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Improving the Availability and Effectiveness of Rural and "Micro" Finance for Small-scale Irrigation in Sub-Saharan Africa: A Review of Lessons Learned

Douglas J. Merrey and Nicole Lefore

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Nevertheless, the authors remain responsible for the contents of this paper.

Project

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Acronyms and Abbreviations

AC	Alternating current
APR	Annual percentage rate
CEO	Chief Executive Officer
CGAP	Consultative Group to Assist the Poor
CTA	Technical Centre for Agricultural and Rural Cooperation (a joint international institution of the African, Caribbean and Pacific [ACP] Group of States and the European Union [EU])
DC	Direct current
DFID	Department for International Development (United Kingdom)
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization of the United Nations
FCFA	West African *Communauté financière d'Afrique Franc*
GPOBA	Global Partnership on Output-Based Aid
GRAD	Graduation with Resilience to Achieve Sustainable Development (USAID project)
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit* (Germany)
GPS	Global Positioning System
GTZ	*Deutsche Gesellschaft für Technische Zusammenarbeit* (former acronym of GIZ)
ICIMOD	International Centre for Integrated Mountain Development
IDCOL	Infrastructure Development Company Limited
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILSSI	Innovation Laboratory for Small-Scale Irrigation (USAID program)
IRENA	International Renewable Energy Agency
IWMI	International Water Management Institute
KES	Kenyan Shillings
KSSI	Kenya Smallholder Solar Irrigation Project (USAID-funded project)
KWFT	Kenya Women's Finance Trust (Kenya Women Microfinance Bank – after 2013)
MFI	Microfinance institution
NGO	Nongovernmental organization
NIAP	National Irrigation Acceleration Platform

NPR	Nepali Rupees
OFID	OPEC Fund for International Development
OPEC	Organization of the Petroleum Exporting Countries
OPIC	Overseas Private Investment Corporation
PAMIGA	Participatory Microfinance Group for Africa
PAYGO	Pay-as-you-go
PV	Photovoltaic
RTO	Rent to Own (company in Zambia)
SDC	Swiss Agency for Development and Cooperation
Sida	Swedish International Development Cooperation Agency
SIM	Subscriber identification module
SNNPR	Southern Nations, Nationalities, and People's Region (Ethiopia)
SOFITEX	*Société Burkinabé des Fibres Textiles* (Burkina Faso)
SSA	Sub-Saharan Africa
SSI	Small-scale irrigation
U-IMCEC	*Union des Institutions Mutualistes Communautaires d'Epargne et de Crédit* (Senegal)
USA	United States of America
USAID	United States Agency for International Development
USD	United States Dollar
VESA	Village Economic and Social Association (Ethiopia)
WLE	CGIAR Research Program on Water, Land and Ecosystems
WMI	Water and Microfinance Initiative
WRS	Warehouse receipt system

Summary

This paper reviews the evidence available on the provision of financing for African smallholder farmers to purchase irrigation equipment such as pumps, pipes and drip irrigation systems. It sets the scene by first reviewing the literature on experiences with providing microcredit and other microfinance services as a poverty reduction strategy. Based on both case studies and several systematic reviews of the literature, it finds that the outcomes and impacts on poverty, gender equity and broader economic development are mixed at best. Microcredit is not a silver bullet solution to poverty, but it can often help poor households improve their lives. The paper then reviews the demand for and supply of financing for smallholders to purchase irrigation equipment. In surveys, farmers express a strong demand for equipment such as pumps, but often point to the lack of affordable and appropriately designed credit as a critical impediment to gaining access to such equipment. Even where microfinance institutions offer agricultural credit, it is usually short-term seasonal credit to purchase seeds and fertilizer. Credit on these terms is not useful to purchase equipment costing several hundred dollars. Focusing on programs specifically aimed at enabling farmers to purchase irrigation equipment, no credible detailed studies were found documenting the impacts and lessons learned. However, there are currently (as of 2018) numerous promising pilot studies and small projects offering a variety of approaches to enable smallholders to make such purchases. The paper reviews what information is available on these. A major recommendation of this paper is that a research project should be designed to carry out studies of these various experiments to identify what works under what conditions, as a basis for scaling out programs to offer financial services aimed at assisting smallholders to gain access to small-scale irrigation equipment.

INTRODUCTION: PURPOSE AND METHODOLOGY OF THE STUDY

1.1 Purpose

The purpose of this paper is to identify how smallholders in sub-Saharan Africa (SSA) can be assisted to get access to reasonably priced financial services that would enable them to use modern irrigation technologies such as pumps and drip irrigation systems. The main focus is on affordable credit to enable smallholders to purchase irrigation equipment; but we also consider credit for small businesses to provide irrigation services for smallholders. The paper is based on a review of the available evidence. There is clear evidence that smallholders having access to irrigation are able to produce more and earn more, especially when they have access to output markets (e.g., Abric et al. 2011; Getacher et al. 2013; Dittoh et al. 2013; de Fraiture and Giordano 2014; Colenbrander and van Koppen 2013). These and other studies also find that lack of access to affordable credit is a major impediment preventing smallholder farmers – women even more than men – from investing in irrigation technologies (e.g., Colenbrander and van Koppen 2013; Giordano and de Fraiture 2014; Namara et al. 2014; Hagos et al. n.d.).

In broader terms, many donors agree that lack of access to agricultural credit, in general, is a serious problem and have financed programs to address this issue. Examples of such donors include the World Bank, Swedish International Development Cooperation Agency (Sida), *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ), United Kingdom Department for International Development (DFID), and the United States Agency for International Development (USAID). The assumption is that expanding the availability of reasonably priced credit would enable farmers to purchase inputs such as fertilizer to improve their production. Therefore, over the last two decades or so, there have been numerous programs aimed at making agricultural credit more widely and easily available in rural SSA. However, as discussed below, most of these programs offer short-term credit for seasonal inputs such as seeds and fertilizer; they rarely offer longer-term credit for purchasing capital equipment.

There is also a related assumption that more rapid uptake of modern irrigation technologies could be facilitated by access to reasonably priced credit. Therefore, the main objective of this paper is to test this assumption by examining the impacts of, and lessons learned from, providing financial services, i.e., credit, insurance, and savings products, aimed at supporting farmers' investments in small-scale irrigation (SSI) technologies. Based on a review of the limited available published and unpublished literature, the paper identifies the main features of rural finance and microcredit products available; reviews experiences with these products, including some recent experimental models; and identifies emerging lessons and gaps in knowledge needing further research.

The paper is part of a larger initiative to enhance the productivity, resilience and outcomes of farming systems of the rural poor in SSA. Implemented by the International Water Management Institute (IWMI) (www.iwmi.org) with support from the CGIAR Research Program on Water, Land and Ecosystems (WLE) (https://wle.cgiar.org/), the research builds on several previous and ongoing activities. These include the agricultural water management innovations which emerged from the AgWater Solutions project (http://awm-solutions.iwmi.org/), past investments by the International Fund for Agricultural Development (IFAD) (https://www.ifad.org/) in agricultural research and adapting research results to the contexts in project countries, and current efforts under the Feed the Future Innovation Laboratory for Small-Scale Irrigation (ILSSI) project (https://ilssi.tamu.edu/) supported by USAID.

The remainder of this section briefly describes the methodology and terminology used in this paper. Section 2 reviews some of the evidence regarding the effectiveness of rural finance for agriculture, especially in SSA, to establish the context for the study. Section 3 narrows the focus to the demand for, and availability of, credit products specifically aimed at supporting farmers' investments in irrigation technologies. Section 4 reviews the evidence we could find on innovative approaches being considered or tested to provide financial services for the expansion of SSI. The paper concludes in section 5 by identifying major lessons learned, and offering specific recommendations for governments and implementing agencies, and for further research.

1.2 Methodology

This study is based on an opportunistic review of both published and unpublished reports, and relevant websites across Asia, Africa and Latin America. "Opportunistic" means that we carried out a broad search using multiple key words and followed up on references that emerged. IWMI researchers had gathered some references as part of their work on this topic focused on Ghana and Ethiopia. We built on their work and (i) used key words to search Google Scholar and Google itself; (ii) followed up on references listed in the studies we found; and (iii) searched the websites of selected investment banks and donors, as well as several topical websites, including the FinDev Gateway (formerly Microfinance Gateway) (https://www.microfinancegateway.org/), Energy 4 Impact (https://www.energy4impact.org/impact/energy-4-agriculture), and Powering Agriculture (https://poweringag.org/). We found that there are no high-quality research studies on the provision of credit for expanding investments in SSI technologies. This limitation suggests that more rigorous research and well-designed pilot studies are needed. There are a number of initiatives underway or planned, some of which are discussed below. These deserve more detailed study.

1.3 Clarification of Terminology and Focus of This Review

The paper focuses on private investments in SSI or agricultural water management technologies such as pumps[1], pipes, and drip and sprinkler irrigation systems, and the installation of wells or farm ponds. These investments may be made by individuals or small groups of farmers. We do not address public financing of collectively managed SSI schemes such as small reservoirs and river diversions or the financing of large-scale irrigation schemes. However, the purchase of equipment such as pumps by farmers who are also served by a public irrigation scheme is included. The paper distinguishes between short- and long-term credit requirements. While the availability of seasonal or short-term credit to enable farmers to purchase seeds and fertilizer or pay labor costs is very important, it is generally not adequate for the purchase of more expensive irrigation equipment. Longer-term credit products, for example 2 to 5 years, are generally required to support these capital investments.

The term *microfinance* refers to the range of financial services provided to the poor. Such services may include savings and insurance as well as credit products. "*Microcredit"* refers to small loans provided to poor families to develop their economic activities (or fairly frequently, if not officially, to pay for other household expenses). Such small-scale financial services are rarely provided directly by commercial banks in rural SSA, because the returns on such small loans are low and the risks are high. Rather, they are generally provided by specialized locally-owned "microfinance institutions" (MFIs), as discussed in section 2.

[1]In this study, pumps include various water-lifting technologies ranging from manual to mechanized, including solar as well as electric, diesel and petrol pumps.

2. EVIDENCE ON THE EFFECTIVENESS OF RURAL FINANCE FOR AGRICULTURE

2.1 Changing Emphasis of Investments in Rural Finance

During most of the second half of the twentieth century, state-run banks in developing countries attempted to push agricultural loans to often-reluctant small-scale farmers. These efforts left a legacy of inefficiency, corruption and squandered subsidies (Seibel and Almeyda 2004; de Aghion and Morduch 2005[2]). In the 1970s, a Bangladeshi professor, Muhammad Yunus, began experimenting with offering small loans to local villagers. In the 1980s, he scaled up this experiment by creating the Grameen Bank (http://www.grameen.com/) to offer very small loans to poor people, especially women. Yunus demonstrated that it was possible to achieve a very high rate of repayment of small loans, with interest, target poor women, and actually make a profit. Professor Yunus was awarded the Nobel Peace Prize in 2006 for his achievements. The Grameen Bank model has been replicated in many countries since then, and other types of MFIs have emerged in most developing countries. The Grameen Bank itself has diversified its business to offer other products and services. Today, more than 200 million people are direct or indirect beneficiaries of microfinance (Khandker et al. 2016).

In 1995, a multi-donor initiative, the Consultative Group to Assist the Poor (CGAP) (http://www.cgap.org/) was established to promote the provision of financial services to those that are very poor, as an explicit poverty-reduction strategy (Weber 2004)[3]. At this time, donors and governments began shifting their investments from the old supply-driven approach to offering agricultural credit (where funds were made available without reference to what the demand was) to building the institutions required to respond to local demand and offering a broader range of rural financial services, including savings and insurance as well as credit, through various types of community-based financial institutions (Seibel and Almeyda 2004; IFAD 2015, 2016). Microfinance in Africa began developing in the 1980s-1990s with little or no government regulation or indeed recognition. Local microfinance institutions, including local cooperatives and nongovernmental organizations (NGOs), developed largely as social rather than business enterprises and their early apparent success attracted a lot of attention.

Informal savings and credit groups that had predated these MFIs continue to operate in most countries. The types and functions of these groups vary widely. Though they fill a gap left by formal financial service providers, they are not a substitute for formal credit institutions, as they do not provide cost-effective credit to micro- and small businesses and rarely develop into formal institutions (Aryeetey 2005). The positive lessons from "traditional" group operations have influenced some formal MFIs (Basu et al. 2004), but van Rooyen et al. (2012) found very few evaluations of "traditional" models. As such, this paper does not look at specific lessons from the informal financial associations.

As described by IFAD (2016), by the mid-1990s, many formal local institutions were facing serious crises, forcing governments and financial institutions to impose financial rules and more

[2] de Aghion and Morduch (2005) provided a balanced and detailed economic analysis of the entire microfinance sector, combining the perspectives of practitioners and academics.

[3] Weber (2004) provided a strong political-economic critique of the liberalization of financial services globally using the case of micro-credit programs. These programs are interpreted as a strategy to reduce resistance to the financial liberalization inherent in the Structural Adjustment Programs of the 1990s.

professional engagement. By 2015, IFAD had invested some USD 1.1 billion in rural finance initiatives in more than 70 countries. Current investments by IFAD are informed by a large number of lessons learned during this time. Examples of these lessons are: (i) the importance of supporting access to a variety of financial services and promoting a wide range of financial institutions, models and delivery channels; (ii) the need to encourage market-based approaches that are demand-driven and innovative; (iii) developing and supporting long-term strategies focusing on sustainability and poverty reduction; and (iv) participation of IFAD in policy dialogues to strengthen agriculture, finance and related institutions (IFAD 2015, 2016).

A report published by USAID (Jansen 2014) reviewed the general direction of the Agency's investments in microfinance, beginning in the 1960s. The emphasis has largely been on improving the availability of finance for micro, small and medium private enterprises, including adapting and capitalizing "traditional" rotating savings and credit groups to increase inclusivity of access. As with the World Bank, USAID has also supported the development of policy, legislation and capacity, with more recent emphasis on digital financial services. Nearly all donors and international financial institutions are investing in agricultural and rural finance services, including microfinance.

2.2 Evidence of the Impacts of Microfinance

The World Bank asserts that "agriculture finance empowers poor farmers to increase their wealth and food production to be able to feed 9 billion people by 2050" (http://www.worldbank.org/en/topic/financialsector/brief/agriculture-finance). Similarly, IFAD (2015) claimed there is "robust evidence" that promoting access to inclusive rural financial services has positive impacts at both the microeconomic and macroeconomic levels. Microcredit has been called "one of the most significant innovations in development policy of the past twenty-five years" (quoted in Ahlin and Jiang 2008: 1).

Some research broadly supports these positive claims. For example, based on an analysis of data on microfinance institutions in 57 countries, Miled and Rejeb (2015) found that countries with higher MFIs' gross loan portfolio per capita tend to have lower levels of poverty (using the Poverty Head Count Ratio) and higher levels of per capita consumption expenditure. They conclude that this confirms the role of microfinance in poverty reduction at the macro level and that poorer countries need to focus more on the equalizing effects of microfinance. We do not view this conclusion as definitive, as there may be other factors affecting poverty reduction.

2.2.1 The Case of Bangladesh

A recent detailed evaluation of the dynamics of the microfinance sector in Bangladesh finds substantial evidence for its positive impacts on poverty (Khandker et al. 2016[4]). This study uses about 25 years of systematic panel data (from multiple rounds since 1991) and other data. It combines sophisticated statistical analysis with the insights of the authors' own long-term engagement with Bangladesh's microfinance sector. The results show that access to microfinance services has indeed contributed to reductions in both moderate and extreme poverty, and women have benefited even more than men. They found no evidence of borrowers falling into debt traps, and claim that "10 percent of the total reduction in poverty among the rural population over the last 20 years—2.5 million rural people out of 25 million—can be attributed to microfinance" (chapter 6, p. 129). With reference to agriculture, the study found that MFI participation "has a significant

[4] This publication pulls together research carried out by the authors over the last 25 years or so, much of which was supported by the World Bank.

(long-term) positive effect for women borrowers in raising crop, non-crop (i.e., livestock/poultry raising and fisheries), and total household farm income" (chapter 7, p. 157). Overall, marginal farmers, and those who are credit-constrained, benefit more than other farm-size groups. Further, microfinance increases aggregate (i.e., both farm and non-farm) employment as well as agricultural wages (chapter 7, p. 157-159). An additional interesting finding is that non-credit services, such as skills training and information sharing, provided by MFIs in Bangladesh have had important positive impacts independent of credit services (chapter 9). Khandker et al. (2016, chapters 10-11) also confirmed that widespread access to microfinance contributes significantly to national economic growth. While this study seems to be very strong methodologically, the methodology used in earlier studies by the same authors has been criticized; one weakness is that Khandker et al. (2016) do not directly engage with studies of the same MFIs that have reached less positive conclusions (e.g., Rozario 2002; Faraizi et al. 2011; Bateman and Chang 2012; Roodman and Morduch 2014).

2.2.2 Case Studies from Sub-Saharan Africa

In SSA, case studies from Ethiopia (Geta and Hamiso 2017; Abate et al. 2015; Haile 2012; Tarozzi et al. 2013), Ghana (Ganle et al. 2015), and Lesotho (Ogundeji et al. 2018) generally find that access to credit has significant and positive effects on crop productivity and household income, though these findings are often nuanced. For example, Abate et al. (2015) found that in Ethiopia, credit through financial cooperatives has greater impacts on agricultural technology adoption than credit through MFIs. Cooperatives seem to generate a higher degree of trust because members are both savers as well as the borrowers of funds. Haile (2012) found that repayment of loans in the Ethiopian zone studied can be a serious challenge. A recently completed USAID-supported project attempted to address this issue in the Southern Nations, Nationalities, and People's Region (SNNPR) using small Village Economic and Social Associations (VESAs) (GRAD n.d.). Tarozzi et al. (2013) found mixed evidence in rural Amhara and Oromiya of impacts on agricultural income and indicators of women's empowerment.

Based on a survey of 300 farmers in northern Ghana, Anang et al. (2016) found that the mean technical efficiency of rice production did not differ significantly between users of microcredit and nonusers; in general, credit was a serious constraint on production even for borrowers, because the amounts available to borrowers were not sufficient to improve production. In another study in Ghana, Akotey and Adjasi (2016) found that while microcredit alone does benefit borrowers, those who combine microcredit with microinsurance derive far more significant benefits because the insurance covers "poverty trapping risks" such as poor health, flood or drought. Ogundeji et al. (2018) found that in Lesotho, farmers who obtained credit had, as a result, higher farm incomes than those who did not, though larger farmers obtained higher loans and presumably benefitted more than smallholders.

Researchers often find mixed results from extending microcredit to poor households – both benefits and harm. Ahlin and Jiang (2008) offer a theoretical argument for this based on a modeling exercise. They find that if microcredit raises incomes but leaves most borrowers trapped at a new intermediate level, it cannot be a stepping stone to full development, though it may be an effective anti-poverty tool[5]. Their study suggests this can be addressed by offering both savings and credit services. Weber (2004), in a strong critique of the entire concept of microfinance as a poverty reduction strategy, cites evidence that the loans are "more often than not" used for "consumption smoothing" purposes rather than for making productive investments. She suggests this was a major reason for the "crises" in the 1990s of non-repayment of loans and high dropout rates.

[5] Khandker et al. (2016) stated that this is not the case in Bangladesh, but this is disputed by Bateman and Chang (2012).

The fundamental problem identified is that microfinance does not challenge the underlying social and economic structural conditions that create poverty, as shown, for example, by detailed localized studies in Ghana (Ganle et al. 2015) and confirmed by studies of the Bangladesh Grameen Bank program (Rozario 2002; Ghosh 2013). For some researchers, "microfinance has gone from being hero to zero in the development discourse" and is even "a poster child of exploitation of the vulnerable" (Ghosh 2013; see also Bateman and Chang 2012).

2.2.3 Systematic Global Reviews of Microfinance Impacts

J-PAL and IPA (2015) reviewed seven randomized evaluations of microcredit around the world. Not all were "rural" and none focused specifically on agriculture. They identified several "key results," including: (i) demand was more modest than expected; (ii) no study found a significant impact on average household incomes, though there was evidence that borrowers had more freedom of choice in how they made and used money; (iii) only one of four studies that measured women's empowerment found a positive effect; and (iv) there was no evidence microcredit had widespread harmful effects either. Gopalaswamy et al. (2016), from a systematic review of microfinance impacts in South Asia, also concluded that the evidence on poverty alleviation is inconclusive; and the impacts on household income, education, women's empowerment and employment are marginal. They suggest that "credit-plus" programs have more impact than stand-alone credit programs. A comprehensive global systematic review of the evidence on the impacts of micro-savings, microcredit and micro-leasing found that there are very few credible and reliable impact studies available (and none on micro-leasing) (Stewart et al. 2012). As is true for other studies, they found, at best, modest impacts on poverty, household income, and women's empowerment: some positive cases are counter-balanced by negative impacts (for example, falling into debt traps). Given the potential for harm in offering microcredit services, they suggest micro-savings programs may be 'safer'.[6]

2.2.4 Systematic Review of Microfinance Impacts in Sub-Saharan Africa

The best empirical study of the impact of microfinance services in rural SSA is a rigorous systematic review of the evidence by van Rooyen et al. (2012)[7]. They note that investment in microfinance is now one of the largest development programs available, both in financial terms and in terms of the number of people affected. The study observes that while many advocates, and some studies, credit microfinance with impressive economic and poverty reduction impacts, other studies have questioned these positive impacts and suggest they are mixed at best. They review the evidence of the impact of microfinance on the poor in SSA to test the claims of its successes and inform future decisions. They initially found 69 relevant impact evaluations, but only 15 met their quality criteria. These were evaluations of programs in 10 countries; of the 15 evaluations, 11 were studies of microcredit, two of combined microcredit and micro-savings interventions, and two of micro-savings alone.

Some of the most important findings included the following: the five studies on the impact of microcredit and micro-savings found that the impacts on income were both positive and negative. The only high-quality study of the impacts on income found no impact on business income. The four studies on the impact of microcredit and micro-savings on poor people's savings levels were more positive though again with caveats. Seven of the studies found positive impacts on the health

[6] Both, the Gopalaswamy et al. (2016) and Stewart et al. (2012) studies were commissioned by the United Kingdom's DFID.

[7] See van Rooyen et al. (2012) for multiple references to the literature. This study was also commissioned by DFID.

of poor people using various measures. Most of the evidence suggests that microfinance has positive impacts on food security and nutrition, though again this was not true across the board. The four studies available on the impact on women's empowerment found some positive evidence, but again three of the studies were inconclusive. Little evidence was found to suggest positive impacts on job creation. Van Rooyen et al. (2012) concluded that the available evidence from SSA suggests that microcredit has both positive and negative impacts on poor people's incomes; taken together, they find microfinance "does not perform well" as a tool to escape poverty – or indeed, as a tool for women's empowerment. Banerjee et al. (2013) came to a similar conclusion based on a study in Hyderabad, India.

2.2.5 Impacts on Women's Empowerment

Empowering poor women has from the beginning been a major goal of microfinance programs. This was and remains central to the Bangladesh pioneers. However, the findings of research studies have been mixed and the most reliable studies are broadly negative in their conclusions. The basic reason is that microfinance does nothing to transform the social structural foundation of poverty (Niner 2018). For example, although Alhassan and Akudugu (2012) found that microcredit improved women's income generation capacity in an urban setting, Ganle et al. (2015) found mixed impacts of microfinance on women's empowerment in a rural area of the Upper West Region of Ghana: some did indeed benefit, while others had no control over the use of the loans (their husbands controlled the funds), and some suffered harassment and became worse off because they were unable to repay the loans. Rozario (2002) found that the Grameen Bank approach in Bangladesh using groups to enforce repayment has negative impacts on women's solidarity. Similarly, based on long-term participatory observation, Faraizi et al. (2011) found that the success of the Grameen Bank is blown out of proportion, because the collective repayment responsibility by groups of women borrowers is as repressive as is traditional debt collectors. On the other hand, Kumar et al. (2013) found, based on interviews of 100 women, that those accessing microcredit are more independent than others and do make their own decisions. Much depends on the social context: microfinance programs cannot change the power dynamics of households. However, they conclude, on a positive note, that better design of loan products, and monitoring and screening to identify women that have sufficient control to use the loan productively will lead to more empowerment of women.

Three recent systematic reviews of the literature attempt to measure the impact of microfinance services on women's empowerment (Duvendack et al. 2011, 2014; Vaessen et al. 2014). Like others, these studies highlight the poor quality of many impact studies, the inherent selection bias in quasi-experiments, and the range of measures and definitions of "women's empowerment" used in the literature. Duvendack et al. (2011)[8] concluded that nearly all the studies are extremely weak methodologically and found no robust evidence of positive impacts on women's empowerment or on poverty. Combining several different types of analysis, Vaessen et al. (2014: 10) concluded that "there is no consistent evidence for an effect of microcredit on women's control over household spending." Further, they claim that those studies that do find positive impacts are invariably biased or have methodological flaws. Using somewhat different methodologies, Duvendack et al. (2014) reached the same conclusion, and also note that what little evidence there is implies that any effect that does occur is weak at best.

[8] This study was also commissioned by DFID. Vaessen et al. (2014) was commissioned by the Millennium Challenge Corporation.

2.3 Paradigm Shift from Agricultural Credit to Financial Inclusion

In response partly to the criticisms and limitations of earlier programs focused on trying to provide small amounts of credit to poor households, and partly because of new technological opportunities, a new more integrated and comprehensive paradigm is emerging in SSA. "Financial inclusion" implies that everyone should have access to a full range of affordable financial services that match client needs, offer good value and avoid causing harm (Meyer 2015; see also World Bank 2016). Meyer (2015) provided an overview of the evolution of the rural and agricultural financial landscape in Africa over the past decade or so. New business models based on new technologies, such as mobile financing, are creating new opportunities for poor rural people to access financial services. By 2013, 36 of the 47 African countries had access to 'mobile money' facilities (ability to carry out financial transactions using a mobile phone), and 98 million people had mobile money accounts. These include insurance, credit, savings, and payment services. More investment funds are becoming available in SSA, and new partnerships among financial institutions and other organizations are emerging, as is demonstrated in section 4 of this paper. Impact investing, often using crowdsourced funds, is emerging (e.g., Kiva Microfunds [Kiva]) (https://www.kiva.org/). Meyer (2015) also outlined emerging risk management strategies, such as credit and life insurance, index crop and livestock insurance, and warehouse receipt systems (WRS) (*warrantage* – a French word used in West Africa to describe WRS). Some of these innovations are beginning to lead to improvements in financial services aimed at scaling up irrigation investments, but this trend is at a very early stage.

2.4 Conclusion: Mixed Results from Extending Microfinance Services to the Rural Poor

Clearly, the main message from the literature evaluating the impacts of providing microfinance services to the poor is, at best, mixed. A few authors claim its negative impacts both on borrowers and economic development more broadly outweigh any perceived benefits. Few studies find that the outcomes are universally positive. All the systematic reviews of the literature emphasize the poor quality of impact assessments while also concluding that the impacts are, at best, modest. This observation applies to some of the studies cited in this section: there is a credibility gap. Detailed participatory observation studies emphasize the critical importance of context with regard to women's empowerment: even if the household is better off economically, women themselves may not be better off, and may even be worse off. It is notable that some studies seem to show that offering a range of microfinance services – savings and insurance as well as credit products – often leads to more positive outcomes. It is important to keep these limitations in mind as we review experiences with providing microfinance services aimed at encouraging investments in SSI technologies in the next section. Nevertheless, recent institutional and technological innovations hold considerable promise for making financial services available for purchasing irrigation equipment more effective.

3. ARE SMALLHOLDERS OBTAINING CREDIT FOR, AND BENEFITING FROM, IRRIGATION INVESTMENTS?

3.1 The Potential for Expanding Small-scale Irrigation in Sub-Saharan Africa

There is abundant evidence that the potential for expanding smallholder-irrigated agriculture in SSA is immense. For example, You et al. (2011) estimated the scope for expanding SSI is around 7.3 million hectares (Mha), with higher internal rates of return for small-scale rather than large-scale irrigation (see also Fujiie et al. 2011). Xie et al. (2014) estimated the potential for motor pump irrigation at 30 Mha. Giordano et al. (2012) estimated that investments in motorized pumps could benefit some 185 million farmers and generate net revenues of around USD 22 billion[9]. Otoo et al. (2018) estimate the potential area that could be irrigated by solar photovoltaic (PV) pumps in Ethiopia to be between 1.1 and 6.8 Mha, depending on assumptions about depth to groundwater. Small motorized pumps, and more specifically solar pumps, have the additional potential benefit of being useful for multiple purposes, by women as well as men (Burney et al. 2013; Nigussie et al. 2017). It is no wonder that farmers are investing in pumps and other irrigation equipment when possible, as described in section 1. However, as also noted there, lack of financial resources seems to be a major constraint.

3.2 Financial Services for Small-scale Irrigation in Sub-Saharan Africa

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and the World Bank funded literature reviews of SSI financing in SSA more than a decade ago (Grimm and Richter 2006a, 2006b; Batz et al. 2010). Grimm and Richter (2006a) found that the literature on experiences with financing SSI in SSA was extremely limited – a statement that remains largely accurate. They make some useful conceptual points and offer useful definitions and distinctions, but there was clearly little in the way of actual field experience in Africa on which they could draw. They also make some assumptions that may seem logical. For example, asserting that "sophisticated" equipment is not suitable for African small-scale farmers, but for which there is little hard evidence. They make a useful, if obvious, distinction between short-term or seasonal "working capital" credit needs (for fertilizer, fuel, etc.) and "medium-term" credit needs – "investment loans" – defined as loans made for less than 5 years, which is useful to purchase more expensive equipment (they advise against longer-term credit for African smallholders) (see also Grimm and Richter 2006b). They also define "effective" demand: when a client is *able* as well as *willing* to repay the loan. Effective demand may be lower than the theoretical demand captured by surveys.

Grim and Richter (2006a) discussed the potential sources of credit in rural SSA. Table 1 presents a typology of lenders based on their study, but with additional sources. In general, African smallholders only rarely obtain loans from formal lenders; these entities are more likely to offer wholesale loans to semi-formal outlets, though this is changing in some countries such as Kenya. Farmers more often rely on informal lenders, especially relatives and friends or their own resources, as found in Ghana by Namara et al. (2014). Community-based semi-formal lenders are growing in importance in many countries, but often do not offer medium-term loans that would support the purchasing of equipment such as pumps (Otoo et al. 2018; Ayele 2015). Financial service providers face high costs and risks in lending to a dispersed population of smallholders; but providing credit

[9] There is also huge potential for other water management investments, such as small communal schemes and rainwater harvesting, in SSA (Giordano et al. 2012; Xie et al. 2014).

for irrigated agriculture has the advantage of reducing risk and seasonality compared to rainfed farming, and pumps may be offered as collateral for the loan.

TABLE 1. Typology of rural lenders.

1. Formal lenders	*3. Informal lenders*
- Agricultural development banks - Rural branches of commercial banks - Cooperative banks - Rural banks/community banks - Commercial microfinance service providers	- Relatives and friends - Moneylenders - Rotating savings and credit associations
2. Semi-formal lenders	*4. Interlinked credit arrangements*
- Credit unions - Cooperatives - Village or semi-formal community banks - NGOs	- Input suppliers/crop buyers - Processing industries - Agricultural wholesalers - Agricultural supply and equipment retailers

Source: Adapted from Grimm and Richter 2006a: 26 (Table 1).

Grimm and Richter (2006b) is a detailed case study of Kenya, which had (and has) a more developed rural financial services structure than most African countries. The authors found that credit for SSI equipment is primarily concentrated in agricultural "high potential" areas; poor smallholders are largely excluded, though they state that increased competition has led to the extension of more financial services to poorer areas and people. A growing number of financial institutions are offering medium-term loans that, in principle, are appropriate for irrigation equipment purchases. However, even in high-potential areas, at the time of the study, financial institutions had not designed financial products aimed at SSI farmers. Grimm and Richter (2006b) found no reliable information on how SSI farmers actually finance their investments and other operating costs. In medium- and low-potential areas, the availability of financing for SSI investments is even more limited. Otoo et al. (2018) also found that few MFIs in Ethiopia offer financing for irrigation equipment that is affordable and tailored to such large purchases; at the time of writing, these typically range from around USD 75 for manual water-lifting equipment to USD 600 for solar pumps (without energy storage) depending on the country and local markets.

To conclude, there is currently very little up-to-date information on what kinds of public financial services or products are available to support African smallholders' investments in irrigation equipment; and very little systematic information on how those who have acquired pumps and other equipment actually finance their investments.

3.3 Is There Demand by Smallholder Farmers for Credit to Invest in Irrigation?

As noted in section 1, irrigated agriculture is generally more productive and profitable and less risky than rainfed agriculture when there are reasonable output markets. With rapid urbanization in SSA, the demand for higher quality food is also increasing. Therefore, it is no surprise that small-scale private irrigation is expanding in many SSA countries, apparently driven by farmers' own initiatives and investments (Giordano et al. 2012; Burney et al. 2013; de Fraiture and Giordano

2014; Giordano and de Fraiture 2014; Namara et al. 2014; Woodhouse et al. 2017). Farmers may be using their own resources or obtaining credit from a range of informal sources – we do not know for sure. However, the rate of expansion is less than what is needed and is curtailed by several constraints, including the availability and cost of equipment, availability and cost of energy, and the high cost or non-availability of financing to make the initial purchase (e.g., Hagos et al. n.d.). That said, Hagos et al. (n.d.) also pointed out that the assumption is often made that simply making credit more widely available will lead to more investment in irrigation equipment. However, there is no evidence to support this assumption.

Hagos et al. (n.d.) have attempted to fill this gap in knowledge for three states in Ethiopia (Amhara, SNNPR and Oromiya). They observe that there seems to be an adequate number of MFIs offering agricultural credit in the sample areas. However, the lending and savings products offered are very limited. With repayment periods of a year or less, the credit is largely used for purchasing seasonal inputs. At an average value of USD 18.40, the loan amounts are a fraction of the cost of even inexpensive equipment. Repayment is a major challenge, because these organizations were historically humanitarian providers of free credit. Based on a survey of 400 households (about half using irrigation technologies, mostly buckets but a few pumps), the researchers found that microfinance programs are targeting the better-off, male-headed and relatively well-educated households, which reduces the risk to the lender. Access to credit is a significant factor in the adoption of irrigation technologies. However, the financial institutions are not offering the kind of demand-driven products needed to scale up irrigation investments, such as sufficient loan size to cover capital investments, medium- to long-term repayment periods, seasonal repayment schedules, and affordable fees and interest rates.

Namara et al. (2014) carried out an in-depth survey of 494 farmers as well as a census of 12,620 households in three regions of Ghana on the use of water-lifting technologies. Nearly all respondents, both male and female, who currently rely on rainfall or use buckets, expressed an interest in using motorized pumps. Most had access to irrigable land, but only about half were using it fully. They said they are constrained by limited access to equipment, high operating costs, lack of access to finance, output market risks and inadequate government support. Pump owners belong to the richest 20% of their community (and are mostly male and better educated)[10], and women and poorer farmers cannot raise the capital needed for such purposes.

In a survey of 240 farmers in three regions of Ghana where groundwater is available, Owusu et al. (2013) found that those with motor pumps had far higher gross margins than other farmers, and that access to credit is a significant (at 1% level) enabler for farmers to purchase pumps. The authors argued that their results show that farmers would be better off if provided with subsidies and microcredit.

Many studies find that the lack of financial means to purchase equipment such as pumps is the most critical gap for several smallholders. Credit from official sources is rare and informal sources are expensive. Based on several case studies, an IWMI workshop report states that "financing is the single most important adoption determinant among many others" (Agwater Solutions Project 2011: 7). Mdemu et al. (2017) and Dittoh et al. (2013) also found that lack of access to finance is a critical barrier for Tanzanian and Ghanaian farmers, respectively. Therefore, developing appropriate financial products through effective institutional support mechanisms is critical to enable poorer farmers, including women, to obtain motor pumps and also other irrigation equipment (Agwater Solutions Project 2011; Giordano et al. 2012).

[10] Namara et al. (2014) attributed no causality to this relationship, but suggest it is likely the owners were better off from the start.

USAID's Feed the Future initiative studied the market for drip irrigation systems in southern and eastern Africa, and analyzed the experiences of its own partners (Fintrac 2016a, 2016b). While there is strong evidence that drip irrigation can be quite profitable for commercial growers of high-value produce, the uptake is disappointing. There are many reasons for this, but lack of credit to enable the purchase of the equipment was found to be a major constraint, even in Kenya. Despite the large returns, drip irrigation systems are not recognized by financial institutions as collateral, because they depreciate rapidly.

Even in the late 1990s, there was sufficient evidence for the unmet demand for financial services for IWMI, CTA[11] and the Food and Agriculture Organization of the United Nations (FAO) to organize a conference examining private sector irrigation in SSA (Sally and Abernethy 2002). In 2011, the World Bank and others published an analysis of the lessons learned from a comparative assessment of smallholder private irrigation initiatives in Burkina Faso, Mali, Niger, and Nigeria. Although many of these initiatives involved substantial subsidies, they did demonstrate the potential of promoting motorized pumps and other technologies through the private sector (Abric et al. 2011).

The value chain required to support this kind of private SSI is quite different from that required to support rainfed or larger-scale public irrigated agriculture (Abric et al. 2011; Giordano et al. 2012; Colenbrander and van Koppen 2013; Giordano and de Fraiture 2014; Bjornlund et al. 2017). It requires, on the input side, a ready supply of pumps, pipes and other technologies at affordable prices; the reliable availability of fuel, spare parts and maintenance expertise, again at reasonable prices; timely availability of quality seeds and fertilizer; and financial resources. Rural African agro-dealers rarely have sufficient capital to keep a selection of pumps, pipes and spare parts in stock. On the output side, reliable well-functioning markets supported by transport, storage and information infrastructure is critical, though Woodhouse et al. (2017) noted that informal regional markets can also be effective sources of demand. Also, farmers themselves need to have a supply of labor, and agronomic and business management skills to be efficient and productive.

As documented in detail for Zambia, improving the entire value chain will be critical to achieving the full potential of motor pump irrigation (Colenbrander and van Koppen 2013). The Zambian pump supply chain is very underdeveloped; it is centralized in a few cities, and farmers find it difficult to obtain information on what is available and the costs. Very few MFIs offer agricultural credit, and only one specializes in financing irrigation equipment. When MFIs do finance irrigation equipment, loans are repayable in 6 months and the interest charged works out to 30-50% per year.

In a few places, effective value chains are already largely in place: in Western Kenya, for example, a thriving horticultural business based on the use of motor pumps has developed, driven by a combination of farmers' demand and increased supply through agro-dealers (Woodhouse et al. 2017). However, this is rare: studies by the Agwater Solutions project found that there are numerous value chain problems that severely limit access to irrigation equipment (Namara et al. 2014; Giordano and de Fraiture 2014). Grimm and Richter (2008) also noted that the conditions that would enable providing financial services for SSI are largely absent in rural SSA. Examples include transport and communication infrastructure, macroeconomic policies and legal frameworks. That said, since the study conducted by Grimm and Richter (2008), there have been technological innovations leading to new forms of financial services.

[11] CTA - Technical Centre for Agricultural and Rural Cooperation (a joint international institution of the African, Caribbean and Pacific [ACP] Group of States and the European Union [EU]).

In a review of financing for water and sanitation services (including SSI), Batz et al. (2010) estimated that the number of potential microfinance clients in rural areas for water supply investments (including, but not only, irrigation) is around 3.1 million in SSA. However, there is a large supply-demand gap for SSI financing, especially for medium- and longer-term finance (Batz et al. 2010; Grimm and Richter 2006a, 2006b).

Recently, substantial attention has been focused on the potential for expanding the use of solar PV irrigation pumps (Burney et al. 2013; FAO-GIZ 2015; IRENA 2016; Otoo et al. 2018). Otoo et al. (2018) analyzed how the growing demand for solar PV irrigation pumps could be met in Ethiopia, given the current weaknesses in the private sector value chain, and limited public finances and capacity. They use a business model framework to identify opportunities for private market chain actor investments that would not require substantial donor input but would bring long-term benefits. Most of their observations on the availability of finance apply to other irrigation equipment as well. They confirm that there is a gap between the size of agricultural loans generally available (mean loan size of ETB 397 [USD 18.40][12] [Hagos et al. n.d.]) and the cost of a solar PV pump (smaller pumps range between ETB 8,000 [USD 400] and ETB 13,000 [USD 650])[13]. Nevertheless, they also confirm, based on the results of a pilot study, that investments in solar pumps can be very profitable for smallholder farmers if various market and other conditions are in place. They examined, in detail, three potential business models (see section 4.5).

3.4 Conclusion: Mismatch of Supply and Demand for Credit

To conclude, while we are not aware of any studies specifically aimed at measuring the demand for credit to finance irrigation equipment purchases, nearly all research on smallholders' interest in or adoption of irrigation equipment find that lack of access to financial resources is a major constraint, though not the only one, especially for poorer farmers, and more so for women than for men. The observation that finance is only one element of the constraints on adoption of SSI technologies suggests that solutions must be integrated packages designed to address the full range of these constraints.

4. INNOVATIVE APPROACHES TO FINANCING SMALL-SCALE IRRIGATION

Based on our review of the available literature, we believe the evidence is clear: there is indeed a large gap between the supply of finance for purchasing irrigation equipment and the demand for this equipment. It is not, however, simply a matter of making more funds available through traditional microfinance or other rural financial institutions. If policymakers want to provide more opportunities to poor smallholders lacking the means to purchase pumps and other irrigation equipment, including women and youth, then it will be critical to design better financial products and make them available to large numbers of farmers. It will also be necessary to support the development of other components of the irrigated agricultural value chain, but that is beyond the scope of this study. Fortunately, there is a growing number of pilot initiatives and innovative ideas that have considerable potential. Unfortunately, as far as we could determine, there are no credible

[12] USD 1 = ETB 21.60 in June 2016.

[13] USD 1 = ETB 20 in December 2016.

studies on how well they work, or under what conditions they are feasible. This section reviews some of these ideas, drawing on whatever evidence we could find regarding their potential for either further testing or scaling out.

The Kenya Women's Finance Trust (KWFT) was an early pioneer in developing a client-oriented financing product linked to a specific water technology in SSA, in this case a tank for water harvesting (Batz et al. 2010: 12 [Box 4]; Kiiru and Pederson 1997). KWFT had a rocky start but stabilized in the 1990s under new management. It pilot-tested a scheme in which women could obtain credit equal to the cost of a water tank for one year. It negotiated with manufacturers for discounts and free delivery to rural areas. KWFT also invested in marketing and training its staff, which led to a rapid increase in demand. In 2013, KWFT became the Kenya Women Microfinance Bank (https://www.kwftbank.com/), which offered a wide range of financial products – including for water tanks and now for irrigated greenhouse kits as well. Some of the lessons of KWFT are being applied today to the agricultural, including irrigation, equipment sector. These lessons include: providing a client-driven product; offering complementary services such as free home delivery; allowing payment over a period of time; and investing in marketing materials, promotional campaigns, and selling-skills training for their field staff (Batz et al. 2010).

4.1 Microfinance for Purchasing Irrigation Equipment

A weakness identified in many studies is that microfinance products are not designed to enable the purchase of moderately expensive equipment such as pumps and drip or sprinkler irrigation systems. Agricultural finance products tend to be limited to seasonal credit for inputs such as fertilizer and seeds. We found several examples where MFIs, with external partners, are testing products aimed specifically at enabling poor smallholders to purchase irrigation equipment.

4.1.1 Senegal: Water and Microfinance Initiative

Launched in 2012, the "Water and Microfinance Initiative" (WMI) aims to facilitate access to irrigation by smallholders who are also clients of MFIs. Its goal is to improve crop production and profitability in an environmentally sustainable manner. This initiative is implemented by the Participatory Microfinance Group for Africa (PAMIGA) (http://www.pamiga.org/index.php?lg=en&rub=&srub=)[14], through a member institution in Senegal, *Union des Institutions Mutualistes Communautaires d'Epargne et de Crédit* (U-IMCEC), with financing by the Swiss Agency for Development and Cooperation (SDC). According to PAMIGA (n.d.), the approach is also being piloted in Benin, Burkina Faso, Mali and Togo, but no information is provided on these cases.

The unique feature of this case is that the MFI is partnering with other entities that have more expertise in irrigated agriculture and environmental issues, and have developed a credit product based on market studies and focus group discussions to ensure it is economically viable. The Senegal pilot is being implemented in an area known for its smallholder horticultural production, where water is available in a shallow aquifer. The loan is designed to be larger with a longer maturity than the typical microcredit seasonal loan offered in Senegal. It covers the cost of labor and equipment (motor pumps, cemented wells, sprinkler and drip systems) needed to enable farmers to expand their irrigation operation. U-IMCEC has invested in identifying agricultural and environmental risks and ways to manage them, developed a variety of guides and manuals, and trained its loan

[14] PAMIGA's Annual Report 2017 is available at http://www.pamiga.org/pdf/pdfen-para400-pamiga-1527503551.pdf (accessed on November 1, 2018).

officers as well as clients on agricultural and environmental best practices. Loans are conditioned on meeting environmental criteria, e.g., installing a cement rim on open wells to reduce pollution of groundwater; and environmental indicators are used to track compliance.

PAMIGA (n.d.) does not specify all the conditions of the loans or the interest rate. Average loan terms range from 24 to 30 months. In the branch of U-IMCEC where the new loan product was initially tested over a 24-month period, 160 projects were financed at a total value of FCFA 119.5 million (approximately USD 207,000). As a result, more than 1,400 small farmers, 74% of whom were women, gained access to productive water. Around 86% of the projects were for motor pumps. The loans were repaid without difficulty. PAMIGA (n.d.) explains that based on these results, U-IMCEC is expanding the product to other regions of the country. A 2015 press release on the CGAP site (https://www.microfinancegateway.org/announcement/opic-pamiga-and-calvert-foundation-partner-increase-access-renewable-energy-rural) briefly discusses additional funding for expanding the program to Benin, Burkina Faso, Cameroon, Kenya, Madagascar, Senegal, Tanzania, and Togo.

The PAMIGA Annual Report for 2017 (http://www.pamiga.org/pdf/pdfen-para400-pamiga-1527503551.pdf) includes very brief descriptions of other PAMIGA irrigation microfinance programs in Benin and Kenya (solar water pumping solutions for smallholder farmers, with the setup of a new partnership with SunCulture [http://sunculture.com/]). However, we have been unable to obtain more up-to-date and detailed information on this innovative financing model[15].

4.1.2 Asset Financing: The Futurepump Case, Kenya

In this model, a solar PV pump manufacturer has taken the initiative. Futurepump (https://futurepump.com/) is a Kenyan company which manufactures a relatively low-cost (USD 650-750) solar PV product called a 'Sunflower' pump[16]. This is said to be a robust, portable pump that comes with a five-year warranty. Finance is accessed by farmers through a partnership between the technology provider and a financial institute. The farmer purchases the irrigation equipment from the supplier using a loan from the partner financial institution. This model enables the parties to share the financial risks (Mashnik et al. 2017). The company provides a one-year warranty on parts and services, and training to the farmer in using the pump and in irrigation practices. The company had planned to partner with a Kenyan bank to offer loans to purchasers who would make a 30% down payment. However, even when it agreed to a 50% down payment, the bank officers hesitated. Therefore, it is working with a local cooperative to pilot an asset-financing scheme with payments timed at harvest. The cooperative financed the purchase of 44 pumps using a revolving fund created with help from Powering Agriculture. The results have not been reported. Futurepump has been testing other financing models, some of which are discussed below.

4.1.3 Solar Irrigation in Rwanda Project

According to the "Energy 4 Impact" website (https://www.energy4impact.org/), the new (January 2018) solar irrigation in Rwanda project (https://www.energy4impact.org/news/energy-4-impact-granted-us1-million-develop-small-scale-solar-irrigation-market-rwanda) is designing financial mechanisms to make small-scale solar irrigation technologies more affordable for smallholders. A working capital facility will support system suppliers to finance inventory purchase and a receivables

[15] We sent an email to PAMIGA, but did not receive a response.

[16] According to the Futurepump website (https://futurepump.com/about/), it is "the commercial vehicle tasked with scaling up that work, and both iDE and the PRACTICA Foundation remain closely involved in guiding the project, holding seats on the board of Futurepump Ltd."

facility to bridge the gap between sale and receipt of funds. In addition, a consumer credit facility will enable farmers and farming cooperatives to purchase the systems on credit. Energy 4 Impact will also provide technical assistance to the farmers and help connect them with technology suppliers and financial institutions for credit access.

The project will support 3,000 farmers initially (50% women), but the overall objective is to support 13,000 farmers to get access to solar irrigation systems over 5 years. The project is supported by the Organization of the Petroleum Exporting Countries (OPEC) Fund for International Development (OFID) and (Sida), and will be implemented in three phases in eight districts of Rwanda. We could not find additional details on the project implementation, but potentially it is another example of integrating the technical and financing dimensions to promote uptake.

4.2 Integrated Technical and Financing Support for Agricultural Value Chains

The literature review has shown the important role of an effective value chain for both inputs (including equipment purchase and support) and outputs that enable producers to make a profit. We found several pilot projects that provide financial services to producers as a component of interventions aimed at strengthening the entire value chain.

4.2.1 From Rainfed to Irrigated Cotton Production in Burkina Faso

A four-year program was launched in April 2018 to support small-scale cotton farmers in western Burkina Faso, a semi-arid region where farmers grow rainfed cotton, a major export crop, and are vulnerable to extremes of drought and flooding. These risks are becoming worse because of the impacts of climate change. The program will provide training to about 1,000 small-scale cotton farmers in land and water management, invest in small-scale irrigation systems, and facilitate farmers' access to credit. The planned beneficiaries are members of cooperatives affiliated with *Société Burkinabé des Fibres Textiles* (*SOFITEX*) (http://www.sofitex.bf/), which is responsible for marketing more than three-quarters of the country's cotton production. The program will be financed and implemented by the Global Partnership on Output-Based Aid (GPOBA) (http://www.gpoba.org/news/irrigation-systems-introduced-small-scale-cotton-farmers-burkina-faso) and the World Bank's International Finance Corporation (IFC).

One project element will finance procurement and installation of SSI systems for areas up to 3 ha. Farmers who successfully implement these investments and meet other milestones will be reimbursed up to 80% of their investment costs. Another project element will help farmers who apply early to get access to market finance through a partial risk facility. A GPOBA grant will help mitigate some risks such as natural disasters, defaults on loan repayments, and incomplete project implementation by compensating up to half the lenders' losses and paying half of the fees for purchasing risk-mitigation products. Farmers will also get a subsidy of 80% of interest on the first year's loan.

This project is the first one under the World Bank's new Sahel Irrigation Initiative Support Project for Western Africa (http://projects.worldbank.org/P154482/?lang=en&tab=overview). Since the project is just starting, there are no results to report as yet. Further, even after searching documents on the website of the Sahel Irrigation Initiative, we were unable to find more details on how the project will operate and, specifically, how the financing of farmers will work.

4.3 Leasing, Mobile Layaway and Rent to Own: "Pay-As-You-Go" Systems

4.3.1 Kenya Smallholder Solar Irrigation Project

The Kenya Smallholder Solar Irrigation Project (KSSI) (https://www.winrock.org/project/kssi/), implemented by Winrock International with assistance from USAID, supported a pay-as-you-go (PAYGO) model that was also implemented by Futurepump, a Kenyan manufacturer of solar pumps. According to a Winrock case study, a woman was paying KES 5,500[17] per season to hire a diesel pump one day a week and irrigated 0.75 acres (0.3 ha) of tomatoes. She also hand-watered 0.25 acres (0.1 ha) of kale. The woman purchased a KES 75,000 solar pump including a 12-meter pipe through the pay-as-you-go program. She paid KES 20,000 as an initial payment, and is making a monthly loan repayment of KES 2,500 for 22 months. This works out to a loan of KES 55,000 with no interest. According to the case study, she now irrigates 1.25 acres (0.5 ha), and her gross profit will increase 350% after she repays the loan (Winrock-KSSI 2017).

In 2018, the project began supporting a partnership between Futurepump and Juhudi Kilimo (https://www.winrock.org/partnering-for-change/) using a new credit line for solar irrigation pumps[18]. Juhudi Kilimo (https://juhudikilimo.com/) is an agricultural microfinance institution that, among others, finances specific income-producing agricultural assets. Some lessons learned from the KSSI project (https://www.winrock.org/getting-pumped/) include the following: the need for an intermediary to connect the technology to the financing institution – for example, financing institutions will accept the pump as collateral only if they are assured of its quality (guaranteeing quality is a role Winrock has played); repayment for solar pumps is possible in 2 years; financial institution staff also need to be trained; there is no one-size-fits-all situation – the package must be adapted to the specific needs of the farmer; bundling packages is important; and offering variously priced packages (theirs varied from USD 650 to USD 2,000) is important.

Another Kenya-based example of pay-as-you-go financing for irrigation equipment is the SunCulture AgroSolar Irrigation Kit (http://sunculture.com/products). It combines the solar pumping technology with a drip irrigation system. SunCulture has partnered with the Shell Foundation to offer this pay-as-you-go option, but we did not find any details on how it works.[19]

4.3.2 KickStart International's "Farmer Friendly Financing"

KickStart International (http://kickstart.org/how-we-work/#our-model) is an international NGO that designs irrigation equipment with poor small farmers' priorities in mind and then undertakes contracts for large-scale mass production. It supports the development of effective private-sector supply chains, and promotes and mass-markets its products to smallholders, partner companies, and organizations working with smallholders. KickStart is well known for its treadle pumps, but is moving into marketing at least two models of solar PV pumps as well. Its equipment sells for a fair market price, i.e., without direct subsidies, to encourage a sustainable market-oriented business. KickStart uses grant funds for training retailers and farmers, product development and testing, monitoring and evaluation, and social marketing. Based in Nairobi, Kenya, where it has established an Innovations Hub, it currently works in 16 African countries[20].

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[17] KES 100 = USD 1 in 2017.

[18] According to the KSSI website, the project ended in late 2017, but apparently there has been an extension. It is not clear whether this is the same pilot discussed above in section 4.1.2.

[19] SunCulture gets support from the Global Innovation Exchange; refer https://www.globalinnovationexchange.org/innovation/sunculture-agrosolar-irrigation-kit

[20] KickStart says its impact data has proven that its "pumps transform families' lives, and have already enabled over 1,000,000 people to lift themselves out of poverty" (KickStart n.d.). See also KickStart and COMACO (n.d.).

Even though its treadle pumps are relatively low cost (USD 60 to 140 depending on the model), they are still beyond the financial means of most poor smallholders. Therefore, KickStart has been testing three financing models to enable poor farmers to purchase its "MoneyMaker" treadle pump. The first model is paying cash up-front to purchase a pump. The second is "*mobile layaway*", a micro-savings service that enables people to make very small payments toward purchasing a pump using their mobile phones via MPesa[21]. This program seeks to enable more women and other poor farmers to save up and purchase a pump. Such "point-of-sale" loans, or "layaway", used to be common in the United States of America (USA) and other places, and facilitated by modern technology, they are making a comeback, according to *The Economist* (August 4, 2018) (https://www.economist.com/finance-and-economics/2018/08/04/tech-startups-are-reviving-point-of-sale-lending?frsc=dg%7Ce).

The third financing model is "*rent-to-own*". In this option, a farmer acquires a pump with a 20% down payment and then makes additional payments as the pump is used to grow crops. A final balloon payment is scheduled for 5 months after the initial purchase, by which time farmers will have earned money from their first harvest.[22] Both cash payment and rent-to-own models provide immediate economic and food security benefits. According to a brochure shared by KickStart, the purchaser deposits 20% of the total cost, then makes monthly payments, described as "rent" for some payments, and "deposit plus rent" for others, with the final payment occurring in month five – at which time the farmer should have made enough profit from irrigation to pay the cost. The total paid includes fees and interest (55% and 34% annual percentage rate [APR], respectively, for the two treadle pump models[23]), so the final cost is greater than the cash retail price. KickStart found significant differences in the gender of customers: of the customers paying cash, 77% were men, while it was evenly divided in the rent-to-own model (48% men, 52% women). Seventy-percent of those using the layaway plan were women (see below)[24].

KickStart is also experimenting with a variation on this "pay-as-you-go" model with solar electric pumps having a built-in chip and cloud-based link, similar to *PAYGO* solar home lighting systems. Several options are being tested: "pay per time passed", "pay per time used", and a "hybrid" system. A USD 370 solar pump is sold with a markup at USD 450 with payments over approximately a year. Over 70 pumps have been sold to date and the hybrid system (fixed amount per week plus extra for the time the pump is actually used) seems to be the most popular[25].

As part of an assessment of the impacts of KickStart's treadle pump program, the International Food Policy Research Institute (IFPRI) carried out a small assessment of the layaway program (*Tone Kwa Tone*, "Drop by Drop", in Swahili), which was initiated in 2012 in Kenya (Njuki et al. 2014). At the time of this study, 250 people had enrolled in the program. The researchers followed up with 12 adopters (seven women, five men). All the women were members of a self-help women's group. Although all 12 appreciated the layaway service because it enabled cash-poor people to purchase a pump, they felt the delay in obtaining the pump was a major disadvantage and expressed a preference for rent-to-own or pay-as-they-use financing models.

KickStart kindly shared a more recent draft unpublished report summarizing the results of a pilot study of the three financing options in three counties in eastern Kenya (KickStart and

[21] M-Pesa is a mobile phone-based money transfer, financing and microfinancing service offered by Vodafone for Safaricom and Vodacom cellphone subscribers in Kenya and Tanzania.

[22] The testing of these two financing models, i.e., mobile layaway and rent-to-own, receives financial support from the Global Innovation Exchange; see https://www.globalinnovationexchange.org/innovation/kickstart-international.

[23] The source for this information is a spreadsheet shared by John Kihia, Director of Field Operations, KickStart.

[24] Based on an email from John Kihia, Director of Field Operations, KickStart, dated August 20, 2018.

[25] Based on an email from Martin Fisher, Chief Executive Officer, KickStart, to Doug Merrey dated August 18, 2018.

Washington State University 2016). This study found that of the 68 people who participated in the mobile layaway plan, only 10 completed their purchase. Apparently, the delay in benefitting from their investment made this option unattractive. In addition, lack of money (to continue payments) and the short repayment period were serious constraints. The CEO of KickStart suggests[26] that this model has not scaled up as well as expected for the following reasons: (i) building trust in the layaway system has taken time and is expensive; (ii) many Kenyan farmers have alternative ways to get credit; and (iii) the largest experiment was during a drought period when water was scarce. Nevertheless, the layaway model may still be valid for low-cost pumps. A separate experiment by myAgro (https://www.myagro.org/) has successfully scaled a layaway model for seeds, fertilizer and farm equipment in Mali and is now moving to Tanzania.

In 2017, KickStart launched a partnership with World Vision's VisionFund International (http://www.visionfund.org/212/media/news/article/affordable-irrigation-to-african-farmers/) to offer an integrated approach to enabling smallholders to access, purchase and use irrigation systems. Building on a pilot test in Zambia that benefited some 3,500 farmers, the partnership aims to help 100,000 farmers in Malawi, Tanzania and Kenya to benefit from irrigating their crops over 5 years. In essence, KickStart will continue to develop and strengthen its pump supply chain in these countries. VisionFund will develop and make available specialized financing products through its network of MFIs. Its approach involves a thorough assessment of each farmer's business and financial status to guard against overindebtedness. A pump loan enables the farmer to have a steady year-round income, reducing the risk and increasing demand for additional loans for inputs. There is a down payment, with a two- to three-month grace period, and the full payment is completed in another 5 to 6 months. Costs for the farmer are high, as with all rural lending, but repayments have "generally been good"[27].

We could not find detailed data on the results of the partnership with VisionFund. However, these models are examples of possible innovations to support more smallholders to get into irrigated agriculture.

4.4 "Contractor" or "Utility" Models

4.4.1 Senegal Solar Irrigation Micro-utilities

Mashnik et al. (2017) referred to this as a "pay-as-you-go" model, but it is really a contractor or "utility" model[28]. They illustrate this with two cases. In this model, a service provider assumes all of the technical, operational and financial risks. Farmers purchase irrigation *services* on-demand based on either time- or usage-based tariffs and pay as they go.

In the first case, in 2013, Columbia University's Earth Institute adopted this business model for a pilot study in Senegal, implemented with a local partner, Millennium Promise (https://www.millenniumpromise.org/), in their Millennium Villages Project (http://millenniumvillages.org/). They developed three pilot micro-utilities managed by irrigation cooperatives each serving seven farmers (one is a women's cooperative farm). Rather than distributing water through pipes, wires are run to each farm and a mobile solar PV pump is brought to the farm when irrigation is

[26] Based on an email from Martin Fisher, Chief Executive Officer, KickStart, to Doug Merrey dated August 18, 2018.

[27] Some of this information is based on an email from Martin Fisher, CEO, KickStart, to Doug Merrey dated August 18, 2018.

[28] Pay-as-you-go or "PAYGO" is a term used in the growing business of off-grid solar energy providers. It allows consumers to digitally pay for solar energy in weekly installments. Refer to the Energypedia wiki (https://energypedia.info/wiki/Advantages_and_Disadvantages_of_PAYGO_Approaches).

requested[29]. According to Mashnik et al. (2017), this model is working well but provide no details. According to the Powering Agriculture website (https://poweringag.org/innovators/micro-solar-utilities-small-scale-irrigation), farmers use prepaid electricity cards issued by the micro-utility and sold on commission by local vendors. Farmers are said to have experienced, on average, 29% increases in production, and the solar pumps have resulted in emissions avoided by not using diesel pumps. Although not clearly explained, it appears that in this tariff-based financing model, "their appliance loans in small payments added to their micro-utility bills" – in other words, farmers may be purchasing their pumps through a pay-as-you-go system (the website is not very clear on this point). The project is seeking partners for scaling up the model.

4.4.2 Bihar, India, Solar Irrigation "Virtual Utility"

The second case is from Bihar, India, where Claro Energy (http://claroenergy.in/irrigation-iaas/) offers a variation on the pay-as-you-go model: a "virtual utility" under which it owns, operates and rents to farmers mobile solar irrigation systems consisting of a portable solar array and pump mounted on a trolley (which can be hauled to a farm by a tractor). The company has developed automated booking, monitoring and payment systems. Farmers prepay for the service using mobile money, a credit card or by making a deposit at a company depot. This is another pilot supported by the Powering Agriculture initiative. Mashnik et al. (2017) provided no further details, but according to the Powering Agriculture website (https://poweringag.org/innovators/low-cost-pay-use-irrigation-using-solar-trolley-systems), the company has installed five fixed solar systems and 25 trolley systems for irrigation, serving 30-40 farmers per day. Some 350 farmers are currently benefiting, 30% of whom are women. A prepaid card system is being used to remotely activate the pump-trolley systems. According to the website, the company was expecting to produce 25 trolleys with a new design by the end of 2017. Most clients cultivate less than a hectare; the cost of the service (refer: https://poweringag.org/news-events/news/agro-centric-mini-grids-solar-trolleys-could-transform-indian-farming) is said to be substantially cheaper than diesel pumping.

4.4.3 Other Fee-for-service Utility Cases

In Morocco, some energy service companies sign a performance contract with a farmer for providing the irrigation equipment, including installation and maintenance. The farmer pays for either the energy or the water delivered (Hartung and Pluschke 2018: 48). This is somewhat similar to the Senegal utility model described above. In Bangladesh, the Infrastructure Development Company Limited (IDCOL) (http://www.idcol.org/)[30] is targeting the deployment of 50,000 solar irrigation systems by 2025. Landholdings are tiny and fragmented. Therefore, in this model, a group of 20-25 farmers forms an association to buy water extracted using one irrigation pump. IDCOL partners with local organizations who install and operate the pump and sell water to farmers. As of 2015, 168 pumps were operating under this arrangement with another 277 planned for installation. IDCOL also uses a combination of grants and credit for farmers with a sufficient land area to purchase small-sized pumps (IRENA 2016: 21).

[29] The pumps are powered by alternating current (AC) as it is said to be substantially cheaper than direct current (DC) electricity. This program was supported by the Global Innovation Exchange; refer: https://www.globalinnovationexchange.org/innovation/micro-solar-utilities-for-small-scale-irrigation-in-senegal.

[30] IDCOL is a government-owned company licensed as a "non-bank financial institution."

4.5 Other Financing Models for Irrigation Equipment

Hartung and Pluschke (2018: 21-22) briefly describe and illustrate several other models through which MFIs finance the purchase of irrigation as well as other equipment by smallholder farmers. One is the use of *social group guarantees combined with collateralizing the financed asset*, providing additional insurance and technical assistance. The example is Juhudi Kilimo (http://juhudikilimo.com/about-us/mission-vision-core-values/) in Kenya, an agricultural microfinance institution mentioned above. No further details are provided on the institution's website. Another model involves *an intermediary that buys equipment in bulk and sells it to farmers at 10% interest, repayable at harvest* – deducted by the buyer who remits part of the proceeds to the intermediary. CoolCap (https://coolcapfund.org/) is a social capital organization in Kenya that follows this model to make "leapfrog technology", including solar irrigation pumps (costing USD 650), available to smallholders. Again, there are no further details on how this works.

There are other examples of *rent-to-own* or *"hire purchase"* systems in addition to the KickStart version described in section 4.3. "Rent to Own" (RTO) (https://rtoafrica.com/) is the name of a company in Zambia that sells productive assets, including irrigation pumps, through an integrated hire-purchase package. This solution enables clients to acquire and pay through payment schedules tailored to the circumstances. According to the online report (https://rtoafrica.com/rent-to-own-boosting-agricultural-growth-with-smallholder-farmers-in-zambia/), typical clients are asset-poor with daily incomes of about USD 2.50 or less. Over a five-year period, RTO claims to have disbursed nearly 2,000 pieces of equipment, valued at USD 2.5 million, of which 1,300 are now owned by the client. RTO has partnered with Kiva (https://www.kiva.org/about), an international non-profit social organization that crowdfunds small loans to poor people in developing countries. According to the Kiva website (https://www.kiva.org/about/where-kiva-works/partners/281), this is seen as a somewhat risky partnership; data on this website show that about 28% of RTO's clients are women, and the average loan is USD 872 at an interest rate of 39% APR over an average loan term of 8.68 months. The delinquency rate seems high at over 25%. There are no data provided specifically on irrigation equipment.

We found another example of this model in Uganda, which focused specifically on providing mobile modular irrigation systems. Agriworks Uganda's technology involves a water delivery system that can be delivered by motorcycle and connected to rain guns, sprinklers or drip systems provided by the company. According to the company (https://sustainabledevelopment.un.org/content/documents/212492-Abraham%20Salomon_AgriWorks%20Uganda%20presentation.pdf), the mobility of the system enables more than one farmer to share it, and being modular, it can be upgraded in a piecemeal way. It is said to be an easy-to-use system requiring minimum technical knowledge to use and low cost, and therefore profitable. The financial model involves making a down payment plus three additional payments scheduled to match the income earned from using the technology. Its cost works out to around USD 800 per hectare.[31]

In a review of West African experiences with pilot private irrigation investments, Abric et al. (2011: 51-52) briefly discussed other financial instruments, some of which appeared promising, but their implementation needed improvement. *Matching grants* were successfully used in projects in Nigeria and Niger, but should be used only to target very poor farmers. Therefore, selection processes must be effective. *Revolving funds* were used in a Mali project to build capacity for credit and encourage savings, but this model requires a strong farmer organization and transparency.

[31] This company has financial support from the Global Innovation Exchange; refer https://www.globalinnovationexchange.org/innovation/agriworks-uganda

Guarantee funds were used in Burkina Faso to capitalize commercial banks, but their requirements need to be adjusted to farmers' needs. A project in Niger had a positive experience with credit secured by stored production of onions (*warrantage*), which enabled farmers to sell at a higher price later. However, few agricultural products can be stored so easily.

4.5.1 Nepal: Variations on Grant-credit Combinations

In Nepal, the International Centre for Integrated Mountain Development (ICIMOD) has tested three possible financing models to purchase solar irrigation pumps (Mukherji et al. 2017). These are relatively large and expensive pumps, putting them out of reach of most smallholders, but there is a high demand for them. The researchers, following government policy, offered a large grant to cover most of the cost of the pump; farmers had to pay a balance. An additional 10% grant was provided to women who had land registered in their name. The balance to be paid was NPR 76,000 (USD 680) for male farmers and NPR 57,000 (USD 510) for women[32]. The three models were "grant", "grant-loan", and "grant-pay-as-you-go." The study found that one-time grants were not attractive (the balance had to be paid up-front), but there was greater demand for the other two options. There is also a viable business opportunity to rent out solar-powered irrigation pumps against rental fees as part of the grant-pay-as-you-go model, if the business can obtain the Nepal government grant. The two market models were attracting farmers who were already better off – they did not reach small marginal farmers. Group ownership was found not to be a viable or an attractive model. The CGIAR Research Program on Water, Land and Ecosystems (WLE) financed this project.

4.5.2 Ethiopia: Three Business Models to Scale Up Solar Irrigation

IWMI recently assessed the viability of three business models for helping smallholders in Ethiopia to obtain solar PV pumps. They are: individual purchase; out-grower or insurer scheme; and "supplier model with bundled financing" (Otoo et al. 2018). The pumps cost USD 450-850, depending on what additional equipment (such as pipes) is needed.

The *individual purchase model* was found to be potentially very profitable, with an additional opportunity to sell unused energy to neighbors. The relatively high cost of credit has a large impact on the return on investment, though an example of financing in SNNPR at 18% APR remains profitable. Otoo et al. (2018) suggest that further research is needed on alternative financing mechanisms, such as matching revolving funds and credit guarantees from development or government agencies to bridge the gap between MFIs' offerings and farmers' capital investment needs. They also suggest that suppliers should consider trying some of the financing models discussed above, including lease-to-own, pay-as-you-go, and buy-as-you-use (farmers pay for use and maintenance services, and obtain ownership after paying an agreed amount). Cost-sharing models, either by a group of farmers or a cooperative are also possible, though there are some constraints as well.

In the *out-grower model*, a commercial agribusiness firm invests in providing solar pumps in the same way that they often provide other inputs to out-growers. The contracted farmers could pay for their pumps using a flexible financing arrangement or the company could provide them "free" if a reliable increase in quantity and quality of production justifies this. The company assumes most of the financial risk of purchasing the pump. Many factors would determine whether this is a worthwhile investment for an agribusiness firm. As an alternative, crop insurance companies could invest in solar pumps for smallholder farmers because they would reduce the risk and size

[32] USD 1 = NPR 111.76 at the time of the study in November 2016.

of damage claims. This is based on the assumption that cost savings outweigh the investment costs. Depending on the net return on their solar pump investments, insurers could offer pumps to farmers free, or at a subsidized cost, or at full cost combined with flexible financing. This option requires further research to assess its economic feasibility.

The *supplier model with bundled financing* is really the same as the model above where pump suppliers partner with MFIs to offer flexible financing and share the risk. Otoo et al. (2018) suggest a variation on this, in which the government provides credit guarantees to banks and other financial service providers. This mitigates the risks of the direct lender and has been used elsewhere. The authors also suggest considering *lease-to-own* or hire-purchase models. A key benefit for the farmers is that they do not need to have collateral to obtain a pump, but the cost may be higher in the long run than a traditional loan. We have seen this being tested by a number of initiatives already, though not in Ethiopia.

4.5.3 Uber for Irrigation Model

If we are going to find effective, sustainable solutions to provide affordable financing services for investments in irrigated agriculture, we need to "think out of the box" and examine options not yet tried specifically for irrigation. One example is *Hello Tractor* (https://www.hellotractor.com/), a Nigerian startup which has been called "Uber for the farm" (https://www.forbes.com/sites/willyfoote/2018/08/14/meet-the-social-entrepreneur-behind-africas-uber-for-the-farm/?org=1364&lvl=100&ite=2098&lea=433331&ctr=0&par=1&trk=#7edfe84d2bc5). This is a web-based platform that links farmers to owners of small tractors. The site also offers a hardware monitoring device fitted with Global Positioning System (GPS) and a subscriber identification module (SIM) card. The 'tractor owner app' has tools for service request management, operator performance monitoring, and tracking activities. The owner knows where his tractor is and what it is doing at all times. Farmers can send a text to Hello Tractor, which identifies the closest available tractor and sends it to the farmer. Like Uber, farmers can rate the performance and see the data on its operations. They can also pay for the service using their mobile phones, but the company has found that having a network of booking agents is more effective. Hello Tractor receives some assistance from USAID's Feed the Future initiative, as part of a "youth agripreneurs program" (http://bulletin.iita.org/index.php/2016/07/22/iita-co-implement-usaidhello-tractor-agripreneurs-program-nigeria/) co-implemented by the International Institute for Tropical Agriculture (IITA). Under this program, currently underway, about 100 youth will receive training in the business of managing a fleet of smart tractors. Hello Tractor will sell about 300 of its smart tractors to these young business people. No information is provided on how the purchase of these tractors will be financed. Even more recently, Hello Tractor has entered into a public-private partnership with John Deere tractor company and the Nigerian Federal Ministry of Agriculture and Rural Development to deploy 10,000 tractors, selling them to farmers on a pay-as-you-go basis. The government will lease the tractors for a period of time and then sell them at a discount. Hello Tractor will use its technology and expertise to implement the program by providing monitoring, security and valuation services.[33]

This web-based model for managing rentals of services or even equipment could potentially be adapted to offering pumping services – a kind of Uber for irrigation.

[33] This is from a recent interview with Jehiel Oiver, founder of Hello Tractor, by *Forbes Magazine*. Available at https://www.forbes.com/sites/willyfoote/2018/08/14/meet-the-social-entrepreneur-behind-africas-uber-for-the-farm/?ct=t(C2025_newsletter12_03152017_DO_NOT_DELET3_15_2017_)#19aceb7b2bc5.

4.6 Evidence on Donor Support for Financing Small-scale Irrigation Equipment

Searching donors' websites for evidence of their support for enabling smallholders to gain access to irrigation equipment was not very productive. As far as we could determine, none of them have a specific focus on this issue. However, we have seen that a number of international financial institutions, bilateral donors, and others have provided support, and some continue to do so. GIZ and the World Bank supported some of the studies discussed above (e.g., Grimm and Richter 2006a, 2006b), as has DFID (e.g., Duvendack et al. 2011; Stewart et al. 2012). As shown in Table 2, Sida, USAID, IFC, OFID, and SDC are among the traditional donors supporting interesting pilot experiments. In addition, a number of special-purpose consortia of donors are supporting pilot efforts; examples include CGAP, GPOBA, Powering Agriculture, Global Innovation Exchange, Energy 4 Impact, and Kiva (a crowdfunding site). Some private firms, especially manufacturers of solar pumps, are using their own capital to test a variety of marketing and financing tools; examples include Futurepump and SunCulture, both in Kenya. KickStart International raises funds from a diverse set of donors and is using some of these funds for the same purpose.

TABLE 2. Summary of irrigation equipment financing models with examples.

Irrigation equipment financing model	Examples	Donor
Partnerships of microfinance institutions with institutions having expertise in irrigated agriculture	• PAMIGA "Water and Microfinance Initiative", Senegal and other places	• SDC and CGAP
Partnerships of microfinance institutions with equipment manufacturers or retailers	• Futurepump and local cooperative, Kenya • Solar irrigation in Rwanda project • KickStart and World Vision's VisionFund International for pumps, Zambia, Malawi, Kenya, and Tanzania • IWMI supplier model with bundled financing for solar pumps, Ethiopia	• None specified • Energy 4 Impact, Sida, and OFID • None specified • USAID Feed the Future initiative supported the study
Integrated technical and financing support for agricultural value chains	• KWFT for rainwater tanks and irrigated greenhouse kits, Kenya • SOFITEX and GPOBA support for irrigated cotton, Burkina Faso	• None specified • GPOBA and IFC
Layaway	• KickStart pilot program for purchasing treadle pumps, Kenya	• None specified
Rent-to-own (hire-purchase) pay-as-you-go model	• KSSI project: Winrock and Futurepump, Kenya • SunCulture AgroSolar Irrigation Kit, Kenya	• USAID • None specified • None specified

(Continued)

TABLE 2. Summary of irrigation equipment financing models with examples. (Continued)

Irrigation equipment financing model	Examples	Donor
Rent-to-own (hire-purchase) pay-as-you-go model	• KickStart rent-to-own pilot for treadle pumps, Kenya • KickStart pay-as-you-go model for solar PV pumps with built-in chips to monitor and charge for use, Kenya • "Rent to Own" firm (RTO), linked with Kiva to crowdfund small loans, Zambia • Agriworks Uganda • ICIMOD grant combined with pay-as-you-go for solar pumps, Nepal	• None specified • Kiva • None specified • WLE
Contractor-utility model	• Earth Institute's solar irrigation micro-utilities, Senegal • Morocco energy service companies • IDCOL supplier of water to farmer associations, Bangladesh • Claro Energy solar irrigation "virtual utility," Bihar, India • IITA and Hello Tractor "Uber for the farm" model, Nigeria (could try *"Uber for irrigation"*)	• Powering Agriculture, Global Innovation Exchange • None specified • None specified • Powering Agriculture • USAID Feed the Future
Other models	• Social group guarantees combined with collateralizing the financed asset • ICIMOD grant combined with payment up-front for solar pumps, Nepal • ICIMOD grant combined with loan for solar pumps, Nepal • IWMI out-grower model for solar pumps provided by agribusiness to smallholder contract out-growers, Ethiopia	• CoolCap • WLE • WLE • USAID Feed the Future initiative supported the study

4.7 Conclusion: Experiences with Microfinance for Irrigation Investments

Although there are as yet no definitive studies on the outcomes and impacts of programs aimed at financing irrigation equipment, we did find a surprising number of interesting pilot studies underway. They represent a diverse set of financing models and include the following (see Table 2):

1. Partnerships of microfinance institutions either with institutions having expertise in irrigated agriculture or with manufacturers and retailers of equipment such as pumps.
2. Integration of technical and financing support for agricultural value chains.
3. Layaway and rent-to-own "pay-as-you-go" models.
4. Contractor or utility models, where irrigation services rather than equipment are sold; and as a possible model.
5. An out-grower model in which a pump and other irrigation equipment are provided by a commercial agribusiness to smallholder contract farmers, or by a crop insurance company seeking to reduce its risk exposure.

All of these are at a relatively early stage, and none have as yet produced conclusive evidence on what works best under what conditions. Nevertheless, we can draw several initial conclusions.

First, it is very unlikely that any single irrigation equipment financing model will prove to be effective under all circumstances. Rather, it will be important to offer a number of options to smallholders and encourage them to make their own choices. Second, the most successful models will be those in which several partners collaborate, contributing their special skills and comparative advantage. Partnerships of microfinance institutions with equipment manufacturers or suppliers, and integration of technical and financing support for agricultural value chains are examples of models likely to be successful. Third, there is a need to manage the related challenges of managing the risks of the institutions providing funding and keeping the cost of financing affordable. Rent-to-own, in which the equipment is the collateral, especially when linked to internet-based monitoring, charging for use and for making payments, is an example. Fourth, encouraging contractor, rental or utility models appears to be a promising option in which entrepreneurs create businesses in making irrigation services more widely available, again using new internet-based technologies to manage costs and service provision.

Finally, a number of both traditional and new types of donors are supporting a variety of pilot experiments and projects aimed at enabling smallholders to obtain access to irrigation equipment.

5. MAJOR CONCLUSIONS AND RECOMMENDATIONS

This section draws together the conclusions and lessons learned from the review of literature and experiences, and then makes recommendations both for scaling out provision of financial support for smallholders' irrigation equipment purchases and for further research.

5.1 Financing Small-scale Irrigation Investments: Conclusions

Microfinance began as microcredit, i.e., providing small loans to poor households, but is now complemented by opportunities for savings and purchasing insurance. In its early years, microfinance was seen as a major poverty reduction intervention. The impact studies conducted over the past decade have raised questions regarding its real impacts on poverty and economic

growth. While some studies find negative impacts, such as households getting into too much debt, overall there do seem to be significant benefits for many poor people. Offering a broad range of financial services seems to lead to more positive outcomes than offering a single service, such as credit. Most microcredit programs offer relatively small loans for short periods, often at high real interest rates. These are not appropriate for poor smallholders to purchase more expensive equipment such as irrigation pumps and ancillary irrigation equipment. Nevertheless, as section 2 concludes, recent institutional and technological innovations hold considerable promise for making financial services more widely available and more cost-effective.

Focusing on the provision of financial services to enable smallholders to purchase relatively expensive irrigation equipment, in section 3 we found no credible studies that directly measure demand for these services. However, many studies find that when asked about constraints to purchasing such equipment, smallholders frequently mention lack of access to financial resources as a major issue. There are other constraints as well (cost and availability of equipment, for example), and women are at a greater disadvantage than men. The fact that finance is only one element of constraints on adoption of SSI technologies suggests that solutions need to be integrated packages. All available evidence suggests there really is a large gap between the availability of finance for purchasing irrigation equipment and the demand for this equipment. There is an important market niche to be filled.

Filling this niche will require policymakers to implement a supportive policy and legal framework as well as the physical infrastructure – transport and communications – needed to develop an effective agricultural value chain, as well as to encourage NGOs, community organizations and private firms to scale out programs offering financial services aimed at encouraging investments in SSI technologies. These requirements are beyond the scope of this paper, but no less important.

Section 4 describes a number of recent or current experiments and pilot projects aimed specifically at enabling smallholders to gain access to irrigation. We found no credible studies of their outcomes and impacts, which is not surprising as they are so recent. Nevertheless, all of them hold some promise of making a large difference and being scalable. The most promising models are: (i) partnerships among microfinance and other institutions (e.g., manufacturers, retailers, agricultural advisors); (ii) "pay-as-you-go" or rent-to-own models that spread out payments and enable farmers to begin benefiting immediately, while minimizing risk because the pump is the collateral; and (iii) contractor or utility models where entrepreneurs offer irrigation services rather than selling equipment. We believe there are opportunities for combining these and other models as well. For example, layaway models are promising but the delay in receiving the item discourages purchasers. Layaway could be combined with pay-as-you-go models. In this model, a purchaser would make small payments until a certain minimum is reached, say 30% of the total cost; then the purchaser would take the equipment home and begin earning on a continuing pay-as-you-go arrangement.

Some projects involve the provision of subsidies or grants to smallholders, e.g., the ICIMOD pilot in Nepal and the IWMI study in Ethiopia. We suggest that this is a slippery slope to be avoided in general or, where used, targeted very carefully. It can easily undermine the emergence of competitive markets. We believe that KickStart's philosophy that the equipment itself should not be subsidized is more sustainable and effective in the long run; but grant funds should be used to cover technology development, social marketing, and strengthening capacities. Some of the literature, including Grimm and Richter (2006a) and Batz et al. (2010), take a similar position.

An important conclusion is that there is no single financial model that will work everywhere. A suite of solutions is required to meet different needs, as emphasized by AgWater Solutions Project (2011). Further, farmers should be treated as valuable customers and provided with sufficient information to make informed decisions about their investments. Another important finding is that

wholesale and retail suppliers also need credit to enable them to stock a range of products and sell them at competitive prices.

An extremely important development is that mobile cloud-based systems, open-source software and a growing menu of digital tools are becoming widely available at a very low cost even in relatively remote rural areas of Africa. Entrepreneurs can now deliver solutions to small African farms at costs that farmers can afford. Even the *Harvard Business Review* has taken note of this incipient revolution (Ekekwe 2017). Examples mentioned in the *Harvard Business Review* paper include: FarmDrive (https://farmdrive.co.ke/), a Kenyan enterprise that connects unbanked and underserved smallholder farmers to credit, while helping financial institutions cost-effectively increase their agricultural loan portfolios; and Kenyan startup M-Farm (http://mfarm.co.ke/) and Cameroon's AgroSpaces (http://africansbuildingafrica.com/agrospaces-connecting-farmers-and-buyers-in-cameroon/), which provide pricing data to remove price asymmetry between farmers and buyers, making it possible for farmers to earn more (Ekekwe 2017). In section 4, we have noted that a number of pilot projects are also making use of these new technologies. Examples include making layaway payments using mobile phones, and using internet-based technologies for making payments and to monitor the use of pumps provided either through rent-to-own arrangements or as an irrigation service.

Finally, an issue that does not get sufficient attention is the social context. There is growing evidence that programs intended to enable women to access financial services, irrigation equipment, and market access have differential impacts in different social systems. In some circumstances, even if there is an overall benefit to the household, women may find they are taking on additional burdens without benefitting proportionally (Snyder and Cullen 2014; WLE 2018). In many African societies, women play critical roles in agriculture and are just as interested in new technologies as men. However, they often face additional obstacles to getting access to these technologies. More gender-equitable policies by financial institutions and others can help reduce these obstacles (van Koppen et al. 2013).

5.2 Recommendations for Scaling Out Financial Services for Small-scale Irrigation Investments

Many studies find that banks and other financial institutions remain reluctant to provide credit for agriculture, and especially reluctant to offer credit on affordable terms that would enable smallholders to purchase more expensive equipment such as irrigation pumps. Therefore, our major recommendation to African governments is to focus on creating a policy and legal framework that supports and encourages financial institutions to find ways to provide effective financial services to poor smallholders. These would include a suite of financial products: savings, insurance and credit; and within these, a suite of products that meet the different needs of smallholder farmers as well as rural entrepreneurs. Credit for large purchases such as irrigation pumps needs to be longer term than credit for seasonal agricultural supplies. It also needs to be affordable: the high cost of credit is frequently cited in the literature as a major deterrent. We are not proposing direct subsidies of credit; rather, we propose exploring ways to reduce the risks and transaction costs of making large numbers of loans that seem small to the financial institution but are large from the perspective of poor smallholders. Several of the pilot studies described in section 4 try to address this problem using new internet-based technologies and treating irrigation equipment as collateral while farmers make periodic payments. African governments and their partners should establish a policy and legal framework that encourages expansion and experimentation using these new technologies.

Another major recommendation to African governments, international financial institutions and bilateral donors is to offer low-cost credit guarantees to local financial institutions that have viable business plans for supporting smallholders to acquire irrigation and other productive equipment, and to finance training, social marketing, and technological innovation. Further, a wide range of approaches to providing financial services and access to irrigation equipment should be encouraged, with appropriate monitoring and evaluation to learn lessons from experience. Donors should be willing to support promising, but as yet untested, innovations. An example is the "Uber for irrigation" model.

Finally, we recommend that governments and their partners make a special effort to design financial products that offer women equitable opportunities. For example, women generally have less collateral to offer than men (though poor men have very little as well). Rent-to-own and possibly layaway plans can help overcome these difficulties; KickStart found that women benefitted from these plans, but were excluded if cash payments for treadle pumps were required. More pilot testing is needed to identify creative ways to level the playing field.

5.3 Research Recommendations

Section 4 describes a number of experiments and pilot studies currently underway. However, finding out the actual costs and benefits, outcomes and impacts, and lessons learned proved to be challenging. We recommend that IWMI and its partners mobilize resources to carry out a multi-country, field-based comparative study of as many of these experiments as is possible. These studies should be carried out in collaboration with the implementing agencies, and include social as well as productive, environmental, economic, and financial outcomes and impacts. The goal should be to identify the lessons that can be scaled out effectively.

One gap that we observed is that none of the pilot projects we reviewed link the provision of credit to credit insurance. Mishra (2016) argued that two related factors hinder smallholders from investing in productive assets: lack of collateral, and riskiness of agricultural returns. Farmers either have no collateral or are reluctant to put land up as collateral given the risks. Also, given the vagaries of weather and markets, agriculture is a risky business, and the likelihood of farmers defaulting can be high. Mishra (2016) analyzed a program in northern Ghana that offered drought-indexed insured loans to both male and female farmers. The credit was mostly in-kind such as fertilizer and seeds, and not irrigation equipment. They found that linking insurance to credit did not have a significant impact on the average likelihood of farmers having access to credit. However, it did significantly increase the probability of female farmers applying for loans by 14%.

Finally, we recommend that linking drought-index insurance to credit for the purchase of irrigation equipment be further explored and tested. Irrigation almost by definition reduces the risk of low agricultural production as a result of drought, while also enhancing significantly the ability of farmers to pay for the credit. As far as we are aware, none of the pilot studies reviewed have included this option, but it is well worth exploring.

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WEBSITES WITH USEFUL INFORMATION

https://www.themix.org/

This website offers data and reports on the performance of the "financial inclusion sector." It is not especially useful for the topic at hand, and it charges for its reports, data and services.

https://www.microfinancegateway.org/library

CGAP library of references on a wide range of topics related to microfinance. All reports are freely downloadable. Searched Africa, rural and agricultural finance, and since 2012. The following were found:

2016 Financing agribusiness SSA

https://www.microfinancegateway.org/library/financing-agribusiness-sub-saharan-africa-opportunities-challenges-and-investment-models%202016

2016 Understanding demand, driving innovation: Smallholder households and financial services (diaries)

https://www.microfinancegateway.org/library/understanding-demand-driving-innovation-smallholder-households-and-financial-services

2015 Financing agriculture and rural areas in sub-Saharan Africa: Progress, challenges and way forward

https://www.microfinancegateway.org/library/financing-agriculture-and-rural-areas-sub-saharan-africa-progress-challenges-and-way-forward

Searched for 'irrigation' – found 31 sources and then narrowed search to SSA; found seven including KickStart-VisionFund case press release, and PAMIGA Senegal case. On the latter, we found an online announcement of the expansion of PAMIGA's program on solar energy to other countries—not clear if it is the same one on water, but it seems focused on irrigation.

OPIC, PAMIGA, and Calvert Foundation partner to increase access to renewable energy in rural Africa

https://www.microfinancegateway.org/announcement/opic-pamiga-and-calvert-foundation-partner-increase-access-renewable-energy-rural

Energypedia is a wiki platform for collaborative knowledge exchange on renewable energy, energy access, and energy efficiency topics in developing countries. However, we found nothing useful on irrigation. https://energypedia.info/wiki/Energypedia; https://energypedia.info/wiki/Portal:Financing_and_Funding; and https://energypedia.info/wiki/Microfinance

The Global Innovation Exchange proved to be a source of information on a number of innovative technology-cum-financing cases. https://www.globalinnovationexchange.org/

USAID Feed the Future initiative. https://www.partneringforinnovation.org/development-practitioners-1/. The authors did not find anything useful on this site.

World Bank agriculture finance and agriculture insurance: http://www.worldbank.org/en/topic/financialsector/brief/agriculture-finance. This site has several links to good material. The site describes World Bank work on agricultural finance and agricultural insurance. There is a wide-ranging program to assist countries to develop this sector, but there is nothing on microfinance or financing SSI.

In Kenya, the National Irrigation Acceleration Platform (NIAP) has recently been launched. It is a national platform "for knowledge sharing, learning, interaction and building of synergies to advance actions that promote and upscale irrigation best practices in Kenya." "Smart finance for smart water solutions" is one if its themes. http://niap.or.ke/?fbclid=IwAR3lf-BweLpcOlb52jlxP0J4RHdqvvCMg5-7EdXawf8ZwDkC5Lr7J9R4z7s.

Rural Solutions Portal. The authors explored this, but it had no solutions that are directly relevant. https://ruralsolutionsportal.org/web/guest?ct=t(C2025_newsletter12_03152017_DO_NOT_DELET3_15_2017_)

PRACTICA Foundation. The authors explored this site, but found nothing that is directly relevant. This site emphasizes technology innovations. https://www.practica.org/expertises/irrigation/

IWMI Working Papers

185 *Improving the Availability and Effectiveness of Rural and "Micro" Finance for Small-scale Irrigation in Sub-Saharan Africa: A Review of Lessons Learned.* Douglas J. Merrey and Nicole Lefore, 2018

184 *Gender Dimensions of Community-based Groundwater Governance in Ethiopia: Using Citizen Science as an Entry Point.* Likimyelesh Nigussie, Jennie Barron, Alemseged Tamiru Haile, Nicole Lefore and John Gowing. 2018.

183 *Community-managed Groundwater Irrigation on the Vientiane Plain of Lao PDR: Planning, Implementation and Findings from a Pilot Trial.* Corentin Clément, Jordan Vinckevleugel, Paul Pavelic, Kong Xiong, Lengya Valee, Touleelor Sotoukee, Binaya Raj Shivakoti and Khammai Vongsathiane. 2018.

182 *Highlights of Soil and Water Conservation Investments in Four Regions of Ethiopia.* Zenebe Adimassu, Simon Langan and Jennie Barron. 2018.

181 *Investigation of the Modalities for an Innovative Financing Mechanism for Participatory Natural Resource Management in the Bale Eco-region, Ethiopia.* Fitsum Hagos, Daniel van Rooijen, Amare Haileslassie, Habtamu Yehualashet and Husien Indries. 2018.

180 *Water User Associations: A Review of Approaches and Alternative Management Options for Sub-Saharan Africa.* Eefje Aarnoudse, Alvar Closas and Nicole Lefore. 2018.

179 *Dependence of Riparian Communities on Ecosystem Services in Northern Ghana.* Marloes Mul, Laetitia Pettinotti, Naana Adwoa Amonoo, Emmanuel Bekoe-Obeng and Emmanuel Obuobie. 2017.

178 *Understanding the Hydrological Impacts of Climate Change in the Tana River Basin, Kenya.* Aditya Sood, Lal Muthuwatta, Nishchitha Sandeepana Silva and Matthew McCartney. 2017.

177 *Sticks and Carrots: Managing Groundwater Over-abstraction in La Mancha, Spain.* Alvar Closas, François Molle and Nuria Hernández-Mora. 2017.

176 *Adapting Aquifer Storage and Recovery Technology to the Flood-prone Areas of Northern Ghana for Dry-season Irrigation.* Seth Owusu, Olufunke O. Cofie, Paa Kofi Osei-Owusu, Vincent Awotwe-Pratt and Marloes L. Mul. 2017.

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