SECURING WATER FOR FOOD

SkyFox Performance Evaluation Report

Integrated Fish and Crop Production in Ghana

AUGUST 2019

SECURING WATER FOR FOOD: A GRAND CHALLENGE FOR DEVELOPMENT

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TABLE OF CONTENTS

ABSTRACT

An external field evaluator contracted by the Securing Water for Food (SWFF) program evaluated the performance of the SkyFox integrated aquaculture and crop production project on the livelihood of end users in Ghana. Specifically, the field evaluator assessed changes in water use, crop yield, time engaged in agricultural activities, income, and poverty of end users as a result of the innovation. A structured questionnaire uploaded on the Fulcrum software and mobile application was used to interview end users with the aid of an interpreter.

The field evaluator found an overall reduction in labor input of 50 percent, while water usage was reduced by 41 percent and fertilizer input was reduced by 36 percent. In addition, there was a 60 percent increase in the mean annual income of end users, and extreme poverty level dropped from 84 to 70 percent. An increase in income was stronger at Dambai, where end users were newly introduced into dry season farming through the innovation, were given farmlands free, and had some labor costs absorbed by the innovation. At Domkorkrom, although the income level was low, there was a significant increase in income. However, all end users interviewed remained in extreme poverty. At Adawso, most end users are in the upper income level and were able to increase their income by benefiting from the more efficient irrigation system provided by the innovation. At least seven end users shifted from extreme poverty to low income and upper income levels. This is a major achievement from the project, especially if this result is extrapolated across over 10,000 end users that benefit from the innovation.

The innovation is a strong strategy for alleviating poverty and improving the livelihood of rural people in West Africa, where more than 70 percent of the people are poor and reside in rural areas. However, there are important aspects of the project that need reinforcement, including access to loans, adequate maintenance of water pipelines, provision of more irrigation equipment, and extension of the fish pond models to provide more wastewater.

INTRODUCTION

Agricultural development is the key driver of economic growth in sub-Saharan Africa (SSA),[1] where about 75 percent of extremely poor still reside in rural areas, and more than 90 percent of those who participate in agriculture are directly or indirectly dependent on agriculture as their source of income.[2] Research shows that 75 percent of the SSA population live in extreme poverty, barely on USD 1.25 per day or less,[3] and almost 33 percent are undernourished.[4] Poverty contributes to poor agricultural productivity, as many farmers cannot afford to purchase necessary farm inputs, such as fertilizer, improved seeds, and irrigation tools, which would increase productivity. The prevailing high costs of essential household and farm needs are more than the low income farmers can earn with backbreaking labor. It is difficult for them to increase yield. In view of the significant role agriculture plays in the livelihood of these people, strategies and innovations that improve productivity and income of farmers must be explored.

SkyFox is headquartered in Ghana and operates in Burkina Faso, Ghana, Guinea, and Sierra Leone. They provide services in agribusiness, sanitation, and water with the objective of improving livelihoods through people-centered business innovations in food, energy, sanitation, water, and shelter. The SkyFox innovation of integrating aquaculture with crop production is a viable intervention strategy in alleviating poverty by helping farmers produce more crops with less water and provide more water for producing food in West Africa.

Through this innovation, rural farmers invest in fish farming and gain up to 31 percent interest on the total amount they invest when augmented with loans from innovators. The project gives an additional 100 percent loan to augment end users' shares. For instance, Skyfox adds an equivalent amount as a loan to the money that farmers invest to double their shares and takes back nine percent interest of the loaned amount. Therefore, farmers receive 20 percent interest on their money and 11 percent from the loan, which brings farmers' interest to 31 percent. However, farmers receive only 20 percent of the amount they invest without the loan. Crop farmers are involved in an irrigation scheme where they are provided wastewater from the fish pond to irrigate their farms. The wastewater also provides nutrient supplement to crops. In this survey conducted by an external field evaluator, end users were interviewed with a structured questionnaire prepared and uploaded on the Fulcrum software.

Data was collected through one-on-one interaction with end users with the help of an interpreter. The aim of the survey was to assess the performance of the integrated aquaculture and crop production innovation on change in water usage, inputs such as labor and fertilizer, time spent on agricultural activities, crop yield, income level, and poverty. The questions in the survey were also meant to help others understand the benefits and problems faced by end users and obtain their suggestions on improving the innovation.

1 Nchuchuwe, F. F. and Adejuwon, K. D. (2012). The Challenges of Agriculture and Rural Development in Africa: The Case of Nigeria. International Journal of Academic Research in Progressive Education and Development, 1(3), 45 - 61.

2 The WorldBank Group (2013). Implementing Agriculture for Development. "The future needs an agricultural system that produces about 50 percent more food to feed the world's 9 billion people by 2050;1 that provides adequate nutrition; that substantially raises the levels and resilience of income and employment for most of the world's poor, 75 percent of whom live in rural areas and most of whom rely on agriculture for their livelihoods"

3 http://www.fao.org/3/i0132e/i0132e03a.pdf. "Seventy-five percent of the dollar poor work and live in rural areas; projections suggest that more than 60 percent will continue to do so in 2025 (IFAD, 2001)".

4 Food and Agricultural Organization (2005). Food Security and Agricultural Development in Sub-Saharan Africa: Building a case for more public support (Policy Brief1). "Almost 33 percent of the African population, some 200 million people are malnourished, which is the highest prevalence in the world".

BACKGROUND

Field evaluation of end users of SkyFox company was carried out from July 26 to August 13, 2019. Across four regions, 63 end users were interviewed, including three at Berekuso (Accra region), 14 at Adawso, 19 at Domkorkrom, and 27 at Dambai. At each location, an interpreter was hired. At Berekuso, Andreas Anthonio from Madina school volunteered to interpret, while Grace Abisiba was hired at Adawso, and Markpobi Kwasi Joseph was hired at Dambai. A prepared questionnaire uploaded on the Fulcrum software was used for data collection. Questions were divided into farmer information, farm information, income and expenditure information, perception of innovation, and other information. The questions were designed to answer the following research questions:

1. How has the innovation changed water usage/availability among end users?
2. How has the innovation changed crop yields or crop survival among end users?
3. How has the innovation changed incomes/livelihoods among end users?
4. How has the innovation changed time spent on agricultural activities?
   a. How does the use of the innovation differ, if at all, between women and men?
5. To what extent is the innovation affordable to end users?
   (Is the price affordable and is financing required?)
   a. What are the equipment costs and are they prohibitive in adoption of the innovation?
   b. What is the attrition rate of the farmers?
6. What other benefits and problems have the farmers experienced during use of the innovation?
   a. How do the benefits from and problems with the innovation differ, if at all, between women and men?
7. To what extent are an innovator's customers below the poverty line? (observational)
8. What changes/suggestions do end users recommend to the innovator?
9. What are the differences in input usage, crop yields, and transport/storage costs before and after the innovation?
10. Has the innovation changed the crop portfolio of the farmer? If so, what is the difference in the selling price per kilo of their crops now before and after the innovation?

One-on-one interviews with end users were conducted with the help of an interpreter. Responses to questions from end users were synced on the Fulcrum app to the main Fulcrum website and later downloaded for analysis. Comparisons were tested statistically in R statistical software version 3.6.1 (R Core Team, 2019).

Gender

The end users interviewed were 38 percent (24) female, 57 percent (36) male, and five percent (three) groups. At Adawso region, all individual end users (12) interviewed were men (Figure 1). Two groups that farm collectively were interviewed: a group of four consisting of three men and one woman, and a group of three men. Nine out of 19 end users interviewed at Domkorkrom were women. End users belonged to groups of not more than 30 members, and 89 percent of the groups had more women than men. Specifically, some groups were 65 to 100 percent women. The two end users interviewed at Berekuso were both women. Equal number of men and women (13 each) were interviewed at Dambai, and one group of 30 members was interviewed.

Adoption of the innovation differed between male and female end users. Generally, more women participated in fish investment that men, while more men were involved in crop farming than women (Figure 2).

FIGURE 1: GENDER COMPOSITION OF END USERS ACROSS REGIONAL LOCATIONS

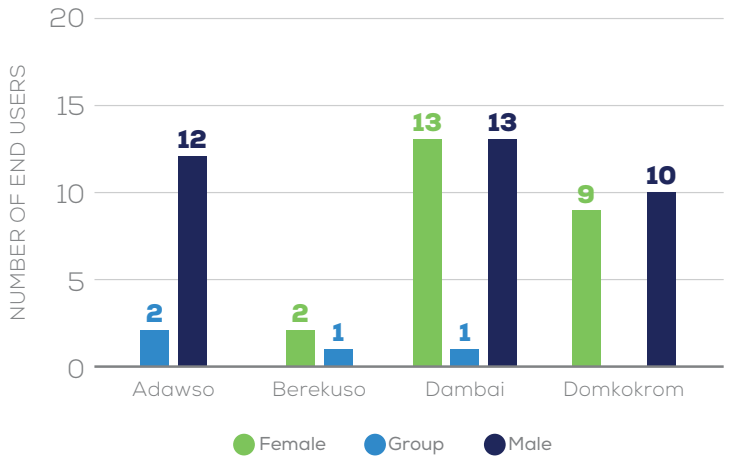
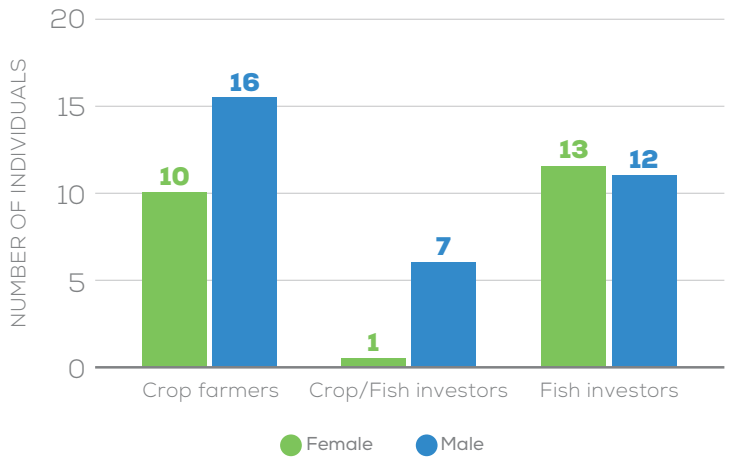


FIGURE 2: INNOVATION USAGE ACROSS GENDER



Farm size

The average farm size is 9.5 acres per end user in Adawso and 2.0 acre per end user in Dambai (Figure 3). Farm size ranged from one to 22 acres in Adawso and one to six acres in Dambai. Land is rented by farmers in Adawso, while end users are given land for free at Dambai. The average farm size is one acre for women end users and six acres for men (Table 1). Dry season farming has been ongoing for a long time at Adawso, so farmers are more established and can rent as much land as they can afford. At Dambai, the innovation provided the majority of the farmers one or two acres of land per farmer and, in a few cases, up to six acres to farmers who can afford labor cost.

FIGURE 3: MEAN FARM SIZE ALLOCATION TO MALE AND FEMALE FARMERS IN EACH COMMUNITY

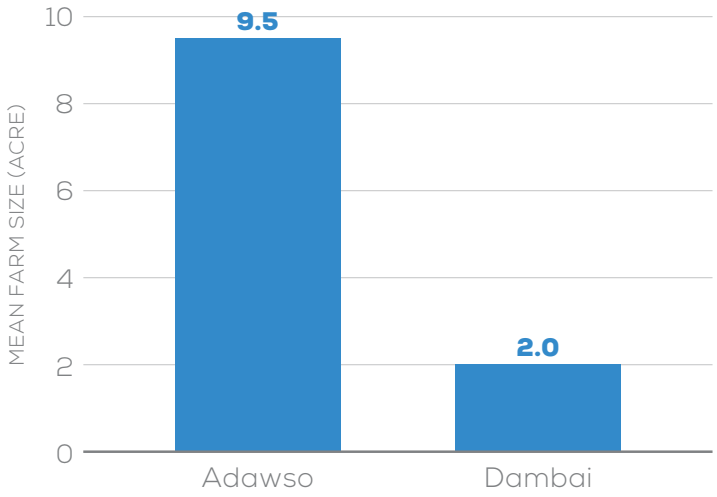


TABLE 1: RANGE AND OVERALL MEAN FARM SIZES ACROSS GENDER GROUPS

GENDER	AVERAGE FARM SIZE (ACRE)	RANGE OF FARM SIZE (ACRE)
Female	1	1-2
Male	6	1-22

Farmer's experience

From the project's start in 2016 until 2019, an average of 29 (46 percent) end users have used the innovation for two years, i.e., from 2018 to 2019. Out of 63 end users sampled, 20 (32 percent) were involved for three years, 10 (16 percent) for four years when the project commenced, and four (six percent) joined in 2019 (Figure 4).

End users in Adawso and Domkorkrom have enjoyed the project for an average of three and one-half years, i.e., from 2016 to 2019. At Domkokrom, where all end users are fish investors, involvement ranges from one to three years (average of 2.7 years). At Dambai and Berekuso, end users have used the innovation for up to two years only, from 2018 to 2019 (Figure 5).

FIGURE 4: YEARS OF FARMERS INVOLVEMENT IN THE PROJECT

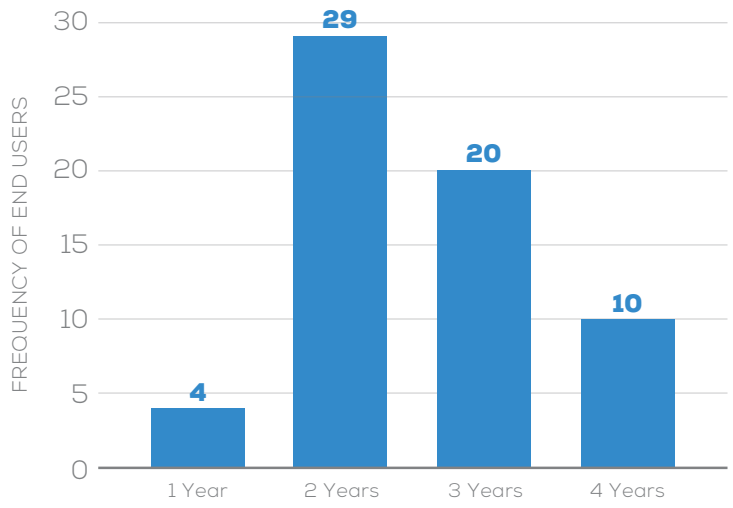
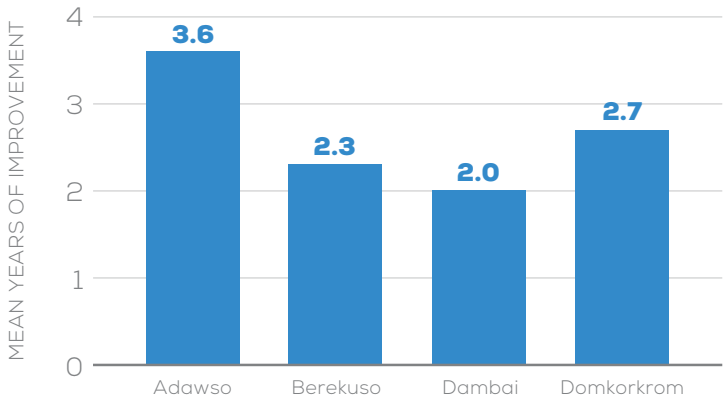


FIGURE 5: YEARS OF INVOLVEMENT IN EACH OF THE SAMPLED COMMUNITY

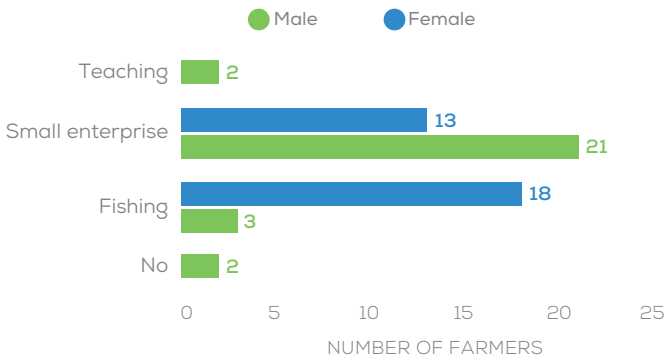


Other occupations or sources of income

Data for 59 individual end users was analyzed, and the four group interviews were removed from the dataset. Occupations other than farming that end users were involved in included small enterprises, teaching, and fishing. Twenty-one out of 59 end users (36 percent) do not have an occupation other than farming. However, up to 58 percent (34) of the end users participate in small enterprises, while three percent each are involved in teaching and fishing (Figure 6).

There also is a clear partitioning of gender participation in non-farming activities. All the women who have other non-farming occupations own small enterprises and are not involved in fishing and teaching like their male counterparts. But, men explore teaching, fishing, and small enterprises alongside farming activities (Figure 5).

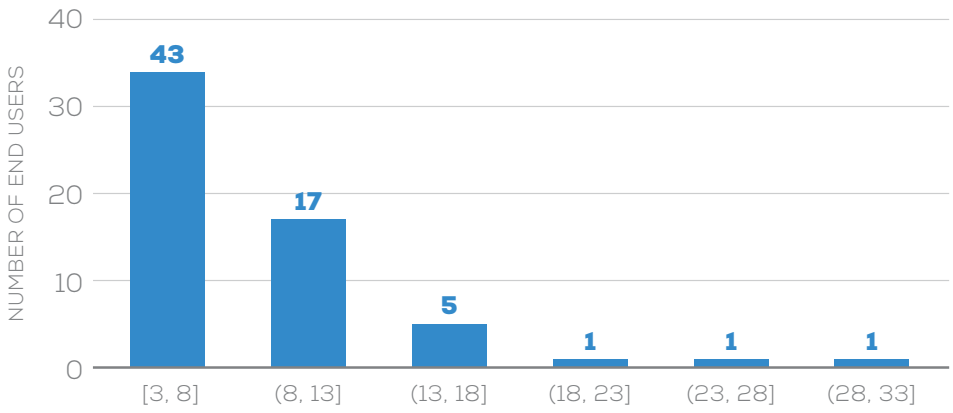
FIGURE 6: OTHER OCCUPATION OF END USERS



Family size

Family size of end users ranged from three to 33 (Figure 7). About 60 percent of end users have three to eight individuals in the family. Some end users have up to 33 individuals who were directly living with them at the time of the interview. These individuals are members of extended families, including aged parents, cousins, and children of late siblings, all of whom directly draw support from end users. Mean family size per end user is nine with a median of eight.

FIGURE 7: FAMILY SIZE DISTRIBUTION OF END USERS



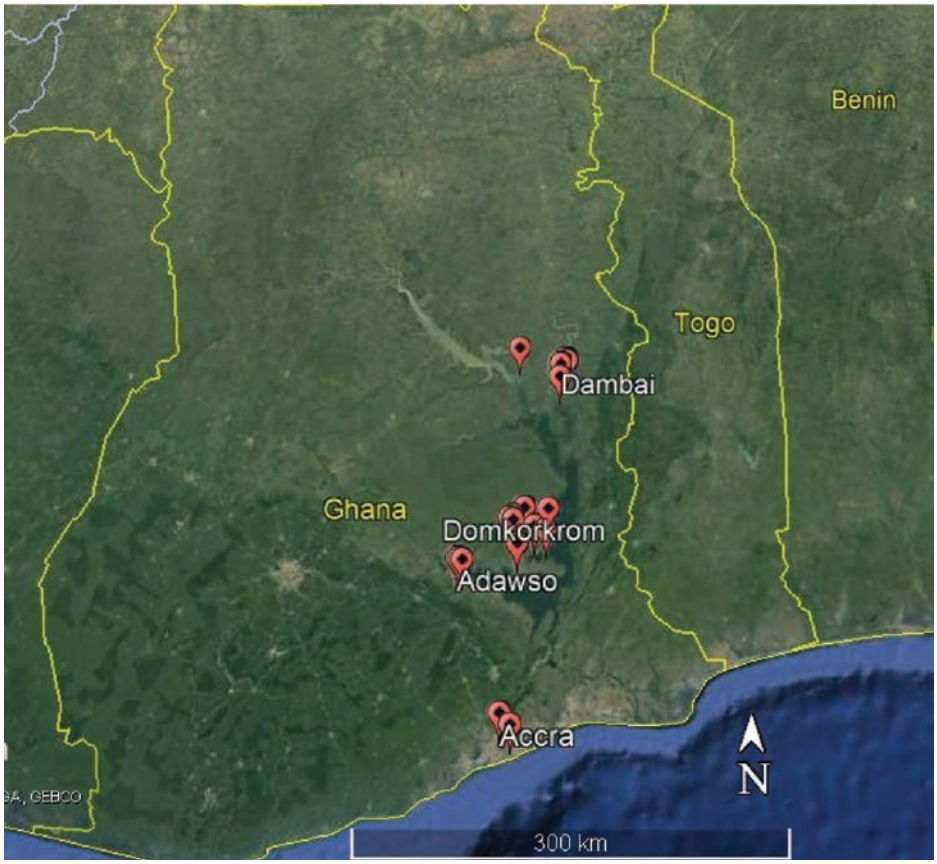
METHODOLOGY

Sample Selection

A total of 80 end users was selected from the list provided by SWFF using randomized cluster sampling. The clusters were obtained by taking each district as a cluster. The Kutools package in Excel was used to select individual names from a pool of each clustered dataset of communities in Adawso, Berekuso, Dambai, Krachi east, Krachi, and Kwahu districts (Figure 8). The sample was selected to reduce the chances of running short of available customers to interview and meet the minimum of 50 participants as recommended by SWFF.

The selected end users represented a relevant group to capture the different gender groups, usage of the innovation, location, and income levels. The end user list was composed of 56 percent aquaculture, 40 percent crop, and four percent crop/fish farmers. Using this proportion, the largest sample size normally would be assigned to fish, which would greatly reduce representation of the three crops (onions, melon, and okra) in the sample. Therefore, the specific samples sizes were assigned to each location: 38 to Adawso to interview 20 fish investors and 18 onion crop farmers; 20 to Dambai to interview farmers involved in both fish investment and crop farming to include melons, onions, and okra; and, two assigned to Berekuso with 10 onion farmers.

FIGURE 8: GOOGLE EARTH MAP OF SAMPLED VILLAGES IN ACCRA, ADAWSO, DOMKORKROM, AND DAMBAI



The interview was carried out in person (Plate 1) by the evaluator using a set of prepared questionnaires uploaded into the Fulcrum software. The evaluator read the questions one at a time and recorded responses to each question in the Fulcrum application. The interpreter aided communication between the evaluator and the end user. The interview also was recorded in audio, and a single photo of the end user was taken. Of the 80 randomly selected end users, 59 individuals and four groups were interviewed. Questions related to crop farmers were skipped when interviewing fish investors, and questions related to fish investment were skipped when crop farmers were interviewed.

There was a technical failure of the android phone used during audio recording. The first three interviews conducted at Madina School and Berekuso were not recorded because the audio software failed to record while using the Fulcrum app. Subsequent interviews at Domkorkrom were recorded with another audio recorder which also failed after several interviews. Therefore, audio recordings from Domkorkrom and Adawso are not complete but there are complete audio records of all interviewed end users at Dambai. In Adawso and Dambai, some end users were not available to be interviewed.

Typical interview setting during survey at Dambai (Rahila Yilangai left in red t-shirt, the end user Christalord Quaicoe middle and the interpreter, Makpobi Kwasi Joseph). Photo taken by Maxwell Apdo, the driver.

RESULTS

EXPERIENCE WITH INNOVATION

End users reported a very stressful experience using the old irrigation method. The new irrigation method (mist sprinkler system manufactured by Aggrico) provided by the innovation has brought great relief. Before the innovation, farmers irrigated for 12 hours and carried pipes around the farm. With the new irrigation tubes, they spend less than three hours and do not have to be present at the farm while irrigation is taking place. Therefore, they have time to do other important things. Water wastage also has reduced with the new tubes. In addition, the heavy droplets of water from the old pipes (photo on left) were damaging crops by uprooting them in the process. The new tubes discharge water gently in mist form which reduces wasted water, washed away fertilizer, and damage caused by trampling and high pressure water discharge (photo on right).

Old sprinkler irrigation system

New mist sprinkler irrigation system (Photo by Rahila Yilangai)

Beyond the irrigation benefits, end users also experienced certain benefits from the innovation (Table 2). However, the innovation is not without problems, and end users reported a few problems faced with the innovation (Table 3).

TABLE 2: BENEFITS OF THE INNOVATION REPORTED BY END USERS

BENEFIT	NUMBER OF RESPONDENTS	PERCENTAGE
Improve business/farming	4	6%
Improved income in meeting immediate family needs especially children's school fees	24	46%
Increase survival of crops	1	2%
Nutritional source	2	4%
Opportunity for investment and saving	5	10%
Provided access to loans	3	6%
Reduced labour cost/production cost	7	13%
Reduced stress	3	6%
Reduced time spent	3	6%

TABLE 3: PROBLEMS FACED BY END USERS WITH INNOVATION

PROBLEMS
Project site is far from them (Domkorkrom)
Road is bad (Dambai)
Water is not enough during the dry season (Dambai)
Breakdown of pipelines (Adawso, Dambai)
Pumping water is difficult when there is no electricity (Dambai)

BENEFITS OF INNOVATION

Agricultural activities benefits

At Dambai, there was no dry season farming occuring before the innovation. This was introduced for the first time by the innovators, unlike at Adawso, where dry season farming has been ongoing and end users are more established farmers. Therefore, newly introduced crops cultivated during the dry season at Dambai were the most noticeable agricultural benefit that farmers derived from the innovation. At Adawso, the type of crops produced did not change as a result of the innovation. At Dambai, however, crops such as melon, okra, onions, peppers, and tomatoes were not cultivated during dry seasons before the innovation. Only a small quantity of some of the crops was produced during the rainy season. The two major crops cultivated through the innovation are onions and melon, with fewer farmers cultivating onions than melon but doing so in larger quantities. This is probably because the demand for onions is higher as it is widely used as an additive in various modern and local dishes in Africa. Other crops cultivated included peppers, okra, tomatoes, and maize at average mass of less than 200 kilograms per season (Figures 9 & 10).

FIGURE 9: NEWLY INTRODUCED CROPS AT DAMBAI CULTIVATED BY END USERS

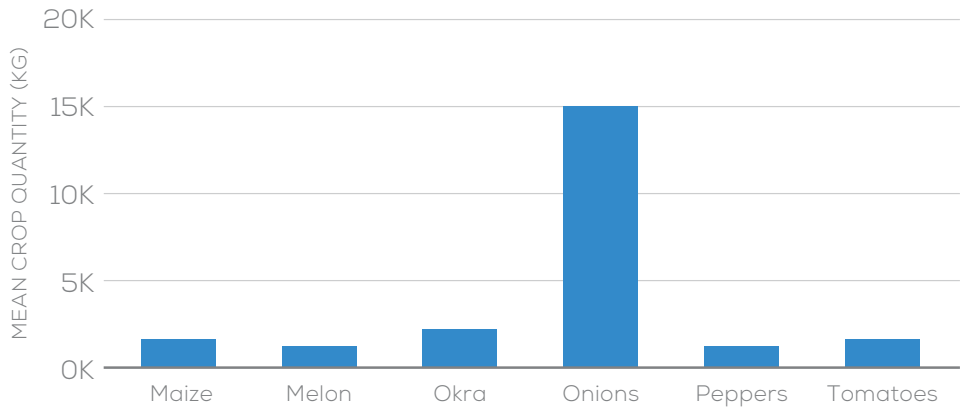
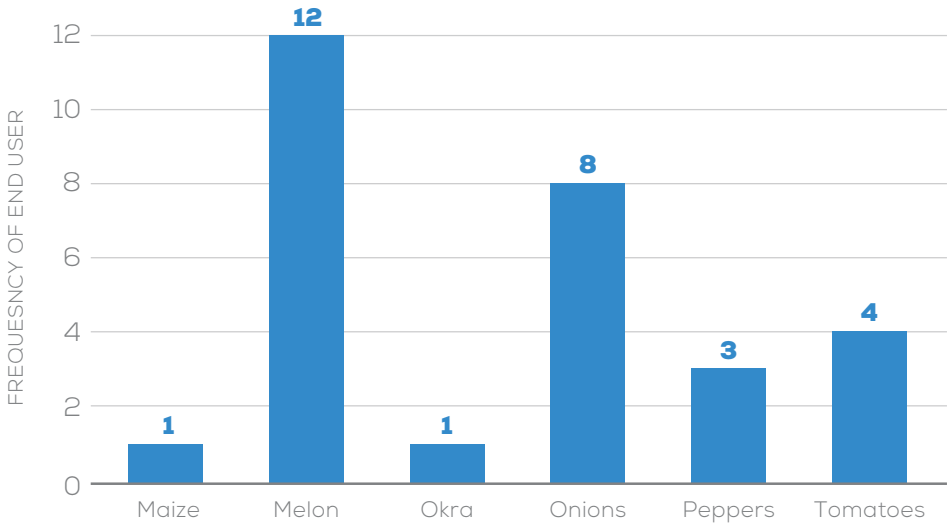


FIGURE 10: NUMBER OF END USERS FARMING EACH OF THE CROPS AT DAMBAI



Water benefits

At Adawso, quantifying water usage before innovation was not possible. Although farmers were able to provide information on the number of hours they pumped water, the size of their farmlands in acres, and the amount of money they spent on pumping water per day, there was no information on the discharge rate of the locally manufactured pump. However, the cost of pumping water before and after the innovation was used as a proxy to evaluate change in water usage. There was a general reduction in cost of pumping water as a result of the innovation (Figure 11). Farmers used less water using the innovation than before the innovation. An average of 2,600 GHs was spent on pumping water after the innovation compared with 4,400 GHs before the innovation. The amount spent after the innovation is calculated based on five percent of total produce charged by SkyFox for wastewater from fish pond. Looking at differences in water usage across individual end users, four of 13 end users spent more money on pumping water after the innovation (Figure 12). Statistically, this difference is significant for all four farmers.[5]

5 Chi-squared test: Yewoena Raymond (X-squared = 395.12, df = 1, $p < 0.001$); Kofi Marfo (X-squared = 28.572, df = 1, $p<0.00$; Lartey Laryea (X-squared = 6.2069, df = 1, $p = 0.01273$); Ankrah's group (X-squared = 206.45, df = 1, $p < 0.001$).

FIGURE 11: COST OF PUMPING WATER BEFORE AND AFTER THE INNOVATION

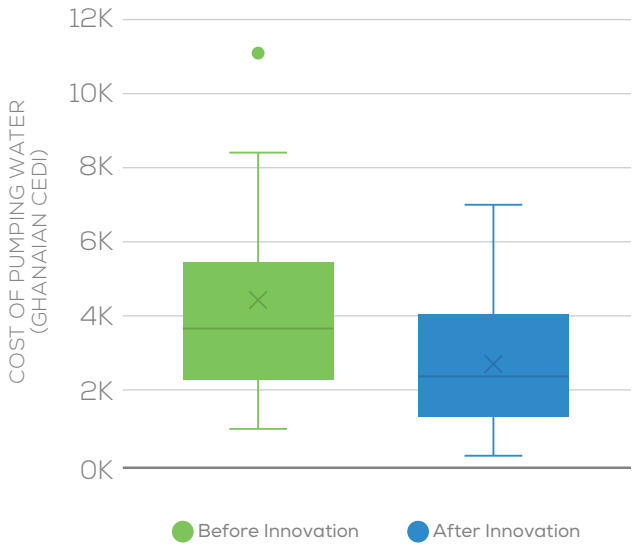
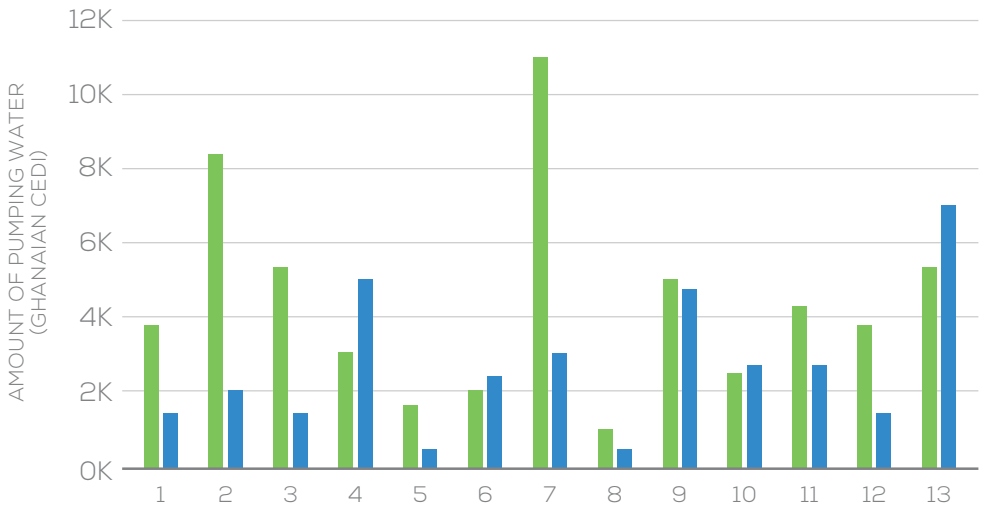


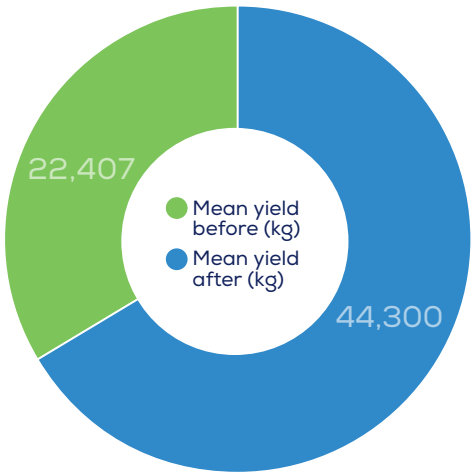
FIGURE 12: COST OF PUMPING WATER AT INDIVIDUAL LEVELS BEFORE AND AFTER INNOVATION COMPARED



Crop benefits

There was a very significant increase in crop yield at Adawso from about 22,000 kilograms (22 tons) to 44,000 kilograms (44 tons) (98 percent) of the most important crop, onions (Figure 13).[6] Other crops cultivated included okra and cucumber which fluctuate in quantity as they are cultivated only in addition to the priority crop of onions. Each bag of onion measures 150 kilograms, and farmers cultivated up to 400 bags per acre.

FIGURE 13: MEAN YIELD OF ONIONS AS THE MOST IMPORTANT CROP BEFORE AND AFTER INNOVATION



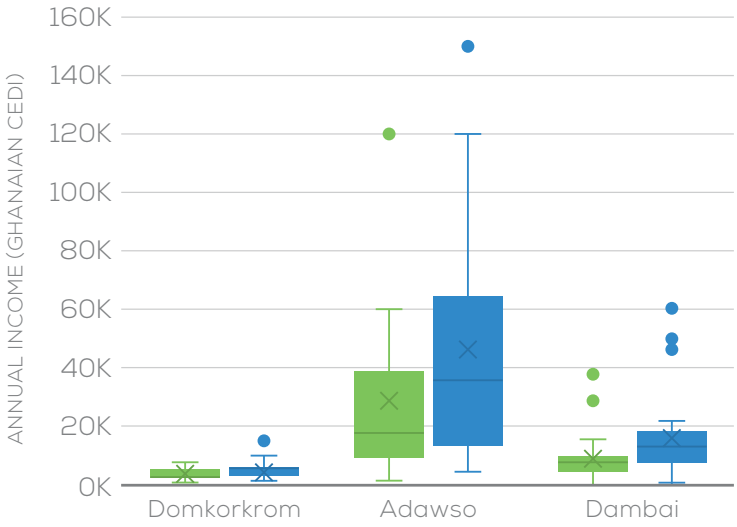
Income benefits

Income of end users increased significantly as a result of the innovation.[7] There was an increase in income across all locations (Figure 14). At Domkorkrom, the income level was lower compared to Adawso and Dambai, generally below GHs 20,000. Adawso was at the highest income level with an increase in maximum income from 120,000 GHs to 150,000 GHs. However, end users' income increased significantly at Domkorkrom,[8] but not significantly at Adawso.[9] Impact of the innovation on income is stronger at Dambai with a high significant increase in income after using the innovation.[10]

The pattern of inclusion in the three locations resulted in the different levels of impacts. At Adawso, farmers rent farmlands and pay one-third of the total produce for labor and five percent of total produce for water. Meanwhile, crop farmers at Dambai receive farm allocations at no cost, do not pay for water, and have some labor costs such as plowing handled for them by the innovation. Therefore, the production cost incurred by farmers at Adawso reduced the strength of the innovation impact as compared to Dambai.

6 Chi-squared test, X-squared = 7185.2, df = 1, p<0.001
7 Mann Whitney U test, W = 1331.5, p = 0.01397
8 Mann Whitney U test, W = 102, p = 0.02259
9 (Mann Whitney U test, W = 73, p = 0.26
10 See non-overlap of median points in fig. 14: Mann Whitney U test, W = 218.5, p = 0.01162

FIGURE 14: ANNUAL INCOME OF END USERS BEFORE AND AFTER INNOVATION AT DIFFERENT LOCATIONS



Poverty reduction benefits

Increased income of individual end users is a measure of poverty alleviation (Figure 15). There was an upward shift in income among end users (Figure 16). Seven end users who were extremely poor before the innovation shifted to the low-income level, and one shifted from extremely poor to upper income level while 42 remained at the extremely poor level, indicating a slight increase in income but not enough to make considerable change. Two out of four low income end users shifted to the upper income level, and one moved to the middle-income level. Likewise, two out of three middle income end users shifted to the upper income level while the three who were at the upper income level remained at that level. There was no downward shift in income level recorded but more than 70 percent (42 of 60) of end users are still extremely poor. However, with this current trend in income shift, there is hope that the extreme poor people will shift to low and higher income levels in the future with continuous involvement.

FIGURE 15: INCOME CHANGE OF INDIVIDUAL END USERS AS A RESULT OF INNOVATION

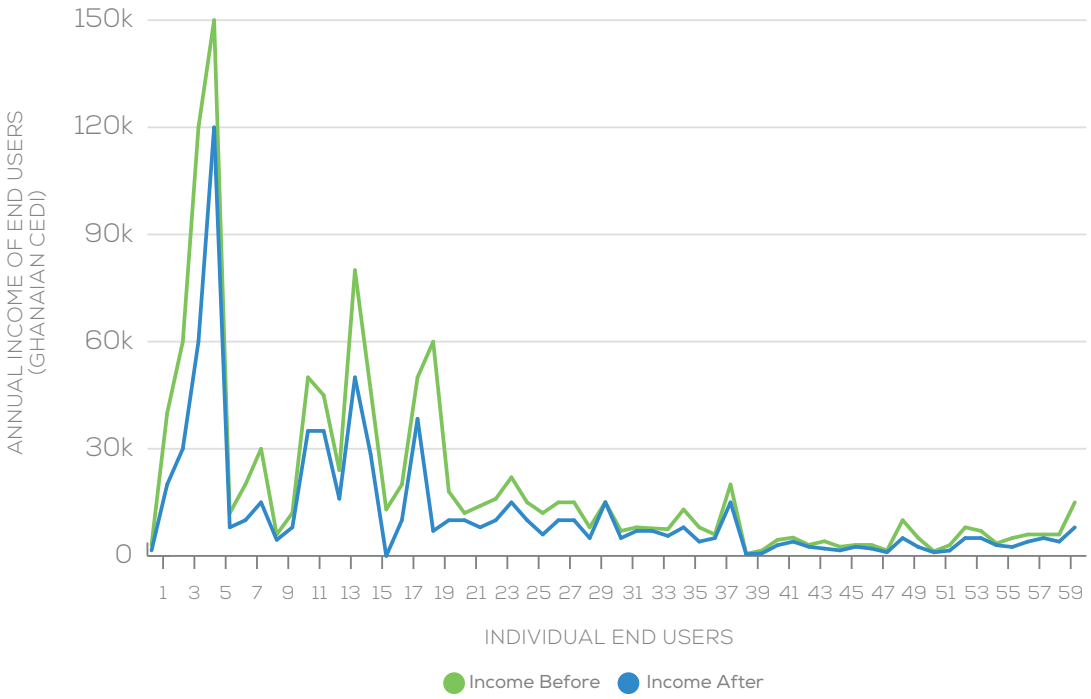
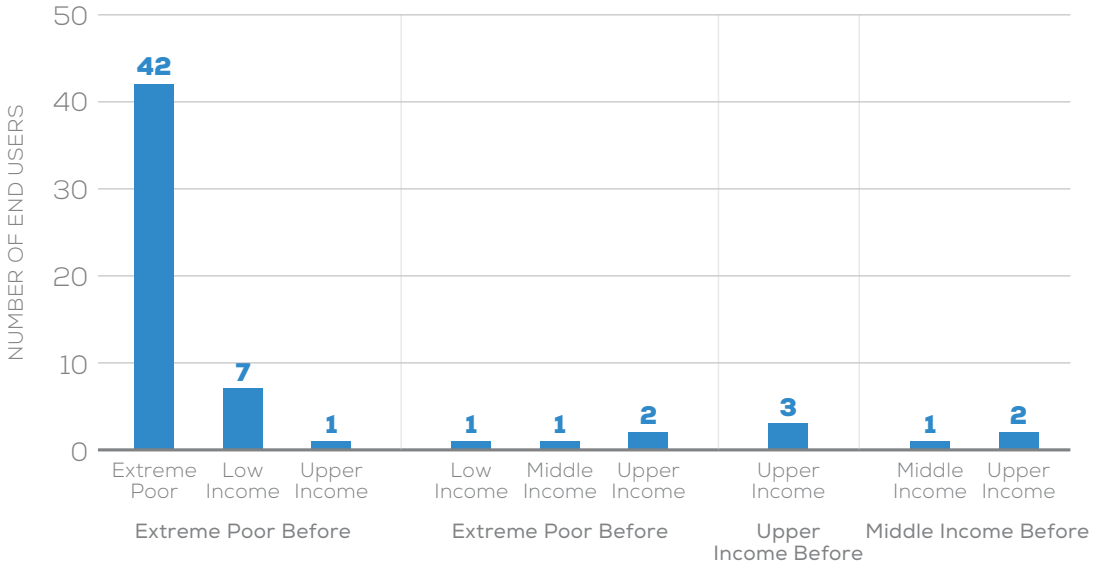


FIGURE 16: INCOME LEVEL SHIFT AS A MEASURE OF POVERTY LEVEL CHANGE AMONG END USERS



Gender differences

Gender differences in the primary occupation of end users seemed to influence adoption of innovation type. Only women have small enterprises as their primary occupation, and fewer women have farming as their primary occupation than have small enterprises. The majority of men (more than 50 percent) have farming as their primary occupation, and a few are primarily involved in teaching and fishing.

More women invested in fish than crop farming in the same way they prefer small enterprises as their primary occupation (Figure 17 & 18). Also, men who were primary farmers preferred the crop farming innovation to fish investment.

FIGURE 17: GENDER DIFFERENCES IN PRIMARY OCCUPATION OF END USERS

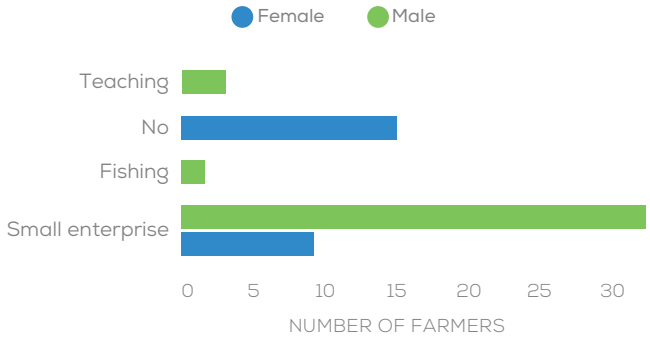
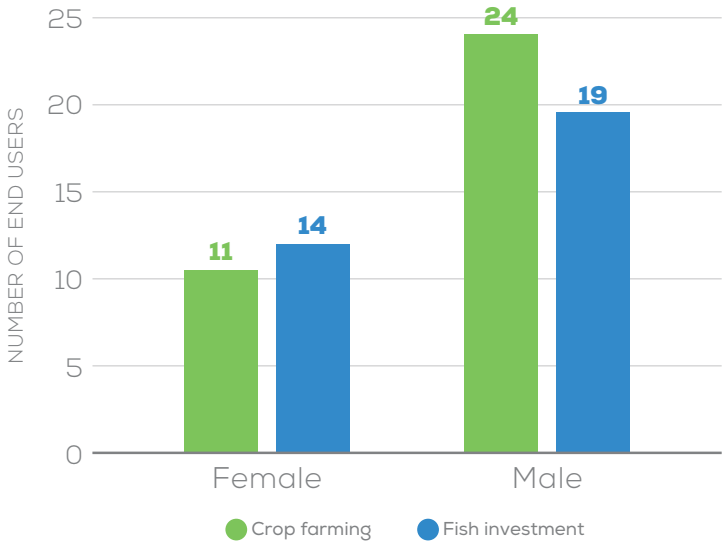


FIGURE 18: PARTICIPATION IN INNOVATION BY GENDER



Regional differences

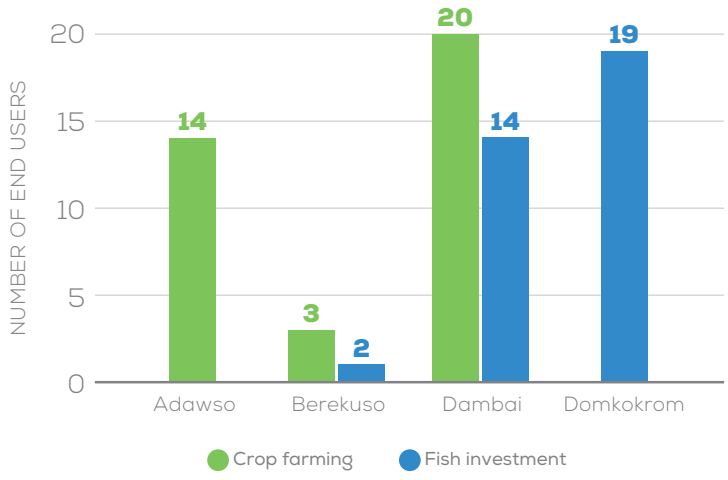
The most obvious regional differences are the poverty levels of end users. Although 70 percent (42) of the pooled sample are extremely poor, 19 out of the 42 are from Domkorkrom. All end users interviewed at Domkorkrom fall under the extreme poor category. Adawso end users are more established farmers with higher income levels, and more farmers at the upper income level. At Dambai, 74 percent are extremely poor, and 11 percent are at the upper income level (Table 4).

Use of the innovation also differs by location, with fish investment at Domkorkrom, crop farming at Adawso, and both crop and fish investment at Dambai (Figure 19). Use also corresponds to the level of benefits enjoyed by end users at different locations since patterns of inclusion depend on the proximity of farmers to innovation model sites.

TABLE 4: POVERTY LEVEL OF END USERS

POVERTY LEVEL	ADAWSO	DAMBAI	DOMKORKROM	TOTAL
Extreme Poor	4	20	19	43
Low Income	4	4		8
Middle Income	1			1
Upper Income	5	3		8
Total	14	27	19	60

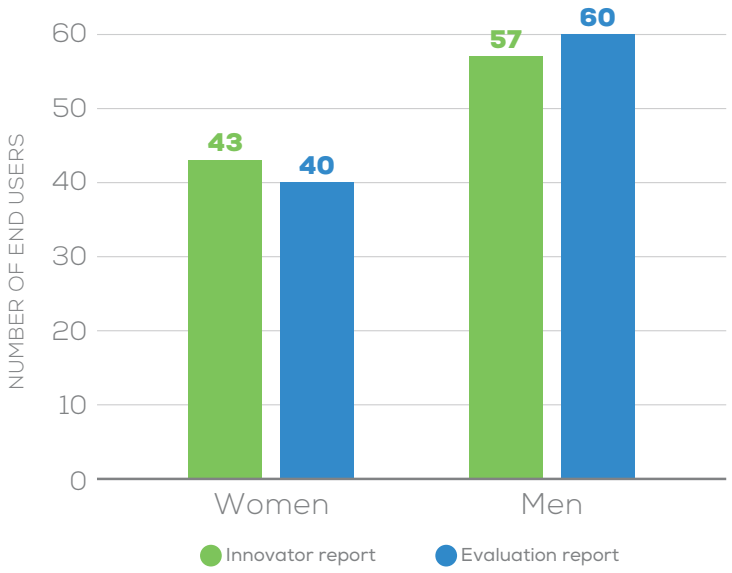
FIGURE 19: USAGE OF INNOVATION BY REGION



Comparison between latest Innovator M&E and latest SWFF M&E

Comparable indicators of Skyfox M&E statistics with the performance evaluation report are gender inclusion for Year 1 and crop yield for Year 2. Gender inclusion of the innovator report showed a similar pattern with the performance evaluation report. The innovator reported 43 percent women while the performance evaluation obtained 40 percent women in proportion to men.[11] For crop yield, there is a high significant difference between reported mass of produce by innovator and mass of produce evaluated from the end users' report.[12]

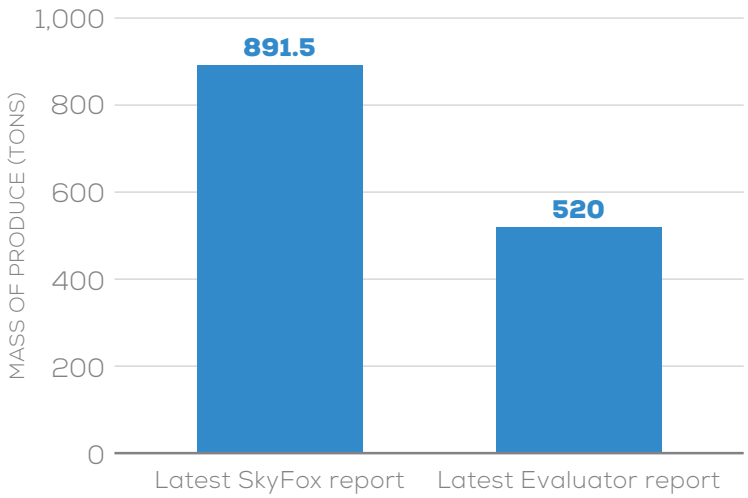
FIGURE 20: PROPORTION OF GENDER INCLUSION FROM INNOVATOR REPORT AND EVALUATION REPORT COMPARED



11 Gender composition of adopted end users in Year 2 was not provided. Year 1 gender composition of latest SKyfox statistics is compared with latest evaluation statistics.

12 In Ghana, total annual yield of onions and melon for 32 crop farmers in Adawso and Dambai is 520 metric tons. We compare with mass of produce for 32 out of 2571 farmers adopted in year 2 from latest Skyfox M&E statistics. Since 32 farmers is 1.2% of 2571, 1.2% of 71627.766 tons produced by 2571 farmers will give 891.5 tons. The difference of 371.5 tons, Chi-squared test: X-squared = 97.777, df = 1, $p<0.001$

FIGURE 21: MASS OF PRODUCE FROM INNOVATOR REPORT AND EVALUATION REPORT COMPARED




No rules

DISCUSSION

Husbands of two end users at Domkorkrom who also were involved in the project raised concerns about why their wives should be interviewed instead of them. At Dambai, a husband and a wife were part of the selected end users, and both were interviewed without problem.

End users were generally enthusiastic about the innovation. End users at Domkorkrom who participate in fish investment see the innovation as a means to invest their income. At Adawso, farmers expanded their farmlands, for example from four to 10 acres, as a result of the reduction in energy demand, cost, and time spent in pumping water by using the new irrigation tubes provided by the innovation.

End users have received various benefits from the innovation, especially in paying their children's school fees. Some were able to build houses, expand their businesses, and purchase tractors and other means of mobility, such as bikes, to enhance farm activities and livelihood. All end users interviewed are willing to continue with the innovation.

However, the pattern of inclusion of end users at the different locations resulted in different levels of impact per location. Because the project site at Adawso is far from Domkorkrom, end users at Domkorkrom were only privileged to adopt the fish investment package. But, involvement in fish investment depends on the financial power to invest. As the majority of end users at Domkorkrom live in extreme poverty, fish investment seemed less effective in raising income levels as compared to participation in crop farming. The impact of the innovation is stronger at Dambai where farmers were newly introduced to dry season farming, are given farms at no cost, and have some labor costs absorbed by the innovation.

Crop yield/survival

Generally, all farmers interviewed at Adawso responded that there was a significant increase in crop yield as a result of the innovation. The most important crop cultivated by end users is onion with an increase in yield of more than 80 percent. Other crops cultivated, although not in large quantities are okra, cucumber, and eggplant. According to a report from farmers, the former irrigation method was damaging to crops because of the high pressure of water discharge from old irrigation pipes. The new method has reduced damage to crops and, consequently, increased crop survival. It is worth noting that crop survival was not directly measured but was reported based on the farmers providing information on crop survival.

Crop yield increased with expansion of farmlands by most farmers. Farmers reported that because of reduction in labor input, quantities of fertilizer, and water use, they are able to expand and cultivate larger farmlands. In the old irrigation method, pipes had to be carried around the farm to distribute water on the entire farm, which was very stressful and time consuming. Before the innovation, at least three hours were used to irrigate one acre of farmland, and most farms of four to five acres would irrigate for 12 hours from 6:00 a.m. until 6:00 p.m.. Using the innovation, farmers can irrigate about 10 acres in less than three hours. Also, since the tubes are systematically laid along crop beds, the time and energy requirements for irrigation have been substantially reduced. Cost of labor generally dropped by one-half (50 percent) from GHs 658 to GHs 329 per farmer, fertilizer input reduced by 36 percent from GHs 1,189 to GHs 759 per farmer, and water usage, although not directly quantified, has reduced significantly as indicated by all the farmers interviewed. In addition, the cost of pumping water dropped from GHs 4,401 to GHs 2,656 (40 percent) per farmer. Although the increase was attributed to changes in the irrigation method, it is not known if external weather conditions contributed to crop yield as this was not measured. However, farmers at Dambai have reported there is delayed rainfall and reduction in rainfall amount now compared to some years before, reducing their crop yield.

Changes in income

There was an overall increase in income by all end users. Farmers harvested an average of 22,407 kilograms of onion per farmer before the innovation, which increased to about 44,300 kilograms as a result of the innovation (98 percent increase) and was sold at GHs 2 per kilogram.[13] A farmer in Dambai harvests an average of 1,345 kilograms of melon annually and sells at the rate of GHs 12 per kilogram, earning up to GHs 16,140 annually.[14] Other crops include okra and cucumbers, which are cultivated in small quantities. The price per kilogram of okra is GHs 2.5, and cucumber is sold at GHs 2 per kilogram. Annual income increased by 60 percent from an average of GHs 12,000 to GHs 19,000 as a result of the innovation.[15] There was no reduction in income reported by any end user, and they did not experience any failure in the innovation that affected their income. Farmers do not spend money on storage because crops are sold as they are harvested. Sometimes people come to the farm to buy, and other times farmers transport their produce to the market to sell. Farmers have

13 Note: Price per kilo did not change as a result of innovation, only yield changed. Prices also fluctuate, low at peak harvest periods

14 Dry season farming was introduced newly to the farmers at Dambai, therefore, there was no data before the innovation to compare with.

15 Prices are provided in local currency, i.e., Ghanaian cedi (GHs)

access to markets and do not have a problem selling their produce. At Adawso, transportation is not a problem because of good roads, although an average of GHs 15 is charged per bag of onion taken to the market. However, at Dambai farmers complain about bad roads from the innovation farm to the market. As a result, people do not come to the farm to buy their crop so they have to transport crops to the market. They also incur damages while transporting crops as a result of the bad roads. There was no change in transportation cost, and farmers still spend as much as they spent on transportation before the innovation.

Reduction in farm inputs have helped farmers to save up to 50 percent from the initial cost of labor, 36 percent from fertilizer, and 40 percent from the cost of pumping water. Four farmers incurred higher costs of water after the innovation. This is probably due to the interplay of factors responsible for high increase in crop yield as a result of the innovation which amplified the five percent normally charged on total crop yield to exceed cost before innovation. For example, if crop survival increased because of reduced pressure and trampling on crops while using the new irrigation tubes, five percent of the total yield will also increase. Another factor could be if the farmers in question were using very efficient pumps with low fuel consumption before the innovation, five percent charge on total crop yield may seem overrated.

Gender differences

Both men and women were involved in fish investment and crop farming. But more women invested in fish than crop farming, and more men were involved in crop farming than fish investment. Therefore, the difference in adoption of the innovation package between men and women was more or less a matter of preference. More women are into small businesses than men, and more men are into crop farming as their primary occupation. End users mentioned the emphasis of the innovation to include women, yet there were still more men involved than women.

Affordability

Generally, the SkyFox innovation is free, except for the tubes that crop farmers buy at GHs 2,000 per acre on a credit basis and the water charged at five percent total produce. At Adawso, the farmers buy the tubes and rent lands at GHs 300 per acre. There was no complaint from farmers as to the affordability of the innovation. At Dambai, farmers are given farms free of charge, provided with irrigation tubes at no cost, and assisted with absorption of some labor cost by the innovation.

Other benefits

Benefits received by end users included improvement in business/farming and income to meet immediate family needs, especially children's school fees. Increased crop survival and nutritional source were other benefits. End users also see the innovation as an opportunity to invest, save money, and access loans. Crop farmers experienced lower labor/production cost and reduced stress and time spent on agricultural activities.

Impact on poverty

There was an upward shift in income level of end users. There was a shift from extreme poverty level to low income and upper income levels, from low income to higher levels. There was no downward shift in income level after the innovation. There was a general increase in income level among crop farmers at Adawso where end users are more established farmers. At Dambai, 74 percent of end users are extremely poor, and the general increase in income was stronger. Extreme poverty reduced from 83 percent to 70 percent, and upper income increased from five percent to 13 percent.

Benefits of innovation on community

The Afram Plains Development Organization (APDO) is the local mobilizing group that works with SkyFox. Because of prior experiences with fake investment schemes, the communities are generally skeptical of joining programs such as these. However, APDO has a credible standing with communities and was able to encourage people to join. At the community level, the innovation has strengthened group participation and improved livelihoods in meeting immediate family needs. The people are able to keep their children in school and save money through the fish investment scheme.

Comparison with latest innovator result

The proportion of men to women from randomly selected respondents was consistent with the gender composition of the latest innovator report for Year 1. Respondents were selected from an updated list of end users for Year 2 using KUtools package in Excel. Therefore, the consistency of the Year 1 report with the randomly selected list of Year 2 implies that the same proportion of gender composition in Year 1 was included in Year 2. Reported mass of produce from the latest innovator report was not consistent with the evaluation report as this difference was very significant. Mass of produce of 32 farmers interviewed was compared with 1.2 percent (equivalent to 32 farmers) mass of produce from the latest innovator report. It is not clear why such discrepancy exists, as it is expected that since respondents were selected randomly, there would not be bias of oversampling farmers with small crop quantities.

CONCLUSION

Findings from the survey show an overall positive impact of the innovation on end users' livelihoods. All individual respondents reported positive impact and are willing to continue with the project. Currently, SkyFox caters to over 10,000 end users in Ghana who benefit directly from the project. Responses of sampled end users extrapolated across this number means 10,000 end users directly and positively benefit from the innovation. This is a strong strategy for poverty alleviation in rural areas especially when specific aspects of the innovation such as access to credits, equipment, and innovation models are reinforced.

End users access the innovation differently at different locations. The fish investment provides an alternative to end users who are at a distant proximity to innovation models. Those who have easy access to the fish pond wastewater and irrigation tubes benefit from the crop farming aspect. Equipment is given to Adawso farmers on a credit basis in which they pay from sales of their produce, while such arrangement is given at no cost at Dambai. Overall, there was a considerable upward shift in income levels experienced by end users. Income level and crop yield have increased while stress, time, labor, and production costs have decreased as a result of the innovation. The majority of end users reported using the additional income from the innovation to keep their children in school, while others built houses, improved their businesses, expanded their farmlands, and bought tractors to enhance their farm activities. If sustained for a longer time, the project has great potential of reducing poverty among rural dwellers in SSA. The pattern of inclusion at Dambai, which provides stronger leverage for farmers, can be considered the most effective strategy to replicate in other locations and for further inclusion of end users.

In summary, key findings from the innovation include:

- Agricultural benefit of cultivating new crops in dry season farming that were not cultivated before the innovation at Dambai is a major achievement of the project. This was seen in the very significant increase in income of farmers as a result of the innovation in this region.
- Reduction in production cost, such as reduction in fertilizer input, water usage, labor cost, and time spent on agricultural activities, resulted in expansion of cultivated lands at Adawso and a corresponding increase in income.

Upward shift in income levels of farmers means that this project can be used as a tool in alleviating poverty of rural people in Sub Saharan Africa

ANNEX 1: SURVEY

FARMER INFORMATION

NAME _____

AGE _____

DATE _____ TIME _____

GROUP INTERVIEW? ❑ Yes ❑ No

GROUP INTERVIEW NOTES

_____

_____

_____

HOW MANY FAMILY MEMBERS LIVE WITH YOU? _____

GENDER ❑ Male ❑ Female

WHAT IS YOUR PRIMARY OCCUPATION?

- ❑ Farming
- ❑ Wage Labor
- ❑ Seasonal Migrant Labor
- ❑ Small Enterprise
- ❑ Other: _____

DO YOU HAVE ANOTHER OCCUPATION?

- ❑ Farming
- ❑ Wage Labor
- ❑ Seasonal Migrant Labor
- ❑ Small Enterprise
- ❑ Other: _____

SIZE OF FARM (ACRES) _____

NAME OF VILLAGE _____

HOW MUCH LAND DO YOU OWN? _____

HOW LARGE IS YOUR FARM/PLOT?

- ❑ Large
- ❑ Medium
- ❑ Small
- ❑ Very Small

HOW MUCH IS LAND RENT? _____

OTHER LAND NOTES

_____

_____

_____

HOW LONG HAVE YOU BEEN USING SKYFOX? _____

DID YOU PARTICIPATE IN AGRICULTURAL ACTIVITIES THIS YEAR? ❑ Yes ❑ No

HOW MANY MONTHS IS THE PRIMARY GROWING SEASON? _____

HOW MANY TIMES DO YOU HARVEST PER YEAR? _____

FARM INFORMATION

WHAT CROPS DO YOU GROW AS A RESULT OF THE INNOVATION? LIST FROM MOST IMPORTANT TO LEAST IMPORTANT:

1. _____
2. _____
3. _____

DID THE MOST IMPORTANT CROP BENEFIT FROM SKYFOX? ❑ Yes ❑ No

DID THE SECOND MOST IMPORTANT CROP BENEFIT FROM SKYFOX? ❑ Yes ❑ No

DID THE THIRD MOST IMPORTANT CROP BENEFIT FROM SKYFOX? ❑ Yes ❑ No

WHAT IS THE WATER SOURCE FOR YOUR IRRIGATION OF CROPS?

- ❑ Own pond
- ❑ River
- ❑ Groundwater
- ❑ Innovation Source
- ❑ Other: _____

WHAT IS YOUR METHOD OF IRRIGATION?

- ❑ Drip feed
- ❑ Flooding
- ❑ Hand watering
- ❑ Rainfed
- ❑ Other: _____

HOW MANY CYCLES OF FISH HAVE YOU HARVESTED?

_____

DO YOU HAVE EASY ACCESS TO MARKETS TO SELL FISH? ❑ Yes ❑ No

HOW MUCH HAS YOUR WATER USAGE CHANGED SINCE USING SKYFOX, IF AT ALL? _____

_____

_____

USING SKYFOX HAS YOUR ACCESS TO WATER:

- ❑ Had no change
- ❑ Improved
- ❑ Fundamentally improved (Improved a lot)
- ❑ Other: _____

PREVIOUSLY GROWN CROPS: DID YOUR FARM PRODUCE DIFFERENT CROPS IN THE PAST THAT ARE NO LONGER GROWN HERE? IF SO, WHICH ONES? _____

_____

MASS OF PRODUCE: WHAT YIELDS DID YOU HAVE FOR EACH CROP YOU MENTIONED?

_____

_____

MASS OF PRODUCE 2: WHAT YIELDS DID YOU HAVE FOR YOUR CROPS BEFORE USING SKYFOX?

_____

USING SKYFOX HAVE YOU, FOR EACH CROP:

- ❑ Used more water
- ❑ Had no change in water use
- ❑ Used less water
- ❑ Other: _____

USING SKYFOX HAVE YOUR CROP YIELDS (ASK FOR EACH CROP):

- ❑ Declined
- ❑ Remained the same
- ❑ Increased
- ❑ Substantially increased

IS THERE A DIFFERENCE IN THE SURVIVAL RATES OF YOUR CROPS DUE TO SKYFOX? ❑ Yes ❑ No

HOW MUCH OF YOUR PRODUCE DID YOU CONSUME IN YOUR HOUSEHOLD? (PERCENTAGE – NOTE IF DIFFERENT FOR EACH CROP) _____

_____

HOW MUCH OF EACH OF THE FOLLOWING INPUTS DID YOU USE BEFORE SKYFOX?

FERTILIZER _____ (KG)
PESTICIDE _____ (KG)
HERBICIDE _____ (L)
CHARCOAL _____ (KG)
WATER _____ (TOTAL)
LABOR _____ (DAYS)
OTHER _____

HOW MUCH DID YOU SPEND ON EACH OF THE FOLLOWING INPUTS BEFORE SKYFOX?

FERTILIZER _____ (KG)
PESTICIDE _____ (KG)
HERBICIDE _____ (L)
CHARCOAL _____ (KG)
WATER _____ (TOTAL)
LABOR _____ (DAYS)
OTHER _____

HOW MUCH OF EACH OF THE FOLLOWING INPUTS DO YOU USE AFTER SKYFOX?

FERTILIZER _____ (KG)
PESTICIDE _____ (KG)
HERBICIDE _____ (L)
CHARCOAL _____ (KG)
WATER _____ (TOTAL)
LABOR _____ (DAYS)
OTHER _____

HOW MUCH DID YOU SPEND ON THE FOLLOWING INPUTS AFTER SKYFOX?

FERTILIZER _____ (KG)
PESTICIDE _____ (KG)
HERBICIDE _____ (L)
CHARCOAL _____ (KG)
WATER _____ (TOTAL)
LABOR _____ (DAYS)
OTHER _____

HOW MUCH DID YOU SPEND ON EQUIPMENT BEFORE AND AFTER SKYFOX? _____

_____

HOW MUCH DID YOU SPEND ON TRANSPORT AND STORAGE BEFORE AND AFTER SKYFOX?

_____

DO YOU HAVE PROBLEMS FINDING A MARKET TO SELL YOUR CROPS IN? ❑ Yes ❑ No
PLEASE EXPLAIN. _____

_____

DO YOU HAVE PROBLEMS GETTING YOUR CROPS TO THE MARKET? ❑ Yes ❑ No
PLEASE EXPLAIN. _____

_____

OTHER FARM NOTES (OPTIONAL).

_____

_____

_____

INCOME AND EXPENDITURES

WHAT IS YOUR ANNUAL HOUSEHOLD INCOME? _____

HOW MUCH INCOME DID YOU MAKE BEFORE SKYFOX? _____
AFTER SKYFOX? _____

HAS SKYFOX IMPROVED YOUR FAMILY INCOME? _____

WHAT PERCENTAGE OF YOUR INCOME DO YOU GET FROM NON-FARM SOURCES? _____

HOW MUCH PRODUCE DID YOU SELL FOR EACH OF YOUR CROPS IN THE LAST SEASON AND THE LAST YEAR? _____

_____

WHAT IS THE PRICE PER KILO YOU RECEIVED FOR EACH OF YOUR CROPS FOR THE LAST SEASON?

_____

_____

DO YOU SELL FISH? ❑ Yes ❑ No

HOW MUCH FISH DID YOU SELL? _____

WHAT IS THE PRICE PER KILO YOU RECEIVED FOR YOUR FISH? _____

USING SKYFOX HAS YOUR ACCESS TO CREDIT:

- ❑ Not improved
- ❑ Improved
- ❑ Improved and have been able to repay over a short period

HOW DO YOU CURRENTLY FINANCE AGRICULTURAL ACTIVITIES?

- ❑ Own savings
- ❑ Credit and savings scheme
- ❑ Other credit

HOW MUCH DO YOU PAY FOR SKYFOX? _____

HOW MUCH ARE YOU WILLING TO PAY FOR SKYFOX?

- ❑ Nothing
- ❑ SKYFOX is free
- ❑ The same as what I pay now
- ❑ 50% less
- ❑ 50% more
- ❑ Other: _____

HOW HAVE YOU SPENT YOUR NEW INCOME?

- ❑ N/A (if no new income)
- ❑ Send children to school or keep children in school
- ❑ Social functions (like weddings)
- ❑ Investment in farming
- ❑ Improving house
- ❑ Other: _____

OTHER INCOME NOTES (OPTIONAL)

_____

_____

_____

PERCEPTIONS OF SKYFOX

WILL YOU USE SKYFOX IN THE FUTURE (5 TO 10 YEARS)? ❑ Yes ❑ No

WHY? _____

_____

HOW, IF AT ALL, HAVE YOU CHANGED YOUR FARMING PRACTICES DUE TO SKYFOX?

- ❑ No change
- ❑ Introduced new crops
- ❑ Changed irrigation system
- ❑ Reduced water usage
- ❑ It helps me decide when to plant
- ❑ It helps me decide which crops to plant

HAVE YOU FACED ANY DIFFICULTIES OR PROBLEMS USING SKYFOX? ❑ Yes ❑ No

HOW CAN SKYFOX BE IMPROVED? _____

_____

HOW DID YOU HEAR ABOUT SKYFOX?

- ❑ Wealthy farmer
- ❑ Neighbor
- ❑ Innovation personnel
- ❑ Extension worker
- ❑ Other: _____

WHAT FACTORS INFLUENCED YOU TO TRY SKYFOX?

- ❑ Demonstration from neighbor's farm
- ❑ Innovation is free from extension services
- ❑ No alternative water source
- ❑ Other: _____

DO YOU SHARE YOUR KNOWLEDGE SKILLS FROM SKYFOX WITH OTHERS? ❑ Yes ❑ No

IF SO, HOW? _____

_____

_____

WHAT DO YOU FEEL ARE THE BENEFITS OF SKYFOX? _____

_____

_____

HAVE YOU HEARD ABOUT CLIMATIC VARIATION? HAVE CHANGES IN RAINFALL OR TEMPERATURE AFFECTED YOUR FARMING PRACTICES OR CROP YIELDS COMPARED TO YOUR HISTORICAL RAINY/DRY SEASON PERIODS? ❑ Yes ❑ No

PLEASE SPECIFY HOW. _____

_____

_____

HOW HAS SKYFOX HELPED YOU? PLEASE RANK THE TOP 3 AND EXPLAIN POSITIVES/NEGATIVES.

☐ Makes water reusable _____

☐ Helps women farmers as well as men _____

☐ They made a special effort to include women farmers _____

☐ Helps in producing more of our most important crop _____

☐ Increases my yield through timely forecasts _____

☐ Helps by lowering cost of inputs _____

☐ Improves health and strength of livestock _____

☐ Helps reduce labor _____

☐ Reduces crop wastage _____

☐ Helps me decide when to plant _____

☐ Helps me decide which crops to plant _____

☐ Other: _____

WOULD YOU RECOMMEND SKYFOX?

❑ No
❑ Yes
❑ Yes, would strongly recommend

ARE THERE NEGATIVE IMPACTS FROM SKYFOX IN THE COMMUNITY? ❑ Yes ❑ No

PLEASE EXPLAIN IF YES. _____

_____

_____

IF THERE HAVE BEEN ANY NEGATIVE IMPACTS, HAVE EFFORTS BEEN MADE TO RESOLVE THEM?
❑ Yes ❑ No

EXPLAIN. _____

_____

_____

OTHER

INCOME/POVERTY NOTES

_____

_____

GENDER OBSERVATIONS

_____

_____

QUESTIONS/REQUESTS

_____

_____

OTHER NOTES

_____

_____

_____

SECURING
WATER
FOR FOOD:
A GRAND CHALLENGE
FOR DEVELOPMENT

Securing Water for Food has sourced and invested in a portfolio of innovative solutions that aim to help farmers use water more efficiently and effectively, improve water storage for lean times, and remove salt from water to make more food. Our cohort of innovators are helping people in 30 low-resource countries with tools they need to produce more food with less water.

To learn more about Securing Water for Food,
visit www.securingwaterforfood.org.