very few commercial drip irrigation companies identified as operating in Mozambique, none of which are primarily targeting the small-scale farmer market segment; however, there are at least two national agro-input chains that have begun carrying small-scale drip irrigation equipment:

Company	Description	Contact
Empreendimentos Jones Limitada (EJL)	Based in Chimoio, this is the distributor of the Reinke and Netafim brand irrigation equipment. It is primarily targeting medium to large scale producers of key cash crops like tobacco, cotton, sugarcane, and soya. It only peripherally targets the small-scale farmer market – if a farmer approaches its branch office in Chimoio, it will sell smaller-scale systems but servicing smallholder farmers individually is seen as unprofitable given increased transport costs and lower product margins. It is beginning to explore a strategy of targeting larger scale producers and processors with smallholder outgrower schemes to introduce drip to its suppliers.	Rob Jones rob@ejlmoz.com +258 843 095 890
Polytech Limitada	Regional company based in Gabarone, Botswana with a local presence in Maputo, and a sister company in Malawi. Polytech molds and assembles its own irrigation equipment components such as water tanks and lines. The quality of its product line is unknown.	Mr. Desai +258 846 042 267
Irritech Irrigation Systems	South Africa based regional distributor of the Netafim brand product line, exclusively focused on large scale systems, including both drip and center-pivot products.	sales@irritechzm.co.zm +260 211 273 111 +260 977 791 387

Company	Description	Contact
TECAP	Established in 1989, focuses on the distribution of agro-inputs, machinery, equipment, including drip irrigation systems and pumps. Also provides technical assistance to smallholder customers.	Ave FPLM, Maputo www.tecap.co.mz
ETG	Based in Chimoio. Plans to open 23 agro-input supply shops and is currently in negotiations with Toro to carry smallholder drip kits, and is interested in discussing with other drip irrigation brand suppliers.	Sridhar T. t.sridhar@etgworld.com +258 845841035

Key Challenges for Smallholder Drip Irrigation Uptake

Extension: Smallholder farmer extension is extremely limited. Only 51 percent of horticulture producers in the Nacala corridor report to receive extension support from government or NGOs, and it is estimated that approximately 90,000 farmers in the Nacala corridor are serviced by only 12 government extension agents[liii]. Stakeholders report that government extension agents nationwide do not have the technical understanding of drip irrigation systems necessary to deliver appropriate training. The only reliable source of farmer training is from large-scale nucleus farm outgrower arrangements, particularly in the tobacco sub-sector.

Finance: Agricultural credit generally is very limited nationwide. Only 1.2 percent of horticulture producers in the Nacala Corridor, for instance, report having access to finance.[liv] Banco Terra is the only financial service provider in the north focusing on agriculture but their loan values start at $15,000. Banco Opportunidad is said to provide credit lines for smallholders; however, stakeholders report that in practice, they are reluctant to disburse loans. GAPI is an investment society implementing donor funded initiatives focusing on financing for producers in the Nampula "green belt" but they are reported to be slow and bureaucratic. Drip irrigation stakeholders report that banks and financial institutions are not willing to lend for private irrigation schemes under 500-600 ha.

Output market access: The majority of smallholders, even horticulture farmers, produce for household consumption. Those who are market oriented have difficulty accessing higher value market segments. They are unable to meet the supply requirements (quality, quantity, consistency) of structured buyers, and returns in informal domestic markets are low. Low returns are also because of poor quality resulting from limited rural transportation infrastructure and bringing product to market during supply gluts when prices are volatile. The returns experienced from intensive vegetable production make smallholders reluctant to invest in upfront and operating costs for mechanized drip irrigation.

Water availability and quality: Most smallholder vegetable farmers have only seasonal access to water through open water bodies which dry up in the summer months. Boreholes are an option in central and northern regions; however, their expense is out of reach for the small-scale farming sector. Shallow wells are not believed to be a viable option in the drier areas of central and northern Mozambique. One irrigation stakeholder also reported that water quality in Manica and Tete are major issues because of the downstream sedimentation from gold mines. This means drip filters and lines fail more quickly than with a good quality source of water.

Key Development Initiatives

Project	Description	Contact
Feed the Future SEEDS Project	With funding from Feed the Future Partnering for Innovation, this initiative seeks to introduce drip irrigation to smallholder cowpea seed producers in the Nacala corridor. This project was forced to import drip irrigation equipment from the United States because small-scale irrigation equipment suppliers were not identified in Mozambique. Drip irrigation distributors operating in Mozambique can explore partnerships for the provision of equipment for future pilots under this initiative.	NCBA/CLUSA Nampula Pippy Gardner pgardner@ncbaclusamoz.org
TechnoServe Promoting Export Quality Horticulture Project	Implemented in Inhambane province, with support from Irish Aid, this project is designed to stimulate inclusive growth of the horticulture sector while enhancing the long-term resilience of the poorest households. The program is growing a network of nucleus and outgrower farmers who are generating income by producing export-quality horticulture crops.	Av. Zedequias Manganhela No. 267 5 Andar, F6 Prédio Jat, Maputo +258 213 26171/73
Feed the Future Mozambique Agriculture Project	A multi-year smallholder agriculture commercialization initiative is currently in the pipeline and expected to be tendered in 2016 or 2017.	TBD

Recommendations for Future Market Opportunities

Geographic targeting: The Central and Northern regions of Mozambique present the highest potential for introducing drip irrigation to smallholder horticulture producers. The Beira corridor (Tete, Manica, and Sofala) possesses more than 220,000 ha of smallholder horticulture land, followed by the Nacala corridor (Nampula), which has approximately 99,000 ha of smallholder horticulture land. Initial efforts to introduce drip irrigation should focus on smallholder lands around the Zambezi river basin where 60 percent of all existing irrigation schemes are operating.

Smallholder targeting: Not all 3.8 million smallholders in Mozambique represent a viable market for drip irrigation; in fact the vast majority of them do not. A more reasonable assumption is for commercial drip suppliers to target market oriented farmers holding from one to five ha, with individual land certificates, growing either cash crops under an existing outgrower scheme or those producing horticulture for sale through domestic market channels. In the Nacala corridor alone, there are estimated to be 20,000 smallholder farmers producing horticulture for urban local markets. These farmers, as well as their counterparts in the central region of the Beira Corridor, present the highest potential market segment for adoption of drip irrigation.

Partnerships with nucleus farms and processors: Many smallholders across central and northern Mozambique are engaged in outgrower arrangements with nucleus farms and to a lesser extent, domestic processors. These buyers have a vested interest in developing a year-round supply base. Where water is accessible, drip technology will enable their suppliers to do so. Drip suppliers can partner with these buyers to extend drip equipment to high performing outgrowers.

Seed outgrowers: The SEEDS project has identified a potentially substantial opportunity to introduce drip irrigation to small-scale cowpea seed outgrowers in the Nacala Corridor. The project indicated an interest in sourcing equipment locally if they were able to collaborate with a domestic drip distributor.

Rwanda: The Market for Drip Irrigation

Market Overview

Rwanda is a small, densely populated country that relies on agriculture. More than eight million Rwandans (80 percent of the country) depend on agricultural production, and the sector contributes about 34 percent to national GDP[lv]. Although nearly 80 percent of the country is classified as agricultural, only 11 percent (2,700 sq. km) is actually permanent cropping land – the remaining area is forests, marshland, and shifting agriculture on hillsides. Production is dominated by upland, small-scale production systems reliant on seasonal rainfall, with 80 percent of landholdings totaling less than one ha, and 70 percent on hillsides.[lvi] With about 2.3 million ha of arable land, approximately 40 percent is allocated to food crops, and 34 percent is allocated to cash crops.[lvii] The main staple food crops grown by smallholder farmers include banana, sorghum, beans, and cassava. Irish potatoes and fruits and vegetables are emerging as important smallholder crops, while coffee and tea continue to be the main cash crops, generating 70 percent of agricultural export earnings. A mere 0.06 percent of the country's cropping area is estimated to be irrigated[lviii].

Smallholder Market Segmentation

Rwanda is the most densely populated country in Africa, averaging more than 400 individuals per square km, so landholdings are highly fragmented. The average landholding in Rwanda is 0.76 ha; however, this area is generally divided into four or five smaller plots dispersed across multiple locations to diversify against covariate natural risks. [lix] This further fragmentation leads to low productivity, low volumes, and a general cycle of subsistence rather than commercialization.

> Land holdings in Rwanda are highly fragmented, but there is a segment of smallholder farmers that is suitable for drip irrigation adoption.

Nonetheless, Rwandan smallholders are not homogeneous, and it is possible to segment the small-scale farming sector into three distinct categories based on landholding size[lx]:

- Smallest size: 36 percent of households (approximately 2.9 million individuals) control 6 percent of agricultural land, with an average landholding of 0.11 ha.
- Medium size: 30 percent of households (approximately 2.4 million individuals) control 25 percent of agricultural land, with an average landholding of 0.6 ha.
- Largest size: 24 percent of households (approximately 1.9 million individuals) control 70 percent of agricultural land, with an average landholding of 2 ha.

Average landholdings can be misleading for estimating commercial viability given the predisposition of farmers to continuously subdivide their holdings into smaller plots, placing increasing pressure on smaller segments of land. Nonetheless, for commercializing drip irrigation, the category of farmers with an average landholding of 2 ha are estimated to be the most viable target market.

Stakeholders in Rwanda further recommend that those producers with sub-plots of at least one acre (0.40 ha) allocated to market oriented fruits and vegetables (tomatoes, cucumber, watermelon) can be considered commercially viable and represent a suitable target market for drip technology.

Geographic Segmentation

Rwanda possesses a land area of nearly 25,000 square km, at an average altitude of 1,250 meters, with 850,000 ha of cultivated area. [lxi] The vast majority of smallholders rely on two rainy seasons–from March to May, and from September to December. The area allocated for food consumption is estimated to make up 92 percent of the total, with bananas accounting for 28 percent, beans accounting for 21 percent, sorghum accounting for 10 percent, sweet potatoes accounting for 12 percent, and cassava accounting for 8 percent. Export oriented cash crops make up the remaining 8 percent of land with coffee accounting for 6.3 percent and tea accounting for 1.6 percent.[lxii]

The lowlands in the east are viewed by stakeholders interviewed as the most viable area for horticulture production, and therefore expansion of the drip technology. This area has available freshwater from the swamps/marshlands, and is dominated by larger-scale commercially oriented producers growing fruits and vegetables, pointing to the opportunity for expanding sales of drip. It is estimated that about 13,000 ha of the eastern swamp lands are currently under some rudimentary form of irrigation including water diversion, headworks, and furrow methods. [lxiii]

Stakeholders also indicate that production of export oriented Irish potatoes has expanded significantly in the hilly areas of the North and West Provinces over the past several years. The rate and area of upland irrigation is not known; however, smallholders in these areas practice several water and soil conservation methods such as grass strips, erosion ditches, hedgerows, and terracing.

Enabling Environment

The Government of Rwanda is widely reported to have paternalistic and authoritarian tendencies relating to central economic planning, including in the agriculture sector. As such, investing and operating in Rwanda require close collaboration with relevant government ministries. The government has prioritized the intensification of smallholder high-value agriculture to improve productivity and competitiveness, and in response has established the Rwanda Horticulture Development Agency (RHODA) in 2007 to work alongside a 'one-stop shop' for investment promotion in Rwanda, the Rwanda Development Board (RDB)[lxiv]. Both of these enabling institutions will be important partners to facilitate market entry or expansion of small-scale drip irrigation.

The Rwandan government is serious about encouraging smallholder high-value agriculture and drip irrigation adoption, but its approach has met with limited success.

Stakeholders interviewed in Rwanda indicate that the government has been serious about encouraging small-scale irrigation for high-value horticulture in both policy and practice. As such, imports of drip irrigation equipment are not subject to duties or VAT. The government also established a 50 percent

subsidy for small-scale irrigation equipment; however, the retail pricing of drip equipment established by the government for commercial suppliers was lower than the landing price of the equipment in Kigali, so commercial providers were unable to profitably participate, and now the program is reported to be 'on hold'.

High-Value Agriculture Dynamics

Fruit and vegetable production systems are seen by stakeholders as the most viable target for small-scale drip irrigation. Nonetheless, this remains a relatively small percentage of the land under cultivation in Rwanda. While bananas are produced widely by smallholders, they are grown as a food crop with low levels of input intensity rather than as a commercially oriented crop. As such, it is not recommended by stakeholders in Rwanda as a primary focus for the expansion of small-scale drip irrigation. Irish potatoes grown in the northern uplands, and fruits and vegetables such as tomatoes, cucumbers, and watermelon grown in the lowland plains and converted marshlands of the east are seen as the focus for expanding horticulture under drip.

While fruits and vegetables are historically available in local markets, there was little formal development of the horticulture sector prior to 2007. The government established RHODA to operate alongside the Ministry of Agriculture and the Rwanda Development Board to promote investment in and development of the horticulture sector. Additionally, horticulture crop research is led by the Rwanda Agricultural Research Institute (ISAR). There are reported to be a small number of medium-scale investors in horticultural contract farming and processing, including Gérard Sina's Urwibutso Enterprises, Shakina Enterprises and Inyange Industries (a subsidiary of Crystal Ventures Ltd.).[lxv] In terms of inputs, there is reported to be a network of rural agro-dealers operating across the country, but horticulture inputs are only available in the burgeoning production areas of the east. These dealers have limited inventory, weak technical capacity, and no experience with drip irrigation.

Key Drip Irrigation Actors

There are two dedicated commercial suppliers of small-scale drip irrigation identified in Rwanda:

Company	Description	Contact
Balton Rwanda	Balton is viewed as the market leader in drip irrigation because of limited competition, its range of products suited to Rwandan producers on small-scale plots, and its efforts to educate smallholders on the opportunities provided by drip. It provides very small-scale kits (8m x 15m and 8m x 24m) as part of an all-inclusive package of necessary inputs including hybrid seed, fertilizer, and crop protection. Balton reports that it has several sales/extension agents operating in the east and north of the country, and invest in demonstration events to raise awareness among smallholder horticulture producers.	Bob Gatera bob@balton.co.rw +250 788 30 8826 +250 758 88 8800
Jain Irrigation Systems Ltd (JISL)	As the world's second largest manufacturer of drip irrigation equipment, Jain was reported to have entered into partnership with the Rwandan government in 2011 to expand access to drip for smallholders. The level of its current commercial activities in countries is unknown.	Head Office Jain Plastic Park, NH No. 6, Bambhori, Jalgaon (425 001) Maharashtra, India. Tel: +91 257 225 8011 http://www.jains.com/Reachus/reachus.htm

Key Challenges for Smallholder Drip Irrigation Uptake

Farmer knowledge: Rwandan smallholder farmers have yet to recognize the market window opportunity for bringing horticulture crops to market in the dry season (May to September), and if they have, they have little or no technical experience with mechanized irrigation. There is therefore a need for both awareness and technical capacity building among smallholders currently producing a market-oriented surplus of horticulture products.

Finance: Financial institutions are reported to be unfamiliar with financing small-scale equipment, and generally unwilling to lend to smallholder farmers. The World Bank suggests that efforts need to be made to raise awareness of the profitability and cash flow potential for smallholders investing in small-scale irrigation equipment.[lxvi] Currently, if banks are willing to lend, they require a 50 percent down-payment by the farmer, which they are often unable to provide. Balton indicated that they are currently working with Equity Bank to design a financing model, but on the whole, they have found that lenders 'don't want to touch it'.

Land availability and degradation: As a small country with the highest population density on the continent, Rwanda is facing a serious problem with the availability of productive lands. With steep slopes continually or rotationally cultivated, there is also a serious problem with land degradation. More than half of the country's agricultural land is estimated to present moderate to severe erosion risks[lxvii], further limiting land available for annual horticulture crop rotation. Apart from Irish potatoes in the northern uplands, the only areas of the country reported to be suitable for introducing drip irrigation are the lowland marshes in the east.

Poorly designed government subsidy program: The drip irrigation subsidy introduced by the government placed an unreasonable burden on private sector equipment suppliers to provide the technology below cost, eliminating any incentive for the private sector to provide the technology. The program was not viable, and needs to be redesigned to account for a conservative, albeit necessary profit margin for commercial suppliers.

Key Development Initiatives

Project	Description	Contact
USAID-Private Sector Development-Accelerating Growth (PSD-AG)	This $25 million project is slated to run from 2014 to 2018, and designed to increase smallholder farmer incomes by promoting private sector investments from international and domestic sources. The project is implemented by International Resources Group (IRG), a wholly owned subsidiary of Engility Corporation, and the goal of the project is to transform smallholder agriculture into a market-oriented, competitive, and high-value sector. The project focuses on the beans, maize, Irish potato, and horticulture value chains.	http://www.engilitycorp.com http://www.psdag.rw/ twitter: @psdag_rwanda Kacyiru, KG 684 St, No 19 Kigali
DfID Improving Market Systems for Rwanda (IMSAR)	This project is anticipated to start in Q4 2016, and intends for the implementing partner (TBD) to facilitate investment from private sector companies in smallholder agriculture.	TBD

Project	Description	Contact
One Acre Fund	One Acre Fund launched operations in Rwanda in 2007. It currently has 1,200 staff, and has served 106,000 farmers with agro-inputs. In four years, One Acre Fund aims to directly serve 10 percent of Rwanda's population. It focuses primarily on inputs for food crops including maize seed and fertilizer, although it also provides technical advisory services and is known to have experimented with drip irrigation.	www.oneacrefund.org Rwanda office location and local contact information not available.

Recommendations for Future Market Opportunities

Targeting strategy: Commercial suppliers of small-scale drip irrigation in Rwanda must appropriately target the market segment possessing appropriate characteristics necessary for the adoption of drip irrigation. This generally includes minimum landholding size, geographic region, and agricultural sub-sector. The market for drip irrigation appears to be most promising for those smallholder farmers capable of allocating a minimum of ~ 0.50 ha of land exclusively to market oriented horticulture. The geographic areas of interest include the eastern lowlands where relatively larger, more commercially oriented producers are cultivating fresh vegetables in areas where fresh water is available, and the northern uplands where smallholders are increasingly producing Irish potatoes.

Demonstration: Commercial stakeholders in Rwanda report that farmers need to participate in practical on-farm demonstrations on a regular basis to observe the potential of the drip technology and learn how to operate the system. Balton Rwanda is currently employing this strategy, and has found positive results in terms of farmer adoption, assuming the appropriate smallholder market segment has been targeted.

Tanzania: The Market for Drip Irrigation

Market Overview

Agriculture accounts for about 25 percent of the Tanzanian economy, contributes 85 percent of exports, and employs 80 percent of the population of 50 million. There are considered to be 44 million ha of arable land, but only 27 percent of this is currently being cultivated, so the potential to expand agricultural production is vast. Importantly, more than 80 percent of arable land is used by smallholders, amounting to more than 9.5 million hectares, while another 1.5 million ha are cultivated by medium to large scale production systems.[lxviii] IFAD also estimates that approximately 30 million ha are suitable for irrigation, but only 340,000 ha are currently irrigated, presenting significant scope for the expansion of irrigation. The majority of existing small-scale irrigation schemes are based on simple water diversion and furrow practices. High-value horticulture is increasingly dependent on small-scale producers with 70 percent of horticulture exports coming from farmers with less than 2 ha.[lxix]

Smallholder Market Segmentation

The total number of smallholder households in Tanzania according to the most recent census is approximately 5.8 million, or 98 percent of rural households. Data on the categorization of farm size and capabilities in Tanzania is limited, but the Agriculture Census suggests the following rough segmentation[lxx]:

- Small farms: 0.01 to 1.5 ha of land (55 percent of households)
- Medium: 1.5 ha to 5 ha (25 percent of households)
- Large: >5 ha (20 percent of households)

While the national average farm size in Tanzania is estimated to be 1.5 ha, those classified as small farms average only .9 ha per farm.[lxxi] Interestingly, this is nearly twice the average landholdings of small-scale farmers in Malawi and Kenya – so it is evident that land availability is not a particularly binding constraint for smallholders in Tanzania.

Drip irrigation's return on investment is high enough for smallholder horticulture producers to repay the cost of investment in one year.

Nonetheless, the average value of crop production on small farms in Tanzania is $422/year[lxxii], more than 35 percent lower than small farms achieve in Kenya. This illustrates that despite larger land holdings, productivity and commercialization of small farmers in Tanzania remains well behind that of small farmers in Kenya. The FAO also estimates that only 3 percent of small farms are irrigated, and only 3 percent of small farming households have access to motorized equipment such as pumps, pointing to the status quo methods of gravity fed furrow irrigation on small farms.

Stakeholders in Tanzania indicate that the commercially viable farmers most likely to adopt drip irrigation in Tanzania are those operating a minimum of .5 ha dedicated to higher value agriculture such as vegetables. Those farmers primarily growing staple crops of maize and rice are considered less likely to adopt drip given the allocation of output to household consumption and low economic returns on surplus production. Most smallholders are engaged in mixed farming systems where food crops dominate, but there are estimated to be 1.7 million ha of small-scale holdings dedicated to horticulture production.[lxxiii]

Geographic Segmentation

Tanzania is a vast country with a land area of 94 million ha, but only 44 percent is arable, and only 27 percent (approximately 11 million ha) is currently being cultivated. The International Commission on Irrigation and Drainage indicates that only 1.68 percent of arable permanent cropping area is currently irrigated, equating to approximately184,000 ha of irrigated land. The remainder of the country relies on seasonal rainfall. While agro-ecological conditions across the country are diverse, rainfed production systems generally rely on two rainy seasons – the 'long rains' from March to May, and the 'short rains' from November to January.

This study will not detail the agro-ecological conditions of the entire country given its diversity and significant areas unsuitable for crop production. Instead, stakeholders in Tanzania have suggested the following regions as the most opportunistic for small-scale drip irrigation adoption based on potential for high-value agriculture (particularly horticulture) because of favorable agro-ecological characteristics and access to output market channels:

Zone	Regions	Agro-ecology (rainfall)
Coastal	Pwani, Tanga, Dar es Salaam, Zanzibar	750-1,200 mm/year
Northern	Arusha, Moshi, Kilimanjaro	1,000-2,500 mm/yr
Southern Highlands	Mbeya, Iringa, Njombe, Morogoro	1,200-2,300 mm/yr

Additional desk research indicates the areas where irrigation is currently being practiced at a higher rate, suggesting greater relative water availability and higher potential to transition current irrigation schemes to drip technology. The areas with the most significant growth in irrigated production from 2003 to 2008 are Kilimanjaro, which grew from 23 percent to 36 percent and Mwanza, which grew from 4 percent to 12 percent. Also, while the national average area irrigated is approximately 3 percent, the regions with approximately 10 percent or more of households practicing irrigation are as follows:[lxxiv]

Region	Percent of households practicing irrigation
Arusha	14 percent
Kilimanjaro	36 percent
Morogoro	9.3 percent
Dar es Salaam	20.5 percent
Iringa	10 percent
Mbeya	10.5 percent
Mwanza	12.5 percent

Enabling Environment

One of the most dynamic opportunities presented for the agriculture sector in Tanzania is the Southern Agricultural Growth Corridor – an initiative led by Tanzania's government in partnership with the private sector and civil society to stimulate public private partnership investments in high-value agriculture across the main corridor running from Zanzibar through the Southern Highlands to the borders with Malawi, Zambia, and the Democratic Republic of Congo. This initiative illustrates the interest and commitment from the government to facilitate new investments from agribusinesses across key smallholder growing areas.

Additionally, and specifically related to policies around drip irrigation, the government has indicated a support for the expansion of small-scale irrigation technology; however, evidence from stakeholders in Tanzania suggest that policy has been less accommodating in practice. For instance, in the latest VAT bill a number of modern agricultural implements which were once VAT exempt have now been removed from exempt status. Drip irrigation equipment is included in this list of implements that are currently not considered VAT exempt. In terms of import duties, the government provides duty free import of drip equipment if it enters the country as a complete scheme; however, individual drip components are subject to import duties. This is in part because of a misunderstanding that some of these components may be used for other non-agricultural purposes such as construction. The Tanzania Horticulture Association (TAHA) is currently advocating for drip equipment to be considered VAT and duty exempt.

Additionally, importing procedures are seen by stakeholders as unnecessarily onerous and bureaucratic. Clearing orders through customs has been known to take several months to process. This places a significant burden on drip irrigation equipment distributors importing equipment from manufacturing countries like Israel (Netafim, Metzerplas, and Rivulus brands), Spain (Azud brand), Greece (Eurodrip brand), India (Jain brand), or the US (Toro brand). Stakeholders indicated that the inefficient importing procedures give a competitive advantage to the largest drip distributors who are able to hold large stocks of equipment inventory to fill orders. Other smaller distributors do not have the capital or warehouse capacity to stock significant inventory, and are therefore often unable to fill customer orders in a timely manner.

High-Value Agriculture Dynamics

The primary staple crops in Tanzania include maize and rice, while key cash crops include tobacco, cotton, coffee, tea, and horticulture (floriculture, vegetables, and spices). Stakeholders in Tanzania have indicated that commercializing small-scale drip irrigation necessitates targeting high-value crop segments, particularly the horticulture sector. This is because smallholder horticulture producers are more commercially oriented than staple crop producers. One study indicates that 88-98 percent of fruits and vegetables are sold by farmers; while only 49 percent of cereals are sold by farmers.[lxxv]

As the table[lxxvi] below illustrates, a significant portion of Tanzania's agricultural land area is allocated to staple food crop production – more than six times as much land as fruits and vegetables; however, nearly 1.3 million ha of land are allocated to fruits and vegetables, indicating a substantial area of land on which drip irrigation can be introduced.

TANZANIA: AREA HARVESTED TO STAPLES VS. FFV		2010	2011	2012	2013
	Cereals, Roots, Tubers	6,869,653	7,365,637	7,952,209	8,111,230
	Fruits & Vegetables	1,190,410	1,313,155	1,248,040	1,288,618
	Staples to FFV	5.8	5.6	6.4	6.3

Additionally, the potential year-round returns from horticulture products are considered higher than bulk oriented (and traditionally rainfed) cash crops, thus enabling smallholders to rapidly pay back investments in drip technology. To illustrate this further, the USAID Tanzania Agriculture Productivity Project (USAID-TAPP) estimates smallholder returns from horticulture crops, as shown in the table below. Stakeholders in Tanzania estimate that the average retail cost for small-scale drip systems is around $1,000/acre (approximately 0.4 ha). Based on the expected farmer return analysis below, smallholder horticulture farmers investing in drip irrigation should be expected to repay the cost of the system within the first year of operations.

KEY HORTICULTURE CROPS	CYCLE, NET INCOME, RETURN ON FARMER INVESTMENT
Onion	13 weeks, $3,200/acre, 302 percent ROI
Passion fruit	24 months: $6,400/acre/yr, 171 percent ROI
Sweet pepper	24 weeks: $4,100/acre, 120 percent ROI
Avocado	Perennial: $400/acre/ year, 85 percent ROI
Tomato	20 weeks: $2,900/acre, 79 percent ROI
Pineapple	15 months: $3,300/acre, 77 percent ROI
Irish potato	13 weeks: $1,200/acre, 68 percent ROI
Cabbage	14 weeks: $1,000/acre, 61 percent ROI
Carrot	11 weeks: $1,800/acre, 60 percent ROI
Watermelon	10 weeks: $900/acre, 55 percent ROI
Banana	12 months: $2,400/acre, 54 percent ROI

Domestic and regional market channels make up approximately 80-90 percent of total production volumes, while extra-regional exports account for about 10-20 percent.[lxxvii] The primary domestic market channels for fruits and vegetables are both high and low value domestic markets, including urban local markets in Dar es Salaam, Arusha, and Iringa; fruit and vegetable processing companies; and emerging supermarket chains. There is also substantial informal cross-border trade of fruits and vegetables with neighboring countries in East and Southern Africa such as Zambia, Mozambique, Kenya, and Malawi.

Additionally, export market channels for crops such as avocado are primarily destined for European markets; however, the Middle East presents yet to be fully exploited potential as an export destination for many horticulture products. Access to reliable infrastructure including roads and ports is critical for smallholders. Those farmers in close proximity to major roads have a comparative advantage in producing fruits and vegetables, and are therefore likely to represent high potential for drip irrigation adoption.

Water is generally easily accessible in the key horticulture production areas in the north, southern highlands, and coastal regions. Smallholders are typically able to tap a relatively high water table through

shallow wells (10-30 meters), and farmers in close proximity to rivers and streams also have year round access to water, although shallow streams tend to provide irrigation water only seasonally. Water catchment ponds have also been successfully introduced by USAID-TAPP for small-scale irrigation systems in high rainfall areas.

Key Drip Irrigation Actors

There are several suppliers of small-scale drip irrigation equipment operating in Tanzania, including dedicated drip equipment distributors, diversified agro-input providers carrying drip irrigation products, and NGOs providing drip irrigation systems and components.

Company	Description	Contact
Balton Tanzania	Widely regarded as the commercial market leader for small-scale drip equipment. Distributing Netafim brand equipment, and offering several small-scale kit products ranging from 500sqm up to one acre, as well as several larger scale systems. Balton has opened a smallholder farmer training center outside of Iringa and operates a business model similar to Amiran in Kenya and Zambia. Balton is widely viewed as the market leader in Tanzania, in part because of its ability to hold large stocks of inventory and fill customer orders more rapidly than its competition.	Edan Begerano edan@baltontz.com
Agro-Rain Ltd.	Local subsidiary of Kibo Trading distributing Jain brand equipment	+255 767 669 656
Irrigrow	Operating since 2014, very much interested in and committed to expanding its product line of drip irrigation for smallholders.	Ian Samakande engsamaz@icloud.com irrigrow@gmail.com
Irrico	Based in Arusha, distributing Rivulus brand equipment, and interested in expanding its network of rural agro-dealers in high-value smallholder production areas.	Niraj Patni +255 683 249 368 Irricointernational.tz@gmail.com
Amgoo East Africa Investments Ltd.	Distributing Azud branded equipment for small and large scale schemes.	Thomas Omary +255 784 242 076 amgooeailtd@gmail.com
Positive International Ltd	Agro-dealer operating across the Southern Highlands providing equipment, seed, fertilizers, crop protection, and increasingly drip irrigation where USAID-TAPP farmers were operating.	Karan Kapoor Karan.kapoor@demeter-group.com +255 28 250 0184
Kickstart	Non-profit organization providing the MoneyMaker Hip Pump, a low cost, light-weight, portable treadle pump that requires manual labor to operate. It sells for $70, weighs less than 10 pounds and can irrigate an acre. Treadle pumps have been distributed mainly in the Mbeya, Dar es Salaam, and Morogoro regions, but sustained adoption rates of remain relatively low because of their labor intensive nature. Kickstart is also known to be developing a low-cost solar pump; however, the retail pricing of this product in Tanzania is unknown.	Plot #57, Serengeti Road/Garden Road Mikocheni B, Dar es Salaam Main: +255 022 2 773400 Other: +255 754 317111 www.kickstart.org

Additionally, mechanized pumps are widely available from rural agro-input suppliers throughout Tanzania and sell for approximately $200-$300, not including operating costs. Unbranded Chinese manufactured

pumps have generally brought the retail costs of the technology down to a point where a critical mass of commercially oriented smallholders are able to invest in the technology.

Smallholders in key horticultural areas of Tanzania have good access to water and strong potential export markets.

Key Challenges for Smallholder Drip Irrigation Uptake

Rural distribution: Availability of agro-inputs for horticulture production in Tanzania is mixed. Generally, smallholder farmers have access to fertilizers and to a lesser extent crop protection products at rural agro dealers; however, access to hybrid seed and drip equipment is limited or non-existent in rural areas. Most entrepreneurial farmers are forced to travel to major urban centers like Dar es Salaam or Arusha to purchase drip equipment. Rural sellers would present an opportunity as distribution partners; however, their technical capacity is extremely weak and they have limited capital to purchase inventory. National distributors have mostly avoided providing inventory on consignment to sellers because of low repayment rates and added administrative burdens. Without a robust rural distribution network for drip irrigation equipment, commercial supplier sales to smallholder farmers will remain limited.

Finance: Small-scale horticulture production under drip irrigation exhibits very high returns, but there continues to be a general unwillingness from financial institutions to lend to smallholder farmers. Commercial banks are not interested in loan values under $5,000, and are located in main towns without sufficient rural lender monitoring capacity, increasing transaction costs to lend to small-scale farmers. Community Banks and SACCOS are willing to provide working capital loans for inputs but have been less willing to finance equipment given higher loan values and extended repayment terms. Additional challenges with drip equipment loans are the rapid depreciation of the drip tape and filter, meaning it can't be used as collateral. Without collateral, farmers are required to put up 40-50 percent of the cost of the drip system up-front which is not possible for most small-scale farmers.

Extension: Most drip distributors in Tanzania do not provide installation services or ongoing after sales support to small-scale farmer customers. Balton Tanzania is the only known distributor providing this service, but training is provided at a centrally located demonstration farm outside Iringa so only a small number of farmers have access. Farmers practicing high-value agriculture production also need comprehensive training in good agricultural practices to maximize returns from drip irrigation. Government extension is not seen as a viable option given officers' limited capacity and resources. Rural agro dealers are reported to have decent agronomists on staff, but they are understaffed and cannot cover all of their customers comprehensively. National agro-input distributors have sales staff that double as extension agents, and this model presents promise, but most companies seek to keep transaction costs down, effectively limiting the value their agents can provide to customers. USAID-TAPP was widely viewed by relevant ministries as the highest quality source of smallholder farmer extension for horticulture in the country, but this project ended in August 2015.

Key Development Initiatives

PROJECT	DESCRIPTION	CONTACT
Tanzania Horticulture Association (TAHA)	A private sector apex member association representing horticulture stakeholders across the country. TAHA advocates for the horticultural industry in Tanzania, and it has consistently identified drip irrigation as a critical technology for the growth and competitiveness of the small-scale sector. TAHA also implements horticulture advocacy projects for USAID, DANIDA, and other interested donors. It regularly partners with the private sector to expand smallholder access to technology.	Jacqueline Mkindi Kanisa Road, House #49 Arusha Tanzania. +255 (27) 2544568, +255 (27) 2544568 info@taha.or.tz
Commercial Agriculture for Smallholder Farmers in Horticulture (CASH)	This project is funded by the EU and implemented by VSO in Zanzibar to support smallholder horticulture producers to improve production practices, increase access to production technology, and access markets.	Kahama Rd, Dar es Salaam, Tanzania +255 22 260 0053 vsotanzania@vsoint.org
IFC 2030 Water Resources Group	In early 2016, 2030 Water Resources Group developed a MoU with the Ministry of Water to address Tanzania's water resource management challenges. It is working with the Financial Sector Deepening Trust (FSDT) which is looking to explore options to develop an irrigation financing facility aiming to boost agricultural and water use efficiency in Tanzania. It is partnering with Matchmaker Group to facilitate private sector and development partner interest and collaboration.	IFC Tanzania P. O. Box 2054 50 Mirambo Street, Dar es Salaam www.2030wrg.org Matchmaker Group Henri van der Land henri@matchmakergroup.com
USAID Feed the Future Mboga na Matunda	As the follow-on project to USAID's successful Tanzania Agriculture Productivity Project, MnM will be a five-year $25 million dollar initiative to support small-scale horticulture production technology adoption throughout key production areas including Morogoro, Mbeya, Iringa, Dodoma, and Zanzibar.	TBD

Recommendations for Future Market Opportunities

Geographic targeting: Commercial drip distributors should prioritize the targeting of smallholder horticulture production areas where higher than average rates of irrigation are currently being practiced, including Arusha and Kilimanjaro in the North; Morogoro, Iringa, and Mbeya in the South; Dar es Salaam on the coast; and Mwanza around Lake Victoria.

Sector targeting: The horticulture sector presents the most significant opportunity for commercializing drip irrigation with smallholder farmers. The FAO and IAEA are also piloting an initiative to introduce drip irrigation to small-scale tea producers who currently rely on rainfall (80 percent) and overhead sprinklers (20 percent). They indicate that drip irrigation provided a tea yield 17 times higher than rainfed yields, and twice that of sprinklers, with only half the water. This initiative is operating in southern tea growing areas of Mbeya region. The tea sector may present a compelling secondary opportunity for commercial drip distributors.

Collaboration with IFC Water Resources Group: The IFC Water Resources group is undertaking a detailed scoping for a proposed irrigation financing facility. This will prioritize combinations of crops, farmers, irrigation technologies, and potential financing products (type, duration, rate or return, loan size). Drip irrigation distributors should contact MatchMakers Associates, a consulting company hired by IFC to facilitate this initiative, to ensure that small-scale drip irrigation is appropriately considered.

Collaboration with USAID Mboga na Matunda: Drip distributors should collaborate closely with the USAID-funded Mboga na Matunda project when it begins sometime in 2016 to expand small-scale drip irrigation demonstrations to smallholders, expand rural distribution networks in areas where the project is operating, and pilot equipment credit schemes with willing financial institutions. Equity for Tanzania has expressed an interest in expanding equipment credit products for smallholder farmers.

Zambia: The Market for Drip Irrigation

Market Overview

The Zambian economy relies on agriculture for 40 percent of GDP, 12 percent of exports, and 67 percent of the labor force.[lxxviii] Zambia is considered to possess abundant natural resources for commercial agriculture, yet maize and cassava are the dominant crops, accounting for approximately 75 percent of national crop production. There are estimated to be approximately 150,000 hectares of land covered by irrigation, primarily for wheat, sugar cane, vegetables, and fruit.[lxxix] Zambia's agriculture sector is dominated by smallholder production. While 90 percent of smallholder production is rainfed, the IFC estimated in 2014 that the promotion of irrigation technologies for smallholders would add 75,000 hectares of irrigation land, representing a potential market of $30 million dollars.[lxxx]

Smallholder Market Segmentation

The vast majority of Zambia's smallholders are asset poor, cultivating staple crops (maize, groundnuts, roots, and tubers) for subsistence, utilizing simple production technologies and employing traditional cultivation practices. These asset poor households cultivate on average less than 5 ha, with the majority cultivating less than 2 ha. It is estimated that less than 50 percent of smallholders sell their crops in any given year.[lxxxi]

Approximately 1.15 million smallholder households grow crops in Zambia.[lxxxii] While precise numbers of farming families by scale classification varies from study to study, the commercial potential of different smallholder segments may be generalized as follows[lxxxiii]:

- **Poor and very poor:** Representing approximately 460,000-690,000 households (40-60 percent of smallholders), these families typically cultivate less than 1 ha of staple food crops. They are chronically food insecure and not commercially oriented.
- **Middle:** Approximately 230,000-345,000 households (20-30 percent of smallholders), these families cultivate between 2 to 5 ha of both food and cash crops. They sell small surpluses in years with good rainfall.
- **Emergent farmers:** Approximately 50,000-120,000 households (5-10 percent), these producers cultivate from 5 to 20 ha and are primarily market oriented, some practicing irrigation.

Some estimates indicate about 150,000-200,000 smallholder farmers participate in contract farming and outgrower schemes for cotton, tobacco, paprika, and vegetables. Although some smallholders have experience with commercial agriculture, this does not automatically mean that they are commercial smallholders. Zambian smallholder farmers engaged in commercial arrangements such as outgrower schemes often continue to lack essential entrepreneurial skills necessary to operate their farm as a business, as they are dependent on inputs provided by the buyer.

Geographic Market Segmentation

Zambia possesses 75.3 million hectares of land, of which 2.4 million hectares are arable permanent cropping area. According to the International Commission on Irrigation and Drainage, only 6.5 percent, or 155,856 ha, are under irrigation. The vast majority of smallholder farmers rely on the primary rainy season that runs from November to April.

The agricultural heartland of Zambia is comprised of the Southern, Central, Lusaka, Eastern, and Copperbelt Provinces, which yields approximately 80 percent of total national food production and the majority of key cash crops like cotton, tobacco, and sugar. There are three major agro-ecological zones in Zambia[lxxxiv]:

- Zone I experiences low rainfall in the Southern and Western Provinces bordering Zimbabwe. This is the hottest, driest, and poorest zone in Zambia. Soils are sandy with poor fertility. Maize, sorghum, groundnuts, sunflowers, and cowpeas are the primary crops cultivated.

- Zone II experiences medium rainfall spanning east-west through the Central, Lusaka, Southern and Eastern Provinces. It presents favorable soil quality, ample irrigation potential, and close proximity to transport infrastructure and urban markets. Higher value fruits and vegetables are often grown here, as is maize, beans, groundnuts, sorghum, and cassava.

- Zone III experiences high rainfall in the provinces of Copperbelt, Luapula, Northern and Northwestern Provinces. This area presents significant water resources from the Luapula and Mansa rivers, and several lakes, with potential for irrigation. Staple foods are the primary crops grown in these areas.

Approximately 40 percent of smallholder households (460,000) reside in the high rainfall Zone III while another 40 percent (460,000) reside in the high potential agro-ecological Zone II, and about 20 percent (230,000) reside in drought-prone Zone I.[lxxxv] The geographic areas associated with a greater prevalence of commercial smallholder production are, as expected, in close proximity to the key trade corridor from the border with Zimbabwe, through Lusaka, up towards the northern Copperbelt. The combination of good agro-ecological conditions, better than average infrastructure, and proximity to urban markets presents this corridor as the most dynamic area for commercial smallholder production.

Although the average landholding across Zambia is approximately 3.05 ha per household, this figure varies by geography. The table below outlines average landholdings per household by province[lxxxvi]:

Province	Average Landholding (ha)
Central	3.23
Copperbelt	3.18
Eastern	2.20
Luapula	2.61
Lusaka	1.98
Northern	6.54
Northwestern	1.70
Southern	2.40
Western	1.75

Enabling Environment

Growth in irrigation has been, to a certain extent, supported by the government's removal of VAT and import duties on irrigation equipment, substantially boosting imports. Commercial drip distributors in Zambia import primarily from South Africa (where Netafim has manufacturing and warehousing), Israel (where Metzerplas, Rivulus, and Netafim are manufactured), and India (where Jain is manufactured). Stakeholders reported that there are few onerous limitations on drip equipment imports. Typically, if a distributor is importing a complete drip system, the shipment is VAT and duty exempt; however, if individual components are imported separately, then they are subject to VAT and import duties. In practice, this distinction is fickle depending on the day-to-day decisions of customs agents.

Additionally, financial sector borrowing costs are high, and credit availability is limited, caused in large part by public budget deficits and high borrowing by the government. Financial institutions find that they can lend to the government by buying treasury bonds and receive an assured 26 percent return on their capital. If they extend credit to the private sector, the base rate is 34 percent. This means that financial institutions see little or no incentive to loan to farmers who present significantly greater perceived risk in order to earn a marginal rate of return over treasuries of only 8 percent.

Limited access to credit and lack of business skills restrain Zambian smallholders from increasing production to a commercial level, even when they are connected with an outgrower scheme.

Further areas of concern for agricultural actors are fiscal and monetary policies regularly disrupting currency valuations and foreign currency availability. In periods of tight monetary conditions, limited foreign currency makes importing more expensive. Alternatively, as the value of the Zambian Kwacha rises, farmers exporting commercial crops find that they are less competitive in global markets. Generally, Zambia's monetary and fiscal policies have been characterized as unstable in recent years, and periodically unfavorable for agricultural stakeholders.

High-Value Agriculture Dynamics

While maize is the dominant food crop grown by smallholder farmers, many smallholders do practice rotations with commercial crops like cotton, tobacco, and even higher value horticulture. With elevations ranging from 1,200 to 1,800 meters, Zambia is characterized as having high potential for horticultural crops such as fruits and vegetables. Vegetables are often produced for the growing domestic market, but domestic production is mainly seasonal because of limited irrigation.

As the table below illustrates, the area harvested for staple crops compared to higher value fruits and vegetables remains significant, with approximately 18 times more land allocated to cereals, roots, and tubers than fruits and vegetables. Only 79,210 hectares of fruits and vegetables were harvested in 2013, and this number has not shown any substantive growth since 2010.

ZAMBIA: AREAS HARVESTED (HA)		2010	2011	2012	2013
	Cereals, roots, tubers	1,492,256	1,482,864	1,439,066	1,409,810
	Fruits and vegetables	79,120	77,932	79,160	79,210
	Staples to FFV	**18.9**	**19.0**	**18.2**	**17.8**

Nonetheless, vegetable production in Zambia for domestic markets engages large numbers of smallholder farmers. It has been estimated that approximately 500,000 smallholders produce vegetables with a national average vegetable area per household at approximately 0.1 hectare (1,000m^2); however, only about 170,000 sell surplus production exceeding $100 in value per year.[lxxxvii]

Smallholder farmers are said to account for a large share of vegetable produce sold in Lusaka and other major domestic markets. Additionally, supermarket procurement from small-scale farmers is seen to be on the rise. Shoprite, a major regional supermarket chain with 18 branches across Zambia, has enacted a policy to obtain at least 60 percent of its products from local sources.[lxxxviii] Zambian farmers, however, have had difficulty competing with commercial fruit and vegetable producers in South Africa.

Nonetheless, supermarkets presents a substantial output market opportunity for commercially oriented producers who are able to meet year round supply expectations – necessitating on-farm investments in irrigation, and presenting a potential opportunity for drip equipment suppliers to target commercially oriented small-scale producers.

Key Drip Irrigation Actors

There were six companies identified as active in the commercial supply of drip irrigation in the Zambian market. These include Amiran Zambia (Netafim brand agent), SaroAgro (Jain brand agent), Irritech (Netafim brand agent), Green 2000, MRI/Syngenta, and RotoTanks (agents for Chinese unbranded systems), but those identified as actively targeting the small-scale farmer market segment are Amiran, SaroAgro, and MRI/Syngenta. The other companies are primarily targeting the large-scale commercial producer market.

Company	Description	Contact
Amiran Zambia	Amiran presents their business model in Zambia as a 'one-stop shop' for all agro-input requirements for producers large and small, including hybrid seed, fertilizers, crop protection, greenhouses, and irrigation equipment. For the small-scale farmer market segment they sell drip kits ranging from 1,000 sqm and up. They have four branches nationwide – two in the north, one in the south, and one in Lusaka. They currently have seven agronomists on staff to deliver technical advice to customers.	Yossi Karni yosi@amiranzambia.com
Saro Agro	A family owned business started in Zambia in 1987, providing a wide range of agricultural inputs and equipment. They have branches in Lusaka, Kitwe, and Mkushi, as well as a vast network of rural dealer and agents. They have been primarily targeting the emergent farmer market (those with >5 ha of land), and have been working closely with the Zambia National Farmers Union, and government owned financial institution NetSave to introduce a package of mechanization equipment for commercially oriented small-scale producers.	Calvin Salah Calvin.s@saroagri.co.zm +260 975 714 426
MRI/Syngenta	Agro-input supplier with an extensive network of 580 supply shops throughout the country. It has handled Toro drip kit distribution, as well as other farm equipment, machinery, hybrid seeds, and crop protection products.	Mark Stokes Plot 5255, Mukwa Rd. PO Box 33088, Heavy Industrial Area, Lusaka +260 978 772 456 mark@mriseed.com

Key Challenges for Smallholder Drip Irrigation Uptake

Farmer mindset: The typical Zambian smallholder farmer does not operate his or her farm like a business. 90 percent of smallholder farmers rely on seasonal rainfall, and staple crops for subsistence dominate land use decisions. Stakeholders have indicated that shifting smallholders to a farming as a business mindset will require time, entrepreneurial skills training, a break from dependence on input handouts, and access to explicit output market opportunities for higher value horticulture.

Extension: Agricultural extension services for smallholders are generally limited in both scale and quality. Sources of extension for smallholders include the Ministry of Agriculture and Cooperatives (MACO), donor-funded projects, nongovernmental organizations, nucleus farms managing outgrower schemes, and input suppliers. However, a survey suggests that about 77 percent of farmers interviewed have never received government extension services[lxxxix]. Amiran indicated that a low-level agronomist costs approximately $1,000 per month, and rural transport to production areas costs another $500-$1,000 per month. At this cost, in-house extension to individual smallholders is less feasible at the margins earned on small-scale kits, so larger group trainings at central locations become necessary, limiting individual attention that many small-scale Zambian producers need to transition to drip.

Finance: The costs of drip systems starting at the 1,000 sqm plot size (the average vegetable plot size in Zambia) are out of reach for most small-scale producers in Zambia, and credit access and availability are limited. Borrowing costs start at 34 percent, and even then, financial institutions are reluctant to lend to small-scale agricultural borrowers. Credit facilities have been made available for larger agribusinesses in key cash crops like tobacco, and cotton. And the government-led Lima credit scheme, implemented through the Zambia National Farmers Union is seeking to expand credit to smallholders for seasonal inputs rather than capital items. So a major gap in credit remains for smallholders to invest in drip equipment.

Key Development Initiatives

Generally, the development community provides more support to rainfed staple crop production and household nutrition initiatives than high-value irrigated agricultural production. Importantly, almost all major initiatives for smallholder farmers are coordinated with the Zambia National Farmers Union (ZNFU) because of their extensive outreach with farming communities across the country. A few of the major development initiatives in Zambia include:

Project	Description	Contact
IFAD Smallholder Productivity Promotion Program	This $39.9M IFAD-funded initiative with co-funding from the Finnish International Development Agency runs from 2011-2018 with a geographic focus on two provinces: Luapula and Northern. The objective is to accelerate growth in smallholder agriculture through improved marketing and increased productivity. The program targets 60,000 farming households with cropping areas up to 5 ha. Target crops include cassava, mixed beans, groundnuts, and rice with a focus on household food and nutrition security.	Abla Benhammouche Plot 10/4971, Tito Road - Rhodes Park Box 31966 Lusaka, Zambia a.benhammouche@ifad.org

Project	Description	Contact
Feed the Future PROFIT+	This $24M USAID-funded Production, Finance, and Improved Technology Plus project implemented by ACDI/VOCA runs from 2012-2016 with a geographic focus in Eastern province with smallholder farmers cultivating 3 ha or less, and in peri-urban Lusaka. The peri-urban Lusaka areas are focused on commercial horticulture production by women-headed households. The project seeks to increase farmer productivity through new technologies.	Alex Pavlovic apavlovic@acdivoca.org
Irrigation Sector Development Program (ISDP)	This $200M World Bank-funded initiative runs from 2011-2018, implemented by the Ministry of Agriculture and Cooperatives. The objective is to increase yields per hectare and value of diverse products grown by smallholders under irrigation. The project seeks to support public irrigation infrastructure construction (dams, canals), to facilitate private investment in productive equipment these schemes, and to provide support services to strengthen local capacity to operate smallholder irrigation schemes on a commercial basis. Stakeholders have described this project as running about four years behind schedule in an effort to ensure appropriate social responsibility and engagement with affected communities.	Charles Annor-Frempong Red Cross House 2nd Floor Long Acres Lusaka, Zambia (260-1) 252-811, 253-219, 253-223
International Development Enterprises (iDE)	Established operations in Zambia in 1997. Focuses on low-cost irrigation as a practical way to address recurring droughts. iDE Zambia is also engaged in linking farmer groups with local supermarkets, vegetable export companies, and other markets. It has also developed a program of farm business advisors (FBAs) who are trained to provide extension services to smallholders for a fee.	Melanie Wilkinson E-mail: mwilkinson@ideorg.org Plot No 5B Twin Palm Road Kabulonga, Lusaka Phone: +260 211 260 988
British American Tobacco	Implementing a smallholder outgrower scheme for tobacco.	20992 Kafue Road P.O. Box 31062 Lusaka 10101 Phone: +260211272287
Illovo Sugar	Illovo is a South Africa company part of Associated British Foods Company with a smallholder outgrower program in the main sugar growing areas of Zone II with riverine access.	Rebecca Katowa Nakambala Sugar Estate, Lubombo Road, Mazabuka Tel: +260 21 3 230 394
Cargill	Implementing a smallholder outgrower scheme for cotton and soya.	Cotton: Nasser Street PO Box 510274, Chipata Tel: +260 216 221 790 Grain and Oilseeds: Stand No 22768 Cnr Great East/Thabo Mbeki Roads Acacia Park Office building, 2nd Fl, Arcades, Lusaka Tel: +260 211 845 785

Recommendation for Future Market Opportunities

Geographic targeting: this market research suggests that the most opportunistic geographic location for introducing/expanding drip irrigation is in Agro-ecological Zone II along the key North/south trade corridor, with riverine access, and around urban market areas. These are the areas where fruits and vegetables for domestic markets are currently being produced, and therefore present opportunity for year-round production under drip.

Household targeting: This market research also suggests that farmers cultivating staple crops for subsistence with less than 2ha of land are not promising candidates for the introduction of drip irrigation technologies. Commercial distributors are likely to be more successful targeting small-scale farmers who are already commercially oriented and are capable of producing a surplus for markets. While the average vegetable plot is .1 ha (1,000 sq meters), early stage efforts to introduce drip irrigation commercially may prove most successful targeting the 'emergent farmer' with holdings of 5 ha or more.

Zambia National Farmers Union: Commercial drip stakeholders in Zambia have indicated that organizing farmers is one of the greatest challenges to promoting their product and delivering technical assistance. Distributors would be well served coordinating product awareness and training events through the ZNFU because of their extensive outreach across the country and established relationships with smallholder farmers.

Collaboration with supermarkets: There are many South African supermarket chains in Zambia and they are receiving pressure from policy makers to source locally. Shoprite has instituted a policy whereby 60 percent of their products will be sourced locally, but they continue to have difficulty sourcing fresh fruits and vegetables from Zambian farmers. FreshMark, the procurement division of Shoprite, has a pilot project in the copper belt to support smallholders to produce fruits and vegetables. Commercial drip distributors may find opportunity in partnering with supermarkets like Shoprite to introduce drip to current and potential smallholder suppliers.

Zimbabwe: The Market for Drip Irrigation

Market Overview

Agriculture contributes around 18 percent of Zimbabwe's GDP, more than 40 percent of export earnings, and livelihoods to more than 70 percent of the population. Per capita income in Zimbabwe is approximately $979, about half that of Zambia and a third higher than that of Mozambique. Major staple food crops include maize, sorghum, millet, and ground nuts, while main cash crops include tobacco, cotton, sugarcane, soya bean, and vegetables.[xc] Tobacco is the leading export crop, cotton is grown almost exclusively by smallholders, and Zimbabwe is the second leading sugarcane producer in East and Southern African behind South Africa. Horticulture production is seen to possess significant potential to stimulate agricultural sector growth and employment opportunities. The vast majority of smallholder production systems are rainfed, although small-scale communal irrigation schemes exist in medium/high potential production zones in east and northern areas of the country. The Land Reform Program continues to influence the incentives for production technology investments, and thus the overall efficiency of farming systems, but must be closely considered when segmenting the target market for small-scale drip adopters.

Smallholder Market Segmentation

Average land holding statistics in Zimbabwe can be misleading. There are important distinctions in farm classifications under the Land Reform Program, and the majority of smallholder systems are mixed, with livestock grazing on pasture along with crops being produced on what arable land they have. It is important for commercial drip distributors to examine the characteristics of each farm segment as classified below[xci]:

- Communal areas: These areas encompass 16.4 million ha, including more than one million households. They are considered marginal land with infertile sandy soils, erosion from land degradation, and low, erratic rainfall. Arable land holdings are generally less than 2.5 ha per farm with leasehold land title.
- Resettlement areas (A1 and A2): These areas encompass approximately 7.6 million ha, including >150,000 households. Considered medium potential land, the average arable land available per farm is estimated to be around 5 ha, although grazing area is also utilized. In 2009, 145,000 farm households were in A1 schemes, and another 16,500 households on A2 plots.
- Small-scale commercial: These areas encompass approximately 1.4 million ha, including approximately 8,600 households with arable land holding of approximately 125 ha per farm, held under either free-hold or leasehold title.

- Large-scale commercial: These areas encompasses 3.4 million ha, owned mainly by white farmers and have an average size of 2,200 ha, with more than 50 percent considered to be in high potential production areas.

A1 and A2 resettlement households are generally considered to be the vulnerable but potentially commercially viable smallholder segment. While A2 farmers hold more land on average, A1 farmers tend to produce more intensively. Both classifications are mixed crop and livestock production systems. A1 farmers are seen to be increasing land allocation to cash crops, particularly tobacco, and seasonal vegetable production for domestic market channels.

Private sector drip irrigation stakeholders operating in Zimbabwe have indicated that farmers with access to at least .1 ha (1,000 sq meters) of arable land can produce a market-oriented surplus; however, the ideal profile of a commercially viable drip adopter would be those with at least .5 ha (5,000 sqm) of arable land available to allocate to input intensive vegetable production.

Geographic Market Segmentation

Zimbabwe possesses 39 million ha of land, but only 3.85 million is considered arable, permanent cropping area. More than 80 percent of Zimbabwe is subject to conditions which make crop production a risky undertaking because of low and erratic rainfall. The International Commission on Irrigation and Drainage estimates that only 4.5 percent of arable land is irrigated, encompassing an area of approximately 170,000 ha. This leaves the majority of smallholders reliant on seasonal rains that are expected to fall from November to March.

Even in parts of Zimbabwe with high potential for intensive horticulture production, most smallholder farms are rainfed, severely limiting the growing season.

There are five agro-ecological zones in Zimbabwe to consider when targeting producers that may be suitable for drip irrigation:

- Natural region I: covers approximately 2 percent of the country and has the highest rainfall (>1,000mm/yr). There are specialist farming systems with intensive plantations, fruits and vegetables, and livestock.

- Natural region II: covers 15 percent of the country with less rainfall than region I (750-1,000mm/yr), but is considered suitable for intensive crop production systems.

- Natural region III: covers 19 percent of the country and is characterized by severe dry spells that create challenges for rainfed crop production systems alone (650-800mm/yr). Farms here tend to be focused on both livestock grazing and seasonal cash crop production.

- Natural region IV and V: covers approximately 65 percent of the country. Rainfall is low (<650mm/yr), and seasonal droughts are common. Rainfed crop production carries great risks, and farmers are dependent on extensive livestock rearing.

Natural regions I and II are considered the more opportune geographies for introducing drip irrigation to intensive, specialized crop production systems. Areas around Harare, Mashonaland Central, Mashonaland West, Mashonaland East, and Manicaland present areas most suitable for intensive,

specialized crop production. In Eastern Zimbabwe (Makoni District) cotton and groundnuts make up 56 percent of farm crop output, maize makes up 36 percent of output, and vegetables make up only 4 percent of output.[xcii] While the agro-ecological potential for intensive vegetable production is high in regions I and II, it remains seasonal, as smallholders typically produce vegetables only in the winter months when surface water is available.

Stakeholders interviewed in Zimbabwe indicate that geographic targeting for commercial drip distribution should also take into consideration output market access for farmers, and therefore those farmers within a 150km radius of major towns in Regions I and II present the greatest opportunities for drip adoption. The areas around Harare, Mutare City in eastern Zimbabwe, and the surrounding areas contribute significantly to large and informal markets of fruits and vegetables, particularly bananas, tomatoes, onion, and cabbage.

The main sources of irrigation water in Regions I and II include open water lakes and rivers, as well as shallow wells from 10-30 meters deep. Boreholes are considered necessary in drier areas, although the cost of borehole drilling is considered to be well out of reach for the majority of smallholder farming families.

Enabling Environment

The government of Zimbabwe has expressed a commitment to increasing the productivity and competitiveness of their agriculture sector; however, policy and practice often diverge. For instance, in the Comprehensive Agriculture Policy Framework 2012-2032 the government pledges to rehabilitate irrigation infrastructure, and establish a National Farm Irrigation Fund for increasing finance for irrigation related investments; however, the implementation of these objectives have not been observed by stakeholders interviewed.

Additionally, the formal policy for importing drip equipment into Zimbabwe is duty and tax free if importing complete irrigation schemes. In practice, private sector drip distributors describe the customs clearance process as 'a bit of a gray area'. Importers typically have to provide a drawing or schematic of the entire system to the customs agent, and informal payments are often necessary to get equipment out of customs. If importers are bringing in individual drip components rather than as a complete scheme, then the equipment is subject to import duties ranging from 5 percent to 35 percent plus an additional 15 percent VAT. The time and cost associated with customs clearance regularly slows down access to drip equipment being imported from South Africa and Israel, and adds costs that are typically passed down to customers.

High-Value Agriculture Dynamics

Generally, smallholder farmers overwhelmingly prioritize land allocation for staple crops relative to higher value fruits and vegetables. Below is an overview of total land allocated to staples vs. fruits and vegetables between 2010 and 2013:[xciii]

Zimbabwe: Area Harvested to staples vs. FFV		2010	2011	2012	2013
	Cereals, roots, tubers	1,942,794	2,192,537	1,492,465	1,433,265
	Fruits and vegetables	71,653	67,822	68,017	68,017
	Staples to FFV	**27.1**	**32.3**	**21.9**	**21.1**

In 2013, more than 1.4 million ha were allocated to cereals, roots, and tubers, representing more than 21 times the land allocated to higher value fruits and vegetables. The land area allocated to fruits and vegetables has actually declined by approximately 5 percent from 2010 to 2013. Given the suitability of drip technology for high-value fruits and vegetables compared to staples, a total area of 68,017 ha provides a general sense of the size of the market for drip.

Smallholder horticulture farmers are reported to be faced with four output market channels to sell their produce, namely: 1) structured buyers like processors and supermarkets, 2) formal urban marketplaces, 3) large-scale nucleus farms, and 4) road-side sales[xciv]. The primary channels utilized by smallholders are formal urban marketplaces, and road-side sales. While selling to structured markets yields the highest returns, most smallholders cannot meet volume, quality, and year-round supply requirements. Smallholders with access to communal irrigation schemes, mainly furrow practices in peri-urban areas, are the main suppliers to the processing companies because of their proximity to town, and the volumes they are able to produce under irrigation. One study indicates that because of the seasonality of horticulture production, 56 percent of buyers around Mutare City could not source enough horticultural produce to meet year round demand[xcv]. Given this reality across many local urban markets, it is evident that drip irrigation would enable smallholder vegetable producers to increase their access to stable output markets, if the technology were utilized properly and in conjunction with good agricultural practices, hybrid seeds, fertilizers, and crop protection.

Key Drip Irrigation Actors

Through interviews with stakeholders in Zimbabwe, four primary drip irrigation distributors were identified: Drip-Tech Irrigation, Pedstock, Waterwright Irrigation, and Ronfleur 2000. Development practitioners indicate that none of these companies have been particularly successful targeting the smallholder farmer market. All of them maintain a primary focus on servicing larger scale commercial farm schemes, although small-scale products are available for the entrepreneurial smallholder.

Company	Description	Contact
Drip-Tech Irrigation	Distributor of Naan dan Jain equipment. It is interested in expanding its pursuit of the smallholder market segment but the majority of sales come from larger scale producers.	Dave Bacon +263 772 143 998 +263 772 143 996
Waterwright Irrigation	Distributing Netafim branded equipment imported from South Africa. It is currently targeting larger scale producers, as it sees challenges with distribution logistics, lower margins, higher transport costs, and limited credit for farmers as barriers to targeting the small-scale farmer market.	Graham Wright 9 Glenelg Road Pomona, Harare sales@wwi.co.zw +263 772 265 639
Pedstock	Distributing Netafim branded drip irrigation equipment. Generally believed to be the leader in small-scale products as they have good name recognition nationally, they offer 250m, 500m, and 1,000m kits, and they organize rural demonstration events to raise awareness and interest among smallholders. Pedstock is also working in close collaboration with the government to introduce communal drip irrigation systems – for instance one project encompasses 500 farmers on 10,000 ha (20 ha each) in an area with access to irrigation water.	Dror Jackson dror@floraline.biz dror@14invest.com
Ronfleur 2000	Distributing Jain branded equipment imported from India. Not actively targeting the small-scale farmer market, but will sell individual components or smaller scale systems to farmers that come directly to their store.	59 Pendennis Rd. Mt. Pleasant, Harare +263 4744329/744578

Key Challenges for Smallholder Drip Irrigation Uptake

The history of smallholder irrigation schemes in Zimbabwe indicates the challenges drip irrigation will continue to face. Farmers are reported to often neglect their schemes because of unstable output market income, poor performance because of limited use of inputs, and lack of credit. Overall, farmers not currently practicing commercial horticulture production have been unable to transition from subsistence staple production to market oriented production.[xcvi] Stakeholders in Zimbabwe have highlighted the following as the key constraints to expanding smallholder uptake:

Equipment credit: The cost and availability of credit are major problems. When available, borrowing costs from banks tend to start at 5 percent per month, and several micro-lenders offer loans starting at 10 percent per month. Additionally, many financial institutions require a minimum of 30 percent of the cost of the system as a deposit which smallholders are unable to provide. Perhaps more importantly, financial institutions are generally unwilling to lend to smallholder farmers for investments in drip equipment as they have low liquidity, they are very risk averse, and the required value and duration of drip equipment loans are more than they are willing to provide.

Farmer awareness and education: Smallholder farmers have little experience with irrigation, and when they do it is primarily low investment furrow practices. On the whole, they have no understanding of drip system operation and maintenance, so introducing the technology requires repeated, practical demonstration events to illustrate the potential and educate them on the technical specifications of drip production. Additionally, drip needs to be presented as a tool within a broad package of good agricultural practices and improved inputs if it is to meet its productivity potential. Unfortunately, extension services in Zimbabwe are limited – agri-techs from the Ministry of Agriculture or NGOs are said to be the primary source of extension, although quality and consistency of service are often lacking.

Operating costs: Most farmers in Zimbabwe are off the electric grid, which means they must invest additional working capital in fuel to operate pumps to lift the water from its source (catchments, wells, boreholes, or open water bodies). Stakeholders report that one liter of diesel fuel costs between $1 and $1.30, so daily pumping costs can exceed $10 depending on the size of the area irrigated, as it is often necessary to fill a gravity tank several times to cover the entire land sufficiently. This is considered a significant expense for many smallholder farmers in Zimbabwe, and often turns them off from the technology entirely. Stakeholders in Zimbabwe recommended exploring the opportunities for commercial drip providers to bundle solar pumps with small-scale drip kits to reduce operating costs.

Key Development Initiatives

PROJECT	DESCRIPTION	CONTACT
Agro Initiative Zimbabwe (AIZ)	A business competition implemented by TechnoServe targeted at medium-sized Zimbabwean agribusinesses with innovative ideas. AIZ supports ideas that demonstrate the inclusion of smallholder farmers with the potential to catalyze industry development. Winners receive up to $50,000 in seed capital to implement their initiative and receive technical assistance tailored to the needs of the business. At least one prize is awarded to the high-value crops sector.	http://www.aiz.co.zw/ 9 Rowland Sqaure Milton Park Harare Zimbabwe info@aiz.co.zw +263 772 158 323/4
USAID Crops Development Program	This is the follow on project to USAID's successful Zimbabwe Agricultural Income and Employment Development (Zim-AIED), which successfully commercialized thousands of smallholder horticulture producers. The Poverty Reduction and Food Security - Crop Development Program is an $8 million project that runs from 2015-2019 and aims to reduce rural poverty and increase the incomes and food security of targeted smallholder agricultural producers through increased agricultural production and productivity, and market linkages.	Godfrey Mudimu d.godfrey_mudimu@leadtrust.co.zw Olivia Mukoko olivia_mukoko@leadtrust.co.zw
EU/FAO Smallholder Irrigation Support Project	This project is assisting the rehabilitation of 20 small-scale irrigation schemes on 1,000 hectares in Manicaland and Matabeleland South.	FAO Representative: Mr Chimimba Phiri FAO-SFS@fao.org
DFID Livelihoods and Food Security program	This is a $72 million four-year program to increase agricultural productivity and incomes and improve food and nutrition security. FAO, GRM International, and Coffey are managing the project. The program seeks to address the specific constraints that smallholder farmers face in raising the productivity of their farms and participating in markets.	Hannah Goodwin hannah.goodwin@coffey.com

Recommendations for Future Market Opportunities

Geographic targeting: Desk research and feedback from stakeholders interviewed suggest that regions I and II present the most opportune agro-ecological conditions to support the uptake of drip irrigation, including medium to high potential soils, cooler temperatures, higher groundwater tables, and open water bodies. Areas around Harare, Mashonaland Central, Mashonaland West, Mashonaland East, and Manicaland are known to support intensive, specialized crop production. Geographic targeting for small-scale drip distribution should also take into consideration output market access for farmers, and therefore should focus on a 150km radius around major towns in Regions I and II such as Harare and Mutare city.

Smallholder targeting: Stakeholders in Zimbabwe have indicated that farmers with access to at least .1 ha (1,000 sqm) of arable land can produce a market-oriented surplus, and the ideal profile of a

commercially viable drip adopter would be those with at least .5 ha (5,000 sqm) of arable land available to allocate to intensive vegetable production. Farmers in resettlement scheme classifications AI and A II within Regions I and II who are currently growing vegetables seasonally for domestic market channels are generally anticipated to possess the land resources necessary to succeed with drip. There are estimated to be approximately 145,000 farm households in A1 resettlement schemes, and another 16,500 households on A2 resettlement scheme plots.

Finance: Following the USAID ZIM-AIED project, there were four to five banks that were willing to extend working capital loans to smallholders (typically $200-$250 in agro-input loans), but this had yet to include drip equipment credit. Nonetheless, those companies that engaged with the USAID project experienced successful repayments with commercially oriented smallholder borrowers and represent potential opportunities to promote the development of small-scale equipment credit products going forward. These companies include: Quest Financial Services, Untu Financial Services, AgiBank, and VIRL Financial Services.

Unmet demand in local urban markets presents an opportunity for peri-urban horticulture producers, if they were to receive the equipment and training to increase the quality and quantity of their produce.

Outgrower schemes: USAID ZimAIED also demonstrated significant commercial successes with the Mutema and Chibuwe-Musikavanhu irrigation schemes in Chipinge. Zim-AIED supported banana production projects in partnership with 441 farmers and the marketing company Matanuska. Zim-AIED also supported 950 sugar bean farmers to grow seed for Pannar and Progene seed companies. Commercial drip distributors would be well-served piggy-backing on these successes by collaborating with firms like Matanuska, Pannar, and Progene to introduce small-scale drip irrigation to participating smallholders.

Solar pumps: The operating costs of pumps for smallholder farmers operating off the electric grid is often prohibitive to the continued adoption of drip technology. Stakeholders in Zimbabwe recommended that drip distributors could play a role in bringing the operating costs of water pumps down by collaborating with local and regional companies providing solar pump products.

Extension agent cost-share models: One commercial drip irrigation stakeholder in Zimbabwe cannot justify the costs of investing in in-house extension agents for small-scale drip systems given the low margins earned on this product line; however, they are now looking into developing partnerships with agro-input suppliers to cost-share extension agents that could serve smallholder clients buying both drip and other inputs such as hybrid seeds, and crop protection products. This model could be initiated in Zimbabwe and if successful, other countries in East and Southern Africa with a robust private sector input supply system.

Annex I: List of Stakeholders Consulted

Stakeholder Name	Organization/Company	Country
James Ogolla	USAID-KAVES	Kenya
Steve New	USAID-KAVES	Kenya
Yariv Kedar	Amiran Kenya	Kenya
Bernard Otieno	Green Zone Agencies	Kenya
Jay Dave	Hortipro	Kenya
Elijah Mugah	G.North & Sons	Kenya
Garron Hansen	Gates Foundation	Rwanda
Bob Gatera	Balton Rwanda	Rwanda
Ian Chesterman	Fintrac, Inc.	Zambia/Ethiopia
Dawit Tefera	Tecmod Water Works	Ethiopia
Vince Uhl	UHL & Associates	Ethiopia
Seyoum Geachew	Agricultural Transformation Agency	Ethiopia
Yossi Karni	Amiran Zambia	Zambia
Calvin Salah	Saro Agro	Zambia
Antonio Coello	USAID-TAPP	Tanzania
Richard Pluke	USAID-TAPP	Tanzania
Ian Samakande	IrriGrow Ltd.	Tanzania
Rob Jones	EJL Engineering	Mozambique
Eduardo Mendias	Toro	Mozambique/Zambia
Pippy Gardner	NCBA/CLUSA	Mozambique
Sandi Roberts	Agdevco	Zimbabwe/Malawi
Laura Harwig	Fintrac, Inc.	Malawi
Kuda Ndoro	Feed the Future Zimbabwe Livestock Dev.	Zimbabwe
Dror Jackson	Pedstock	Zimbabwe
Graham Wright	Waterwright Irrigation	Zimbabwe

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