



Developing agro-pastoral entrepreneurship: bundling blended finance and technology

Eliud Wakwabubi, Yusuf Ahmed, and Stephen Omware

Abstract: *Development of agro-pastoral and pastoral entrepreneurship in arid and semi-arid lands (ASAL) of East Africa is constrained by lack of access to financial services, limited technology, and low capacity to engage in high value crop production. This is exacerbated by high risks associated with providing these services to pastoralist communities in ASAL areas in Kenya. The communities' preference for ethical financial products and services has exacerbated this exclusion. This article presents a new intervention area that addresses these challenges. It argues that bundling ethical financial services with agricultural technology and capacity building positively affects entrepreneurship and income generation among pastoral communities that are transitioning into crop production. This article is based on the Islamic Relief Kenya (IRK) project implementation experience and participatory action and quantitative research conducted with randomly selected members of 180 Alpha Group Savings and Loans Associations (AGSLAs).*

Keywords: entrepreneurship, technology, blended finance, agro-pastoralism, Islamic finance, climate change

Introduction

PASTORALISM IS A LIVELIHOOD AND production system practised in the arid and semi-arid lands (ASAL) in the Horn and the East of Africa. Some of these pastoralists are sedentary while others are migratory; moving from one area to another in search of water and pasture for their livestock. There are estimated to be 4 million pastoralists in Kenya, constituting more than 10 per cent of the population (Kirkbride and Grahm, 2008), and mostly occupying the north-eastern region of Kenya comprising Mandera, Wajir, and Garissa Counties. These counties are characterized by high levels of poverty; Mandera County has 77.6 per cent, Wajir has 62.6 per cent, and Garissa has 65.5 per cent of the population living below the national poverty line compared with the national average of 36.1 per cent (Kenya National Bureau of Statistics, 2018). Traditionally, pastoralists do not practise crop production. In the 10 years since 2009, this situation has been changing rapidly due to climate change and protracted disasters such as droughts that have led to high livestock mortality, high population growth that has reduced land for livestock grazing, and increasing

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conflicts over natural resources. Islamic Relief Kenya (IRK) is supporting pastoralist communities to adapt to all these changes by developing agricultural entrepreneurship as an effective livelihood resilience strategy through the Securing Water for Food (SWFF) project. This is an innovation challenge fund by a donor group of the United States Agency for International Development (USAID), Swedish International Development Agency (SIDA), Government of the Netherlands, Department of Science and Technical, Republic of South Africa, and Islamic Relief (IR) partners in the US and Belgium. The project 'Increasing Agro-Pastoral and Pastoral Incomes through Adoption and Production of High Value Fresh Fruits and Vegetables Using AgroSolar Irrigation Technology' in Mandera County aimed to support effective and sustainable transition from pastoralism to high value vegetable and fruit production through efficient utilization of irrigation water from River Daua along the borders of Kenya and Ethiopia. This article explores the relationship between financial inclusion and the economic opportunities of pastoralists and agro-pastoral communities in northern Kenya. A number of studies show linkages between entrepreneurship, financial services, irrigation technology, and economic empowerment. Passarelli et al. (2018) conducted a cross-sectional study in Ethiopia and Tanzania, which showed that households in both countries that used irrigation produced more vegetables, fruits, and cash crops, and are less food insecure, have a higher value of production, and have higher production diversity and dietary diversity compared with non-irrigating households. Walkerman et al. (2015) argue through a study in Tanzania that despite significant efforts in agriculture market development, millions of smallholder farmers remain isolated from markets due to remoteness and low farm productivity. This study demonstrates how local entrepreneurs linked 'push and pull' in the Aga Khan Foundation (AKF) market development programme to access inputs and increase their yields and income from smallholder farming activities.

We argue that lack of access to ethical financial services, climate smart technology, and technical knowledge and skills has limited the capacity of agro-pastoral and pastoral communities to exploit available economic opportunities. These services can effectively be delivered through a partnership approach. Several studies have been conducted to explore the relationship between value chain strengthening and smallholder farmers in Nicaragua (Donovan et al., 2017) and Uganda (Naziri et al., 2017). These studies conclude that smallholder farmers need access to an array of specialized technical, business, and financial services that a single NGO may not be able to provide. This article discusses financial inclusion and blended finance as critical approaches for economic empowerment. In addition, financial services also strengthen the role of women in household decision-making. Based on a study conducted by Care in Bangladesh, financial services enable women to increase their power in influencing household decision-making (Norell et al., 2017). Financial inclusion is defined as 'providing access to an adequate range of safe, convenient and affordable financial services to disadvantaged and other vulnerable groups, including low income, rural undocumented persons, who have been underserved or excluded from formal financial sector' (FATF, 2013: 12). Through the example of Alpha Group Savings and Loans Associations (AGSLAs), this article reports that informal savings groups are seen as 'a springboard to financial inclusion,

fostering good savings behavior and asset accumulation' (Smith et al., 2015: 7). The SWFF project experience highlights that blended finance is a strong and viable tool/product for financial inclusion. Blended finance is a package comprising concessional funding provided by development partners and commercial funding provided by a financier. Blended finance can provide financial support to high-impact projects that will not attract financing on strictly commercial terms because their risks are high and their returns are either unproven or not commensurate with the level of risk (Townsend et al., 2018). According to FinAccess data (Central Bank of Kenya et al., 2016), Mandera is among the counties in Kenya where access to financial services is very low, with over 52.2 per cent excluded from formal financial services when compared with the national average of 17.4 per cent of the population who are financially excluded. Financial exclusion is driven by limited presence or complete lack of financial institutions to address financial needs of smallholder farmers. Where these institutions exist, smallholder farmers and transitioning pastoralists are unable to meet the requirements for obtaining conventional loans and the available windows for ethical finance. Most importantly, local communities who are largely Muslims do not take loans from formal financial institutions because they fear that they will be charged interest.

Islamic Relief Kenya (IRK) designed a project that uses blended finance, agro-solar irrigation technology, and capacity building to help agro-pastoralists engage in high value crop production as an enterprise. Expected outcomes include increased production of crops and consequent improved income and profitability, making farming a viable commercial activity for agro-pastoral and pastoral communities. According to Walkerman et al. (2015), local entrepreneurs are defined as individuals who are based in the local area, who are business-minded and active in their own community. Their business orientation increases the likelihood that they are able to build and maintain working relationships with lead firms who need business-oriented local partners. Denison et al. (2016) conducted a study on entrepreneurship in South Africa and argue that enhancement of entrepreneurship is seen as key to growth in a free-market economic system, including in the agricultural sector. This study identifies two categories of informal enterprise, namely survivalist enterprises and micro or growth enterprises. While survivalist enterprises are motivated by necessity (a push factor), generate limited income, and rarely go beyond self-employment, microenterprises tend to be more motivated by opportunity (a pull factor) and offer the best potential to grow, create employment, and bring about economic development. According to Townsend et al. (2018), technology and innovations are creating new opportunities to lower costs, to raise incomes, and to support entrepreneurship in agricultural value chains.

The challenge of agro-pastoralism and pastoralism

The risks for pastoralists transitioning into farming, and irrigation farming in particular, are high. While water availability in River Dawa partially mitigates the production risk, agro-solar irrigation technology brings additional financial, technical, and management problems. This irrigation technology is also associated

with higher intensity agriculture, typically producing crops in two seasons per year. In order to move beyond subsistence farming that typically uses diesel irrigation pumps, it is necessary that the benefits in food or profits from the sale of high value crops exceed the costs of production. This is even more important for agro-solar irrigation technology since it is complex and costly when compared with rainfed farming. Further, use of agro-solar irrigation technology, which combines a pump, drip irrigation materials, water regulation/timing switches, and so on, requires knowledge, technical skills, and financial resources that surpass the capacity of agro-pastoralists. Costs for inputs and infrastructure are high and wage labour must be paid by the agro-pastoralists. Markets for high value crops must also be found to maximize returns from the sale of crops. Challenges notwithstanding, the impact of climate change on agro-pastoralist and pastoralist livelihoods demands the strengthening of entrepreneurial capability as an effective resilience and economic strengthening opportunity. This article builds on the limited evidence to date that successful agro-pastoralists using irrigation systems in Mandera County can overcome climate change and cultural and marginalization barriers; it does so by responding to the research question: *'What has enabled pastoralist communities to successfully engage in high value crop farming as a business enterprise and how and why did they succeed?'*

Methodology

The data used in this paper were collected as part of the SWFF project implemented by IRK in Mandera County. Due to the multiplicity and depth of research themes, an exploratory, mixed-methods approach was used. The mixed methods approach is a research process in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches and methods in a single triangulated assessment.

Data collection was conducted between January and March 2016 and September and October 2018. Over 180 Group Savings and Loans Associations (GSLAs) (2,729 households) were selected for inclusion in the assessment, all in their second year of operation. Information was collected using the Household Economic Assessment (HEA) tool and focus group discussions (FGDs). We used a purposive sampling methodology among the GSLA members. Using pre-existing membership lists of active GSLA members, and applying a probability sampling formula to total GSLA populations, we arrived at 295 households as the sample population. The surveyed sample contained a total of 295 households divided into two research groups, one with 145 households (49.2 per cent) using the Agro Solar Irrigation Kit (ASIK) and one with 150 households using diesel pumps (50.8 per cent). A review of AGSLA member records and farm records was also conducted. Monitoring of water usage, production levels, sales, and expenses was conducted throughout the project. A multiple-case study approach was also used to collect case studies specific to individual AGSLAs.

The HEA data was collected electronically using Open Data Kit (ODK) and collected data were uploaded to the Ona web-based platform. Data analysis used

SPSS version 25. Data were collected from a random selection of ASIK farmers and non-ASIK farmers who used diesel pumps. ASIK farmers are beneficiaries of blended finance, technology, agronomic, and business development trainings while diesel pump users did not access blended finance or capacity development services related to farming as a business. The identification of these households was done in consultation with IRK SWFF field project staff using GSLA membership lists that were arranged according to the two categories of farmers.

Ethical financial services

Pastoralist communities in Mandera County are largely Muslim. These communities are financially excluded and this is attributed in part to the lack of sharia-compliant financial services. IRK is using sharia-compliant financial services to expand financial access and promote inclusion of Muslim communities. Sharia-compliant financial services follow Islamic law and do not allow payment of interest on deposits and do not charge interest on loans. Risks and profits are shared, or assets are traded. El-Zoghbi and Tarazi (2013) argued that sharia-compliant financial inclusion represents the confluence of two rapidly growing sectors: microfinance and Islamic finance, a system of finance based on sharia. With an estimated 1.28 million clients, Islamic microfinance may still be a small industry, but it has the potential to grow very fast, considering the large number of people who are not using formal financial institutions in many Muslim majority countries. Islamic finance is rooted in 'ethical foundations'; it is founded on the core belief that money is not an earning asset in and of itself. Islamic financial principles are premised on the general principle of providing for the welfare of the population by prohibiting practices considered unfair or exploitative. According to Karim et al. (2008), the general principles that are of particular importance for Islamic 'sharia-compliant' or 'ethical' finance include the following:

- Interest is forbidden since it is a predetermined, fixed sum owed to the financier irrespective of the outcome of the business venture in which the capital is used. Money is not an asset in itself; it cannot be bought and sold as a commodity. A return on capital is only allowed provided that capital participates in the productive process and is exposed to business risk.
- The specifications, existence, and ownership of the product or service that is bought or sold must be clear to both parties and the remuneration for such products or services should be agreed where this will typically include the price and payment terms.
- A financial transaction needs to have a 'material finality'; that is, it should be directly or indirectly linked to a real, tangible economic activity as opposed to financial speculation.
- There should be no funding of *haram* (sinful) activities such as the production of alcoholic beverages or gambling, and funds should preferably finance socially productive activity. In broad terms, Islam forbids all forms of economic activity that are morally or socially harmful.

- There must be some risk exposure to the underlying activity to legitimize the profit, whether funds are used in a commercial or productive venture.
- A financial transaction should not lead to the exploitation of any party in the transaction.

These are the principles that IRK applied to ensure that the SWFF project uses financial services that are acceptable to Muslim communities in Mandera County.

Agro-pastoral and pastoral entrepreneurship

The key proposition in the project is that increased benefits from using ASIK for high value vegetable and fruit production will be driven by agro-pastoralists who identify opportunities, develop strategies to exploit these, and turn these into viable and profitable irrigated crop production (and perhaps processing) enterprises. Entrepreneurial farming is characterized by full market engagement with the primary purpose of generating profits, and therefore with high market dependency and related high risk. Entrepreneurial farming can be called 'business' farming in the context of this project as the emphasis is on the individual (i.e. individuals in business farming). To support the transformation of agro-pastoralists and pastoralists into entrepreneurs, the SWFF project adopted the following techniques and models.

The AGSLA model

IRK adapted the GSLA model in 2016 to deliver financial services to poor communities in pastoral and agro-pastoral areas of Kenya, South Sudan, Ethiopia, Somalia, and Sudan as part of its economic strengthening strategy in these countries. Ethical financial services are either completely lacking or very limited in the East Africa region. Such services are strongly dependent on the levels of income and economic activities, but more importantly on the culture and religion of the communities. To address these gaps, IR modified the conventional GSLA model into the *Alpha Group Savings and Loans Associations (AGSLA) Programme Guide – The Ethical Alternative*. This programme guide offers financial services that are in compliance with the ethical requirements. The main changes reflecting ethical issues are as follows:

- No interest and high late payment fines on loans given to members.
- Provides ethical guidelines to help members develop their group constitutions.
- Addresses sustainability issues, for example return on savings and investments, in an ethical manner.

The IR regional office delivered the AGSLA training to over 20 IR Kenya staff to roll out the AGSLA model in Mandera, Wajir, Garissa, Kilifi, and Kajiado in early 2016, including to communities engaged in the SWFF project being implemented in Mandera County. The project mobilized agro-pastoralists and pastoralists to form and join AGSLAs of between 15 and 25 members each and provided the intensive nine-module training using the AGSLA programme guide. Each group began with regular weekly meetings in which each member was required to contribute

US\$2–3 according to the group rules. The contributions were deposited in the group savings account opened with Equity Bank. The aim of these AGSLAs was to purchase the ASIK for the production of high value vegetables and fruits. To date, 180 AGSLAs have been formed and trained, with a membership of 2,729 (62 per cent female and 38 per cent male). The 26 AGSLAs that have purchased ASIK to date have accumulated total savings of \$27,791.

The Murabaha instrument

The main instrument of financing used by the SWFF project is *Murabaha*, a trade with mark-up or cost-plus sale instrument. The purchase of ASIK is financed for a profit margin, with the asset purchased on behalf of GSLA members and resold at a predetermined price. To make the transaction Islamically acceptable, IRK entered into agreement with SunCulture to provide ASIK to GSLAs that qualify for *Murabaha* loans. According to El-Zoghbi and Tarazi (2013), *Murabaha* is a 'cost-plus mark-up' sale contract often used to finance goods needed as working capital. Typically, the client requests a specific commodity for purchase, which the financier procures directly from the market and subsequently resells to the client, after adding a fixed 'mark-up' for the service provided. Ownership of the commodity (and the risk inherent thereto) strictly lies with the financier until the client has fully paid the financier. The mark-up is distinct from interest because it remains fixed at the initial amount, even if the client repays past the due date. GSLAs were provided with loans to purchase ASIK from SunCulture and were expected to repay the loans using income earned from the sale of high value crops and fruits. Once selected GSLAs had passed the screening stage and had completed all the documentation, project financial partners would then make payment directly to SunCulture for the kits. SunCulture delivered purchased ASIK to IRK's Mandera area office from where they were picked up by the groups. The kits were sold to groups at an agreed mark-up of 10 per cent.

The business model

Through SWFF project support, IRK developed a financial model to serve as a valuable input into its negotiations with financial partners on behalf of the AGSLAs in Mandera County. The result was a financial modelling tool that enables financial partners to forecast the cash flows and financial returns from the AGSLA perspective and also model the financial institutions' view. As its discussions with financial institutions evolve, IRK now has a tool that it is using to calculate how different scenarios play out financially for the AGSLA farmers. The results of this intervention are reflected in the production and financial performance of Rhamu Marhaba AGSLA (see Box 1).

We collected financial information for one farming season that lasted 3.3 months for 12 AGSLAs (6 for ASIK users with 124 members and 6 for diesel pump users with 91 members). ASIK users planted crops in 6.75 acres (2.73 ha) of land while diesel pump users planted in 6.5 acres (2.63 ha) of land. Overall, ASIK users

Box 1 GSLA promoting adoption of ASIK

Rhamu Marhaba AGSLA in the Rhamu location of Mandera North sub-county has received AGSLA model training and receives regular supervision and mentoring visits by IRK field staff. This has improved their operations, promotes group bonding and cohesiveness, and builds financial literacy. Marhaba group currently has a total of 23 members with 14 women and 9 men. The total savings for the group over a period of 8 months is US\$650, which has enabled it to receive a loan of \$4,800 from SWFF financial partners based on the viability of the business model developed by the project. Out of this amount the group has repaid \$1,000 (20 per cent of the total loan) over a period of 3 months. The group used the loan to purchase and install ASIK in their 2-acre farm (0.81 ha) for growing tomatoes and onions. The group harvested 1,700 kg of tomatoes from which they earned a revenue of \$3,400 after selling the tomatoes in the local market and thereby earning a profit of \$2,000 from their total investment. According to the chairman of the AGSLA,

‘We regularly meet to discuss the way forward for our group, the dynamics as well as the critical point of savings in the group. Without the external loan and profit earned from the sale of tomatoes and onions, we could not have been where we are now’.

During a meeting with the group, one member asserted that ‘Islamic Relief trained us on the group savings and loans association model; the aspect of saving was not common amongst our community, but now we are able to save some small amount of money for emergencies and to support ourselves’.

experienced higher production and income from growing onions, tomatoes, kales, and capsicum than diesel pump users who grew similar crops. In only one season that lasted 3.3 months, ASIK users earned a revenue of \$16,780 while diesel pump users earned a revenue of \$9,618. Given that this was the first attempt at using ASIK, this level of production and the financial performance are rated as great achievements. The total operational cost (land preparation, fertilizer, seed, agro-chemicals, labour, irrigation technology, fuel, operations, and maintenance costs) for ASIK users was \$21,590 and for diesel pump users was \$11,633. It is important to note that diesel pump users were given diesel pumps valued at \$6,700 by local government and NGOs operating in the county; the cost of these pumps is not included in the operational expenses for diesel pump users. The value of crop sales for ASIK users was \$15,865 while that of diesel pump users was \$8,095 as shown in Figure 1. According to our business model, ASIK users will be able to recover all their investments by the end of three seasons of farming as the one-time cost of ASIK valued at \$17,927 and operational costs will be covered by the revenue earned from sale of crops. In the long term, operational and maintenance costs for ASIK will be very minimal when compared with diesel pump users, whose main expenditures are for fuel and maintenance costs.

This outcome has motivated group members and the neighbouring community members to consider irrigated farming using ASIK as a serious business and alternative economic activity in the face of the adverse effects of climate change. The Bismillahi AGSLA secretary explained:

The ASIK uses less labour, no fuel cost at all, no wastage of water when compared to diesel pumps. This is a real moneymaker; we have been able to realize a rapid increase in production and crop yields for using ASIK compared

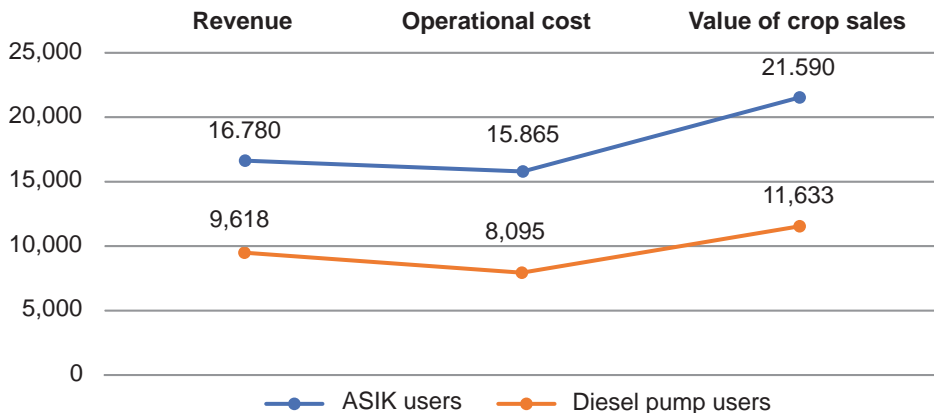


Figure 1 Revenue and expense analysis

Note: Figures in US\$

to previously when we used diesel powered pumps to irrigate our farms. We have managed to sell our produce locally at very good prices because of joint production and marketing.

Smallholder farmers also reported that ASIK has minimized labour used for growing high value crops, reduced water wastage, reduced soil erosion thereby contributing to environmental conservation, and also increased yields, thus reducing the size of land under agriculture and increasing the size of land available for livestock grazing.

We also collected and computed IRK's operating costs over a period of 3.3 months in the delivery of financial services to the six GSLAs that had purchased ASIK. We note that the operating cost of establishing and managing relationships with GSLAs for the purchase of ASIK is initially high in relation to the financial capacity of agro-pastoralists. IRK works with community leaders and farmer organizations to find potential GSLA members and these leaders or organizations serve as agents to share information on the work of IRK. At the lowest level, IRK uses GSLA Promoters (paid staff) to mobilize and form GSLAs, conduct training, and work with potential GSLAs to ensure that they understand the loan instrument/product. They also screen and select members who are interested in the product and have potential for repaying. The operating costs (\$4,569) and mark-up (\$1,660; covering 36 per cent of the operating costs) reported in the financial records of the project in the 3.3-month project period are generally categorized as indicated in Figure 2.

The high costs of providing sharia-compliant products, particularly trade-based products such as *Murabaha*, are often blamed for the lack of product diversity and customer take-up. The main cost drivers, particularly in marginalized, remote, and arid and semi-arid land areas with poor physical infrastructure such as Mandera County, include group development and training costs (47 per cent of the total operating cost), travel costs/costs incurred by staff in daily travel to the field (30 per cent of the total operating cost), personnel costs/salaries paid to employees (16 per cent of the total operating cost), and administration costs (6 per cent of the total operating cost).

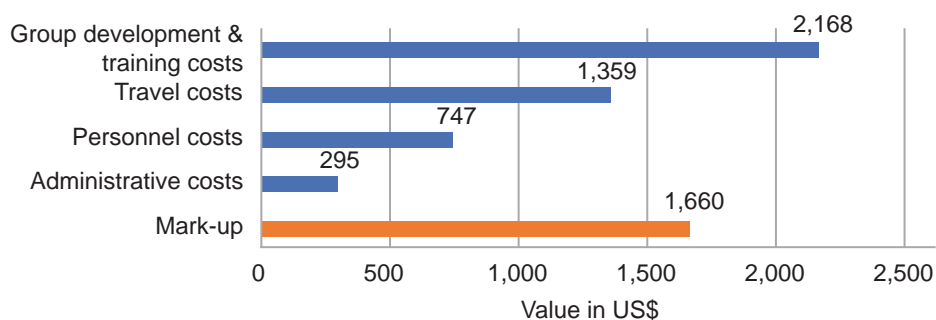


Figure 2 Operating costs and mark-up

IRK's cost of funds is low, since project funds were raised through IR partners as grants with no costs involved. IRK views these funds as not sustainable and is planning to identify another source of funding for its sharia-compliant portfolio to be delivered through its growing IR Microfinance Department.

The blended finance model

IRK designed an innovative finance model that promoted access to agro-solar irrigation technology. Despite low operational costs, the cost of one ASIK on average is \$3,000, which is a high initial investment, particularly for agro-pastoralists. At the initial stages of the project, agro-pastoralists and financial partners were hesitant to participate due to the risks involved and the fact that the business model was not yet tested and there was no guarantee that there would be returns. Blended finance is an innovative way of leveraging technological benefits for financially excluded communities in poor contexts. IRK designed an innovative finance model with the support of its funding and financial partners to overcome this barrier to purchasing the technology. Due to the innovativeness of the project and collaborative learning events, IRK secured additional funding for the project from IR partners in the USA and Belgium which it used to develop the blended finance product.

To accelerate ASIK adoption, IRK used the blended finance product through a guarantee/risk fund deposited with financial partners to act as security for ASIK financing. This blended finance product is being operated as a revolving fund in order to scale up support to more agro-pastoralists. Through blended finance, AGSLAs have been linked to financial partners for additional funding to cover the gap. Each AGSLA is required to raise 20 per cent of the total cost of the ASIK, i.e. \$600 (total cost of the technology on average is \$3,000), as the down payment and then finance partners will provide the rest as a normal loan to the group based on Islamic finance principles. Over 26 AGSLAs have successfully met the requirements for the blended finance product, which they have used to purchase and install the ASIK. The value of loans provided with the blended finance as security is \$78,051, out of which 60 per cent of the total loan had been repaid at the time of the assessment.

AgroSolar irrigation technology

IRK partnered with a technology company, SunCulture, to bring its AgroSolar Irrigation Kit (ASIK) to agro-pastoralists in Mandera County. The ASIK is the only 'one-stop solution', providing a comprehensive set of clean energy services tailored to the needs of smallholder farmers; a technology initiated, founded, and promoted by SunCulture Ltd. ASIK utilizes a solar photovoltaic powered drip irrigation system. The technology is a combination of off-the-shelf, proven, no-frills, cost-effective, solar powered pumping and drip irrigation technologies as shown in Figure 3. ASIK is designed to be as low-touch as possible but provides a long-lasting irrigation solution with minimal maintenance and repairs. This technology also utilizes the efficiency of venturi fertigation to apply fertilizer, eliminating fertilizer waste and producing the best quality crops, as illustrated in Figure 3.

ASIK has helped agro-pastoralists to mitigate the effects of droughts and lack of water during dry seasons, and has helped them to stabilize, increase, and diversify their production and increase their income. ASIK has enabled agro-pastoralists to save money compared with those who are using diesel pumps. From financial information collected from the 12 AGSLAs that had purchased ASIK on the cost of fuel, service, and spare parts for diesel pumps, they are saving more than \$1,412, the cost incurred by those who are using diesel pumps. Solar energy is low-carbon and therefore contributes to environmental conservation by using energy from renewable sources. There was a dramatic reduction in water wastage for AGSLAs that purchased and used ASIK. Diesel pumps use more water than ASIK and most of the water goes to waste which also contributes to soil erosion. Using water usage data collected from ASIK users (6 AGSLAs) on their 6.75 acres (2.73 ha) of land and diesel pump users (6 AGSLAs) on their 6.5 acres (2.63 ha) of land over a period of 3.3 months, ASIK farmers used 5,810,000 litres of water while diesel pump users used 16,560,000 litres of water in the same period. This means that ASIK farmers saved 10,750,000 litres of water, a water saving of 185 per cent compared with the diesel

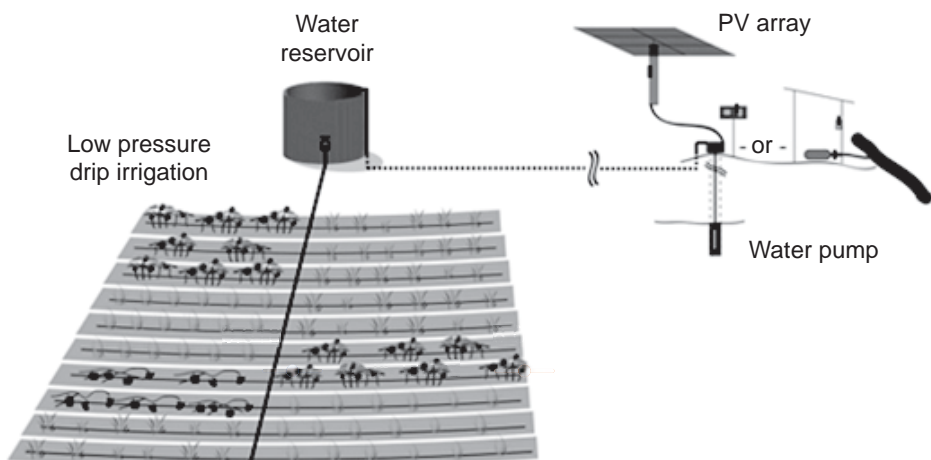


Figure 3 ASIK features

pump users; a substantial contribution to climate change adaptation. This result is in line with other studies that found water savings from solar powered drip irrigation. Solar pumps allow a potential reduction in greenhouse gas emissions by up to 97 per cent for water pumping compared with electric pumps, and by up to 98 per cent compared with diesel pumps (Denison et al., 2016).

Capacity building

To address capacity and technical gaps on the use of ASIK, IRK designed and implemented various training interventions aimed at changing the knowledge, skills, and attitudes of agro-pastoralists. IRK conducted a value chain assessment for high value vegetables and fruits in Mandera County and selected areas of intervention which included training agro-pastoralists on ASIK installation, operations and maintenance, financial literacy through AGSLAs, high value vegetable and fruit production husbandry, and small business development training. IRK also supported AGSLAs to aggregate and form marketing cooperatives. All capacity building interventions were complemented by strong technical oversight, feedback, and mentorship from IR staff. From discussions with AGSLA members, capacity building interventions accelerated the use of ASIK and adoption of high value crop production by the agro-pastoralists. We also collected information to establish the cost of capacity building/training for the six GSLAs that purchased and used ASIK. The total cost for group development and training was \$2,168. This cost constitutes 47 per cent of the total operating cost.

Project results

The use of ASIK for growing high value crops has provided an opportunity for agro-pastoralists to increase their income. This article provides evidence on the linkages between ASIK and household income. Using data from HEA, we explored the potential of ASIK to contribute to increased incomes and determined the relationship between ASIK and household income. HEA results show that 61 per cent of ASIK users generated more income (high income of more than \$300) compared with only 39 per cent of diesel pump users over one farming season. Incomes of ASIK users were almost twice those of diesel pump users and, on average, were five times above the poverty line of \$1.90 per day. The majority of the diesel pump users, 77 per cent, reported low income (less than \$150) from crop sales compared with 23 per cent of ASIK users in the last farming season.

Irrigated agriculture using diesel pumps can result in increased agricultural yields but use of ASIK produced greater yields. By introducing ASIK, higher yields were realized by participating agro-pastoralists and production was possible through dry seasons, with cultivation continuing over two to three seasons per year. Comparisons show that 59 per cent of ASIK households fell into 'high production' ranking (>2,000 kg) for onion, tomato, and watermelon crops compared with 41 per cent

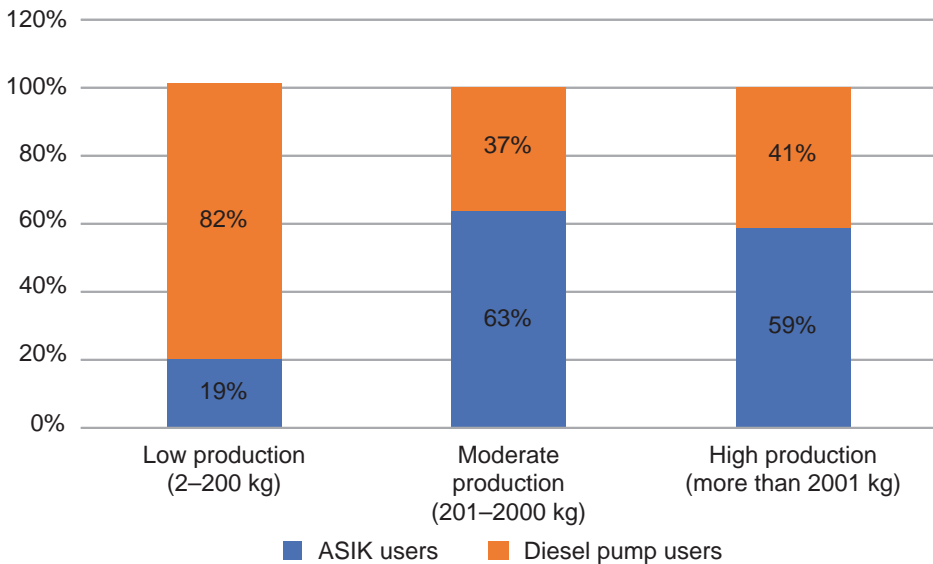


Figure 4 Yield production

of diesel pump households, as shown in Figure 4. ASIK households therefore have a higher production capacity.

Increased high value vegetable and fruit production has ensured availability of food with greater nutritional value and greater economic benefits from income earned from the sale of the surplus. While more ASIK households cultivated on small areas of land of between 1 and 2 acres (0.40–0.81 ha) (68 per cent compared with 32 per cent of diesel pump users), ASIK users produced better yields, as shown in Figure 4.

The SWFF project contributed immensely to women's economic empowerment, including decision-making authority and access to and control over resources associated with the adoption of ASIK. Improving women's economic empowerment in a pastoralist environment is a huge challenge given high levels of marginalization and cultural barriers. However, using the AGSLA as an entry point for accessing ASIK provided a good platform for sharing ideas, knowledge, and resources for building women's social capital, financial literacy, and decision-making power over agricultural production and income. HEA findings show that within ASIK households, the majority of women (59.2 per cent) solely decide how household income is spent/used compared with 40.8 per cent of men. This is not the case with diesel pump households, where it is mostly men (in 59.4 per cent of households) who decide how income is spent/used compared with 40.6 per cent of households where women decide. Additionally, ASIK has contributed to a reduced labour burden faced by women, particularly in using containers to water their crops, as ASIK is programmed to automatically switch on water and lock at appropriate times. Bivariate analysis using the Chi-square test was conducted to establish the relationship between the type of irrigation technology (ASIK or diesel

pump) and household decision-making on how income is spent or used, with no attribution to causality (statistical significance is $p < 0.05$). The findings show that there is a statistically significant relationship between type of irrigation used and household decision-making on how income is spent or used (Chi-square = 13.67, $df = 3$, $p = .003$).

We see significantly higher food security among ASIK households compared with diesel pump users. On a Household Hunger Scale, 62 per cent of ASIK users reported little or no hunger compared with 32 per cent of diesel pump users; 48 per cent of ASIK users reported severe household hunger compared with 52 per cent of diesel pump users. HEA findings show higher dietary diversity among ASIK households than diesel pump users. On the Food Consumption Score (FCS), 62 per cent of ASIK users reported acceptable food consumption compared with 38 per cent of diesel pump users; 45 per cent of ASIK users reported poor food consumption compared with 55 per cent of diesel pump users. ASIK households are therefore more food secure than diesel pump users. Bivariate analysis using the Chi-square test was conducted to establish the relationship between type of irrigation technology (ASIK or diesel pump) and household food security with no attribution to causality (statistical significance is $p < 0.05$). The findings show that there is a statistically significant relationship between type of irrigation used and household food security (Chi-square = 31.52, $df = 2$, $p = .000$).

Linking the SWFF project and entrepreneurship

Herrington and Kew (2017) define entrepreneurship as 'any attempt at new business or new venture creation, such as self-employment, a new business organisation or the expansion of an existing business, by an individual, a team of individuals, or an established business'. From this definition it can be derived that a business, however small, is a tangible outcome of entrepreneurship. Griffin and Ebert (2006) defined business as 'an organisation that provides goods or services in order to earn profit'. This definition can be used for the agro-pastoralists in the SWFF project who are producing high value vegetables and fruits for the market. Farming is 'business' when it involves the sale of produce. Accordingly, for the purpose of this article entrepreneurship in the SWFF project is defined as the production of high value vegetables and fruits for markets.

One of the striking differences between diesel pump and ASIK users is the purpose of production. Though production of crops by both groups was for the market, ASIK users were more strongly focused on the market (more commercially oriented) considering the objective of engaging in agricultural production and level of investments in agricultural inputs. The objective for engaging in agricultural production for the majority of ASIK users (59 per cent) was earning cash compared with 41 per cent of diesel pump users, as shown by the findings in Figure 5. HEA findings show that the inputs of diesel pump users were mostly low compared with ASIK users whose inputs were largely high. The majority of ASIK users (54 per cent) invested more than \$300 in agricultural inputs compared with 46 per cent of diesel pump users. The majority of the diesel pump users

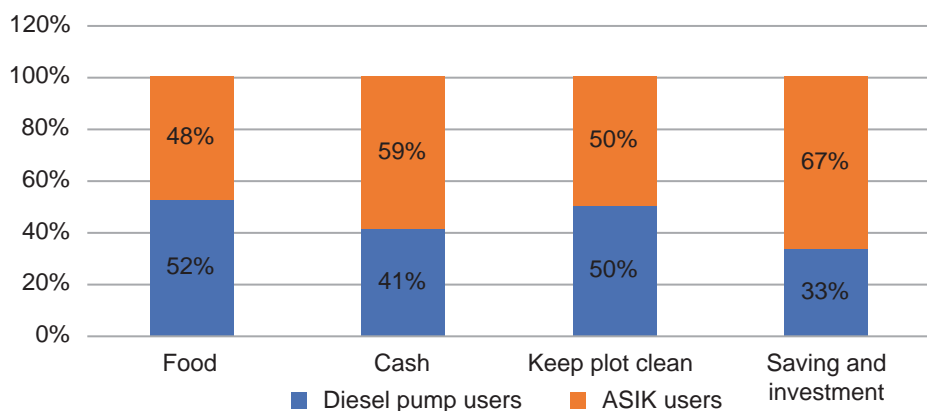


Figure 5 Objective of agricultural production

(76 per cent) invested less (less than \$10) compared with 24 per cent of ASIK users. Therefore, ASIK users purchased inputs, mainly improved and drought tolerant seed varieties, fertilizers, and agrochemicals in order to produce more for the market.

There was a slight/insignificant variation in the aspiration of growing farm enterprises between ASIK and diesel pump users (51 per cent and 49 per cent, respectively). However, from FGDs, ASIK users aspired to grow their 'farming businesses' by expansion, acquiring more farm assets and accessing new markets. This ASIK aspiration is corroborated by the case study shown in Box 2.

Box 2 Bismillahi farmers realize bumper harvest using ASIK

Bismillahi AGSLA was formed in 2016 by 20 smallholder farmers from Shantoley in Mandera County. The AGSLA heard about the ASIK through a marketing event conducted by IRK within their community. Initially community members were not interested in the technology because it was deemed by them to be expensive, and they also did not want to engage with a private company since they feared that they would be exploited. Additionally, IRK had been providing free services, particularly diesel pumps and fuel for irrigation, and they found it odd to be asked to begin purchasing the technology. After developing the business model and explaining it to the members of the group, they began to see the value of adopting the technology and finally they agreed to use it. At this point, another barrier emerged. Community members did not have enough money to buy the technology. During a discussion forum, Ismail, one of the AGSLA members, said:

After sensitization, mobilization, and marketing of the irrigation technology and the business model by the IRK team, we got impressed and felt it was a great idea to embrace the new agro-solar irrigation technology to replace the costly diesel-powered pumps. As farmers in Shantoley location of Mandera County, we collectively agreed to form a group to enable us to accumulate savings and generate enough funds to enable us to purchase new irrigation technology.

To address this challenge, IRK organized them into AGSLAs where members were required to make small savings in their weekly meetings. Each member was required to contribute

(Continued)

Box 2 Continued

\$2.50 per week according to their group constitution; this translates to \$50 savings per week for the group's 20 members. The group's treasurer was required to keep this money in a bank account opened by the group at Equity Bank. Over a period of three months, Bismillahi AGSLA had accumulated savings valued at \$600, which was 20 per cent of the total cost of the irrigation kit. This was sufficient for them to be linked to a financial partner for further financing of \$2,400 for them to purchase the ASIK from SunCulture Ltd. Once the loan was provided to the AGSLA using the normal loan processing procedures, the group transferred the amount to the SunCulture bank account and the irrigation kit was delivered to the GSLA in August 2016. The group had already prepared 1 acre (0.40 ha) of land and had purchased onion seeds ready for planting. The kit was installed by SunCulture technicians in August 2016 and thoroughly tested for operational efficiency and capacity to deliver sufficient water to the prepared land.

With the technical support and extension services from IRK, SunCulture, and the government's Department of Agriculture, group members prepared the land and planted the high value onions, the *hagarmoud* variety which is suited and tolerant to the arid climatic and soil conditions of Mandera County. The selected onion variety is also consumed by the local people and therefore was expected to have better market and returns. The group began with preparations of seed beds, and nurseries, and transplanted the seedlings appropriately along the drip lines.

Group meetings are used as learning forums for discussion about productive behaviours and practices on their farm in addition to contributing savings and repaying loans. This served to improve the quality of onions on the farm as members also shared responsibilities for working and managing the farm to ensure high productivity and returns. The AGSLA chairman said:

Our group has rules and we meet regularly to discuss matters concerning the welfare of our group, especially our farm activities and savings. Our group is very dynamic as well and this enables us to support each other, to teach each other, and to learn from each other. As a group, we decided to start with onions, the *hagarmoud* variety in the first season based on the local demand. Regular saving is critical in the group; without money we would not have been able to purchase the irrigation technology. But our ability to manage the farm as a group has also ensured that we succeed.

To strengthen learning and collaboration among group members, IRK provided tailored small plot horticulture training with a focus on high value crops, covering broadly crop husbandry among other topics. One GSLA member explained that:

The knowledge we received from the training that IRK provided was instrumental to our success. We acquired basic understanding of this new technology which most members can operate and manage with ease. We also know how to water our crops, spacing, and managing crops in stages.

During harvest, Bismillahi AGSLA invited IRK, government officials, other neighbouring AGSLAs, and farmer groups to witness, learn from, collaborate with, and celebrate the success of the group. During harvesting, one group member, when making a presentation to the people gathered, said:

The amount of fuel used on the 1 acre of land is zero, minimal labour was used, and every member of the group was tasked to undertake a particular activity. We used teamwork and commitment otherwise we would not have been where we are now. I feel good to be a member of the first group to grow and produce onions using ASIK. Time spent by women in agricultural production was reduced to a great deal. As a group, we would like to thank IRK for connecting us to SunCulture Ltd and to the financial service provided. Without them, this irrigation technology would never have been ours.

Recommendations

The project experienced challenges from the beginning which were addressed through consultations and collaborative learning with different AGSLAs and stakeholders. We propose below a number of strategies that can be used to tackle the main obstacles and that can be used to accelerate adoption of agro-solar irrigation technology and transformation of agro-pastoralists into entrepreneurs.

Such a transformation requires long-term access to appropriate financial services and products. Financial exclusion is still very high in ASAL areas and this scenario may not be changing soon. Subsidizing financial services through tools such as blended finance will increase utilization of financial services and accelerate adoption of technological tools that promote local economic growth in an environmentally friendly way. The project anticipated that because of financial exclusion, the GSLA model and blended finance product would easily be adopted and used by target communities. There was a risk that the financial services in pastoralist contexts, particularly in the ASAL areas, are not ethically appropriate and therefore will not be used by community members. For example, internal AGSLA and external loans will not be utilized, since they attract some service fees and 'interest'. Clear design of products and services and communication to end users can mitigate the knowledge gaps on the question of 'interest' among the pastoral communities in the Horn of Africa. With clear messaging and collaborative learning events, feedback, and mentorship, it is possible to overcome cultural and religious barriers to financial access. The assumption that local communities are too poor to make any contribution towards savings is very common and popular among stakeholders and communities in ASAL areas; this contributes to the limited adoption of life-changing and innovative technologies such as ASIK. While poverty levels are high in ASAL areas, opportunities for economic empowerment also exist, which can effectively be addressed through economic strengthening interventions such as those adopted by the SWFF project but coupled with other innovative risk mitigation strategies such as blended finance. Successful AGSLAs were very instrumental as change agents/role models in influencing the hesitant ones to join the project, purchase, and use ASIK. Through this mechanism, the adoption of the new technology and related financing model increased from 6 AGSLAs during the first year to 26 AGSLAs by the end of the second year, and this trend is likely to continue. Responsive and predictable capacity building is required to successfully implement an innovative project such as this. The AGSLA model requires intensive training, supervision, and oversight of groups, which implies that more staff and staff time is required. While technical skills and capacity in working with ethical financial services, both formal and informal, through the AGSLAs are limited in the region, developing champions that promote ethical products and services will increase the use of financial services among agro-pastoral and pastoral communities.

Land that can be used for irrigation should be identified and set aside in advance before installation of ASIK. Land tenure in most of the ASAL areas is not clear; ownership of land is on a communal basis, with local leaders, mainly the local administration, having powers to determine who uses land. Lack of clarity on land

ownership limits the potential for adoption of ASIK; further, it also limits AGSLA members from leasing land where they can install and use ASIK. Prior agreements over land use stipulating size and period of use of land should be specified. We recommend establishment of appropriate local institutions for land leasing that can help potential farmers to lease land that can be used for irrigation. In case of conflicts over land, local institutions for resolving them are absent.

Developing links between ASIK users and fresh produce markets both within and outside the project location will expand the markets and increase income, which will incentivize agro-pastoralists to engage in high value crop production. It is important to monitor how this process works out to ensure that farmers are not exploited. Markets to be considered include supermarkets, local government procurement tenders (hospitals, schools, etc.), and cross-border markets in neighbouring counties and countries such as Somalia and Ethiopia. Local markets can be strengthened to offer better prices if there is better coordination among agro-pastoralists to avoid saturation of markets with fresh produce. Better timing, planting, and harvesting of crops and ensuring that crops grown are aligned to the needs of the target markets will ensure better incomes for the farmers, as saturation of markets with fresh produce will be reduced. Large quantities of crops and fruits produced go to waste due to lack of or poor pre- and post-harvest management practices. Better management practices after harvest such as packaging, transportation, and cold storage including processing will reduce wastage, contamination, and losses. Access to markets is a major motivator of pastoralists to engage in high value crop production. Using the Making Markets Work for the Poor approach can act as a major incentive for pastoral communities to engage in high value crop production. We recommend supporting formation and strengthening of farmer marketing cooperatives through aggregation of several AGSLAs for collective marketing. AGSLAs can be segregated into two: those that produce (located in rural areas) and those that purchase (in peri-urban and urban areas) high value vegetables and fruits. The two groups can be linked to increase and strengthen marketing opportunities.

Stakeholder and beneficiary project buy-in are critical for its success. This is always guaranteed in a project in which beneficiaries are required to pay in order to access services. At design, one of the project assumptions was that there would be a stakeholder buy-in due to the innovative nature of the technology and the business model of the project. During project implementation, there was a realization that stakeholder attitudes play a more critical role in technology adoption. It also takes a long time for project stakeholders to accept a project that requires beneficiaries' contribution in a context where people have been receiving humanitarian aid for decades. Most of the stakeholders initially doubted the participation and contribution from agro-pastoralists and pastoralists who have been affected by severe climate-induced disasters, drought, and flood, but these doubts changed when community members began purchasing and using ASIK. A project in which beneficiaries pay for technology products and services is effective in delivering development services to poor communities.

More research is required to develop appropriate but affordable solar-based irrigation products. The high initial cost of ASIK is a barrier to the majority of

agro-pastoralists, and without access to financial services they may not be able to afford it. We argue that the underlying cost structures and business model, for example using community level staff (field agents), privatizing training so that GSLAs pay for the training from profits they earn from their enterprises, and increasing ASIK sales to more GSLAs, can facilitate delivery of sustainable, sharia-compliant financial services and increase access to life-changing technologies.

Conclusion

This article demonstrates that there is a relationship between agro-pastoral entrepreneurship and blended finance, ASIK, and training which interact to influence income, production, food security, and women's empowerment. Both qualitative and quantitative analysis has shown that ASIK households produced more high value vegetables and fruits, were more food secure, and earned more income than households that used diesel pumps. Results indicate that households using ASIK improved both household income and production yields more than diesel pump users. Thus, ASIK users were driven by the intention to commercialize their agricultural activities. We therefore conclude that agro-pastoral entrepreneurship, which involves the production of high value vegetables and fruits for markets, contributed significantly to improving the livelihoods and economic status of the households. These households were motivated more by 'opportunity' presented by ASIK than 'necessity', which was a major motivation of diesel pump users. The majority of diesel pump users received the pumps at no cost (donations) from the local government and international NGOs and this explains their low entrepreneurial capability compared with ASIK users, who paid for the technology.

The findings also indicate that improving agricultural productivity and income contributes to increased household food security, which implies that women are benefiting more from the SWFF project. By improving women's nutritional status, their contributions to irrigation decisions, and control of income earned, a better way of contributing to women's empowerment has been developed by the project. Solar-based irrigation technology is therefore a better entry point for women's empowerment.

From the findings, we can conclude that the 'diesel pump users' are agro-pastoralists who engage in crop production mainly because they received diesel pumps from the local government and NGOs. Their interest in and knowledge of crop farming is to grow crops but on a less commercial scale. They are sandwiched between 'survival' and 'commercializing' crop production and therefore have some potential to become entrepreneurs. The 'ASIK users' are agro-pastoralists who started as home gardeners and diesel pump users, but have shifted from 'subsistence' to a 'commercial' orientation in crop production. These agro-pastoralists started adopting and using ASIK after a period of saving, planning, building on social capital through AGSLAs, and accessing financial resources and technical and business skills from the SWFF project to engage in high value vegetable and fruit production as their farming enterprises. ASIK households therefore seized the opportunity presented by the SWFF project through technology, blended finance, and capacity building to turn a previous 'potential' into actual viable entrepreneurs. ASIK users displayed more

entrepreneurial characteristics than diesel pump households. The ASIK households displayed a stronger business outlook, were risk takers (took the risk of investing in the new technology), were more optimistic, and were goal oriented in their farming activities. Mentoring and supporting these farmers to transform their businesses further, increasing access to ASIK, more land and water for farming, and marketing support will further strengthen their entrepreneurial capacities and enable them to achieve more positive results. Bundling blended finance and ASIK with training offers a more promising economic strengthening opportunity for marginalized pastoralist groups residing in arid and semi-arid lands.

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