Impact Evaluation of the Sustainable Water Fund (FDW)

Integrated Water Management and Knowledge Transfer in Sisili Kulpawn Basin (FDW/12/GH/02) in the Northern Region of Ghana

Final report December 2018

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List of Abbreviations

ATE	Average Treatment Effect on the Treated
ATH	African Tiger Holding Ltd
CA	Conservation Agriculture
CFM	Conservation Farming Methods
DA	District Assembly
DiD	Difference-in-Difference approach
FFS	Farmer Field School
GDP	Gross Domestic Product
GIDA	Ghana Irrigation and Development Authority
ICM	Integrated Crop Management
ITT	Intention to Treat Effect
IWAD	Integrated Water and Agricultural Development Ltd.
MDG	Millennium Development Goal
MoFA	Ministry of Fisheries and Agriculture
NGO	Nongovernmental organization
PPP	Public Private Partnership
RMG	RMG Concept SA
RoI	Return on Investment
SADA	Savannah Accelerated Development Authority
TA	Traditional Authority
ToC	Theory of Change
WGL	Wienco Ghana Limited

1. Introduction

This is the final report of the evaluation of the Sisili Kulpawn (SK) Basin project in Northern Ghana. The project started in 2014 and ended in 2017. The intention of the project was to foster smallholder farmers and enhance private sector-led growth through the promotion of improved farming practices, integrated water management methods and the development of irrigation agriculture in the savannah agro-ecological zone in the Northern Region of Ghana. The project was a pilot project and plans exist to scale up the project in the next years. Therefore, a robust impact evaluation of the content of the project and the Public Private Partnership (PPP) is important to assess the effectiveness of the interventions and the added value of the PPP to achieve this result.

Ghana is, according to the World Bank country classification, a low middle-income country. Despite the prospering economic situation, there exist large disparities within the country, especially from north to south. About 46% of the population lives in rural areas and most of the people are engaged in agriculture as smallholder or subsistence farmers. Ghana has seen many improvements in its overall poverty situation since 1991 and has met the Millennium Development Goal (MDG) 1A, halving the population that lives below the 1.25 US$ a day poverty line, by 2010, 5 years ahead of target. However, Ghana's three Northern Regions (Northern Region, Upper-West and Upper-East) are facing the highest burden of extreme poverty. The most recent estimates of 2012 measure the national poverty headcount ratio to be at 24.2 percent (WDI, 2018). A key challenge are the working poor, i.e. working fulltime but earning below the poverty line. Two aspects that have a direct influence on poor agricultural performance require urgent attention: Low agricultural productivity and limited support for food crop farmers. Low agricultural productivity occurs as a consequence of constraints on agricultural productivity growth due to reliance on rain-fed farming and limited adoption of modern agricultural techniques. Limited support for food crop farmers is a key challenge since farmers often face the problem of market and price instability regarding their farm produce which in turn creates instability in the income of farmers, making them vulnerable to adverse external shocks (UNDP, 2015).

Agriculture is the most important income sources for people living in rural areas in Ghana's Northern Regions. In 2010, about 40 percent of the Ghanaian workforce was employed in agriculture. The contribution of agriculture to GDP has been declining during recent years. A sharp decline of agriculture as share in GDP since 2009 can be noted from 31 percent to 18 percent in 2016. Recent research found that this is not the result of a structural transformation process but rather resulting from a decline in agricultural productivity. The decrease stems mainly from a declining contribution of the crop sector from 24 percent to 17 percent in agriculture (GSS, 2014). Agricultural productivity, measured as output per unit of arable land, was estimated to be declining by 8.5 percent

during the period 1999 to 2009 due to slow increases in the output of staple crops (3.7 percent per year) but even faster growing cultivated land area (5.7 percent per year) (Akudugu et al, 2013).

Rain-fed, traditional agriculture, widely practiced in West Africa, will not meet the food demand of the growing populations. Besides conservation agriculture (CA), irrigation is identified as a coping strategy for climate change (IPCC, 2014). In Ghana, the conventional irrigation systems are mainly initiated and developed by the Ghanaian government (in cooperation with the Ghana Irrigation and Development Authority (GIDA)) or nongovernmental organizations (NGOs). The emerging or informal systems are initiated by private entrepreneurs and farmers. Very little is known about the location, development and management of irrigation schemes.

FAO (2014) estimates that less than 2 percent of the irrigable land in Ghana is actually irrigated. About half of the total arable land of 15 Mio ha is estimated to have the potential for irrigation. The problems of the public irrigation schemes are lacking maintenance, difficult or insufficient cost recovery because of under-utilization and insufficient capabilities of workers and farmers. The infrastructure has deteriorated, and many public irrigation projects are not able to fully develop their potential or not functioning at all (Namara 2011; FAO 2014). Landownership conflicts are another reason for difficulties arising from public irrigation schemes (Alhassan et al, 2013).

Besides irrigation, conservation agriculture (CA) along with the targeted application of chemicals is a promising strategy to sustainably increase the agricultural productivity of smallholder farmers in Sub-Saharan Africa. CA includes a set of soil management practices, promoting sustainable and profitable agricultural development, away from a subsistence level towards a surplus level, by reducing the disturbance of the soil's structure as well as its composition and biodiversity to a minimum level. Introduced by the FAO as a "concept for resource-efficient agricultural crop production based on integrated management of soil, water and biological resources" (Giller et al. 2009, 24), it calls into question the cleaning of the seedbed through conventional tillage based on the intensive use of a heavy plough. CA includes three major, simultaneously applied principles:

1) Continuous minimum mechanical soil disturbance or minimum tillage, 2) Permanent organic soil cover or mulching and 3) Diversification of crop species grown in sequences or associations, i.e. crop rotation instead of mono-cropping (FAO, 2015).

Examples are integrated disease and pest management, avoidance of crop residue burning and limitation of human as well as mechanical traffic upon the topsoil. In the last decades, the development community - from political and institutional decision-makers to academic researchers and extension workers - has announced the

urgent need for a more sustainable agricultural production and the practice of CA (Knowler and Bradshaw 2007; Wall 2007; FAO 2015). South America has the largest area under CA application where about 70 percent of the total cultivated area is permanently under CA cultivation. In Africa, CA methods are mainly practiced in the continent's Eastern and Southern regions. About 40 percent of the total area under CA is located in South Africa, where it is mostly practiced by large-scale commercial farmers.

Farmer field schools (FFS) for smallholder farmers strengthen the understanding of CA and its adaptation. At the same time, supply chains are fostered in order to develop the necessary machinery for CA adoption in smallholder farming systems. With special regard to the challenges of African smallholder farmers, CA can address the challenges of climate change, high energy cost, environmental degradation, and labor shortages (Kassam et al. 2009).

Based on difficult savannah agro-ecological conditions such as annual flooding, erratic rains, drought (dry spells) and poor soils, the Sisili Kulpawn Basin has been chosen as the project area. Despite the challenges identified, the region also provides opportunities for the development of large-scale commercially irrigated agriculture with the availability of land, water resources and human resources. The project area is relatively peaceful despite some land conflicts among chiefs in the area since 2010.

The objective of the evaluation is to analyze the direct and indirect impacts of the irrigation scheme and FFS, which focus on CA and water management practices in the Sisili Kulpawn area. A detailed theory of change has been established to analyze the outcomes and impact of the project. A mixed-methods approach is used to underline the main quantitative findings resulting from a difference-in-difference approach with results from the qualitative interviews with experts and stakeholders related with the institutional PPP structure and Focus Group Discussions with the beneficiaries of the project interventions.

The report is structured as follows: Section 2 reports on the interventions of the project. Section 3 describes the evaluation approach. Section 4 provides the qualitatively analysis of the institutional background of the PPP before turning to the quantitative evaluation results in section 5. Section 6 discusses the findings and concludes.

2. The Intervention

The intervention introduced effective water management practices (WMP) and CA or conservation farming methods (CFM) into an area which is traditionally characterized by dry-land, rain-fed farming. Through providing a reliable source for irrigation water, introducing water conservation measures through improved crop and land

management and offering knowledge transfer to smallholder farmers, an improvement of living conditions (see Theory of Change below) was envisaged.

Two different interventions, irrigation and FFS took place in multiple dimensions: development of irrigation infrastructure through the building of an irrigation dam, bulk water infrastructure, market access and input supplies for smallholder farmers and knowledge transfer via FFS in the form of training farmers on the cultivation of five different crops using improved farming methods as CA and improved farming inputs (seeds and chemicals) during the rainy season, which is the main farming season.

The technical component of the project contained the construction of four different systems in the irrigation block scheme: Pivot irrigation, overhead sprinkler, furrow irrigation and drip irrigation. The irrigation systems can be used for an additional harvest in the dry season and as a supplement in case of a drought or low rainfall in the rainy season. The intervention introduced effective WMP by providing a reliable source of irrigation, water conservation measures through improved crop and land management and offered knowledge transfer to smallholder farmers. During the pilot project, the total irrigated area covered 400 ha, out of which 250 ha are allocated to nucleus farms (commercial farming by IWAD) and 150 ha to smallholder farmers of four villages (Yagaba, Loagri, Gbima and Kuuba). An assignment strategy of the program, set by IWAD as a requirement, is that farmers who participate in the irrigation farming get a proportionate amount of plot with irrigation in relation to their current land holding, experience, education level and yield. This assignment assures that farmers have some experience in farming on larger plots where they sell part of the harvest and not only do subsistence farming. In total 150 out-grower smallholder farmers were planned to benefit from the irrigation intervention by receiving access to irrigated land, training and assistance. Additionally, IWAD grew different crops as cowpeas, sorghum and groundnuts using contracted casual workers (see for more details section 5.5).

The other part of the intervention is the knowledge transfer component that goes directly to farmers participating in FFS on CA methods and improved farming inputs. Farmers initially received training on the planting of five different crops: cotton, rice, soybean, maize and sorghum in the course of 14 training sessions during the farming season. This strategy was changed in the course of the project which will be discussed in section 5.1. The content of the FFS session was structured for a whole planting period, starting with sowing, followed by chemical use and ending with harvest and clearing the fields. Farmers could qualify to receive inputs on credit only if they followed the training completely. The credit was given per crop and in-kind as seeds, fertilizer, herbicides, pesticides and in form of constant supervision. Farmers pay back the credit in cash or in-kind in form of produce at the end of the season. Farmers also had the possibility to sell their harvest to IWAD. In total 3000 out-grower smallholder farmers

were intended to benefit from the program by receiving training and assistance on conservation rain-fed farming in the project villages.

2.1 The project area

The project was implemented in the Mamprugu Moaduri district, one of the 25 districts in the Northern Region of Ghana. The baseline survey was conducted in four different districts: West Mamprusi, Mamprugu Moaduri, North Gonja and Builsa South. All districts except the latter belong to the Northern Region of Ghana and all share borders with the project district. The Mamprugu Moaduri District with its capital Yagaba where the irrigation block was built, was part of West Mamprusi (capital Walewale) until decentralization reforms in 2012. Builsa South, with its capital Fumbisi, is a district of the Upper East Region, however, it shares borders in the south with Mamprugi Moaduri and in the west with West Mamprusi and has the most frequented regional market. North Gonja, segregated in 2012 under decentralization reforms from West Gonja, is the fourth district included in the baseline survey as the project might expand to this district in the near future (see www.ghanadistricts.com).

Besides the official political structure, traditional structures are still prevalent, powerful and important in Ghana. These traditional systems are also referred to as traditional authority (TA) and differ across the country due to every locality having its own culture, tradition and structure (Mahama, 2009; Tonah, 2012). The traditional authorities are also widely known as chieftaincies. Overall the composition of the TA is similar with the chief as the traditional leader (both official and spiritual) of the hierarchy and around him the council of elders who provide advice and guidance. The government acknowledges the importance of the traditional leadership, however, it defines clear roles for them in order to enhance accountability and governance (Mahama, 2009). The chiefs draw their prestige from the social and economic (landownership) role they play and have relatively strong judicial power, mainly in civil affairs such as inheritance, family law and land tenure matters. Every community has its own chief to ensure peace and tranquility. In all four districts, a system is in place whereby an overall chief is appointed as the leader of all the communities within his area. In the Mamprugu Moaduri and West Mamprusi district, all chiefs are obliged to the king of Mamprugu, the Nayiri. In Builsa South, all chiefs have to oblige to the paramount chief, the Sandem-Naba, who leads the entire Builsa traditional area. For North Gonja, the leader is the Wasipe-wura, who rules the Wasipe traditional area which is one of the five areas in the Gonja Kingdom (GSS, 2014).

Most farmer families in the project area obtain their land from the local chief who is the land holder, official and spiritual leader. Land is acquired mainly through patrilineal inheritance or distribution by the chief. The crops commonly cultivated in the four districts are cereals (maize, rice, and millet), root plants (cassava, yam), cowpeas,

groundnuts and soya beans. Most farmers use fertilizer but overuse or misuse often happens. Pest control is not wide spread.

3. Evaluation Approach and Impact Measurement

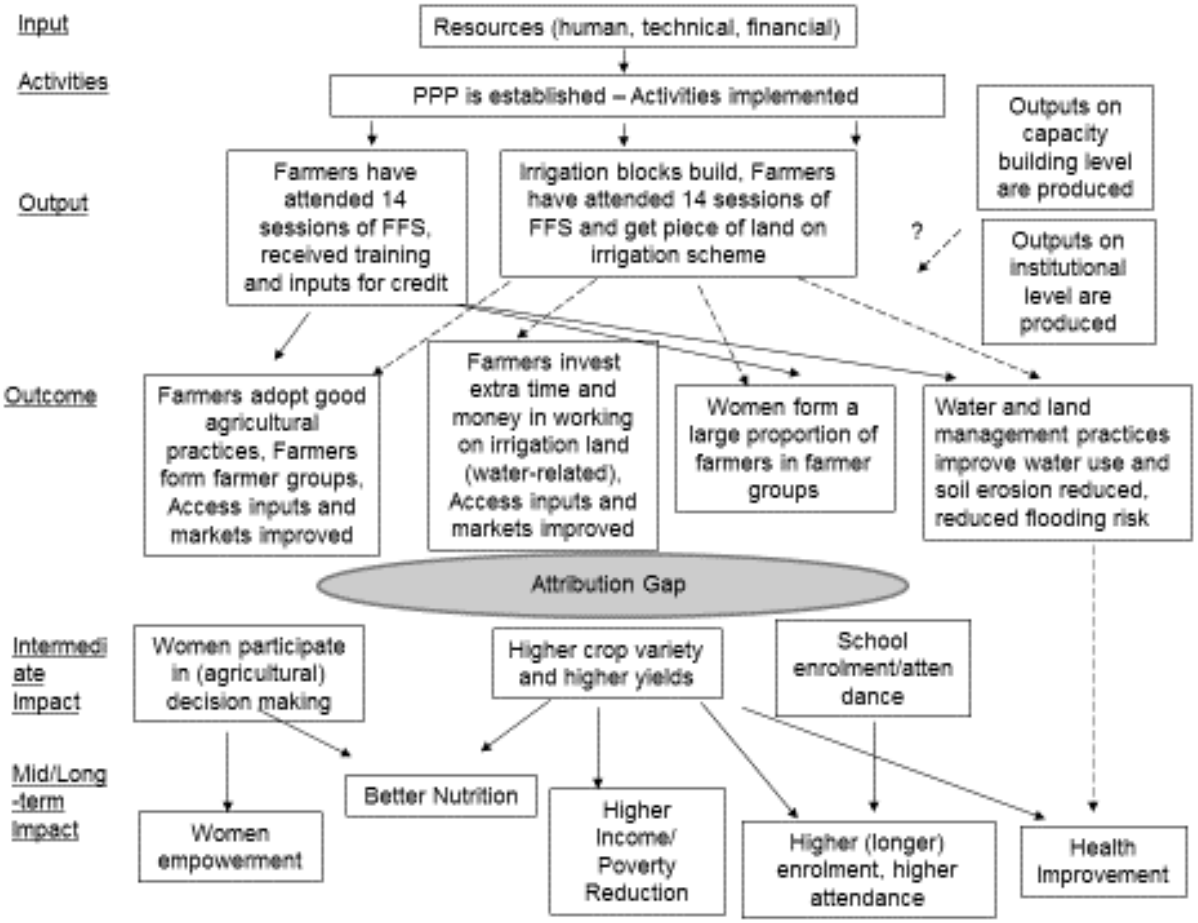
3.1 Evaluation objective

As this project was a pilot project which is planned to go to a larger scale in the future, a robust evaluation of the activities of the project is deemed necessary. Based on the monitoring and evaluation system of the project and the relevant literature (Waddington et al, 2014), a set of possible output, outcome and impact indicators were defined. Using this available set of evaluation indicators and complementing it with existing findings of recent research as well as the view of local experts, it was possible to develop a Theory of Change (ToC) (see Figure 1). According to the ToC, a set of evaluation questions was defined for each level. Annex B displays evaluation questions and proposes corresponding indicators of how to approach these questions. A structured questionnaire (see Appendix D and E) was derived from the ToC and evaluation questions for conducting a baseline and follow-up survey among the treatment and control group in February and March 2015 and 2018, respectively.

A mixed-method approach was used combining findings from the institutional, stakeholder and beneficiary dimensions. Several data collection and research tools were applied to analyze the output, outcome and impact indicators based on the TOC. The data collection and research tools are further described in section 3.4.

As described in the former section, the intervention implemented activities on two different levels: the irrigation scheme with four different technologies and access to irrigated land for farmers in four villages, and FFS in villages without irrigation.

Figure 1 Theory of Change



Source: own illustration, also Waddington et al. (2014)

The intervention's outcomes influenced farmers in three dimensions: farming, household and generally in living conditions, see Figure 1.

For activities on the farmer or household level of farmers participating in the FFS, direct outcomes were observable. The assumptions of the ToC were that: Farmers would eventually i) adopt new farming behavior and technologies, ii) use improved seeds and chemical inputs and iii) practice CFM. It was expected that farmers would understand the importance of land clearing methods without bushfires, of the application of chemicals (timing and method) and of proper harvesting methods during the whole cultivation process. Accordingly, the outcome "adoption of good agricultural practices" in the ToC represents the set of potential changes in behavior that are intended through the FFS as minimum tillage, crop rotation, mulching and precision chemical application. Exact

indicators for this study were designed based on theory and reviews of agricultural studies, survey material and expert interviews.

On the irrigation scheme level, IWAD planned to supervise farmer groups closely to implement the new technologies and the application of CA. Farmers additionally were to i) adopt new irrigation farming technologies ii) invest own time and money to work on the irrigation farm (in contrast conservation farming farmers work on their own land) and pay for water.

For farmers participating in the irrigation block scheme, the impact of improved agricultural practices and technologies was expected to result in a second harvest per year. This means not only 100 percent higher yields and income increases but also implied more effort demanded from every farmer in terms of labor input. Farmers participating in a FFS on CA could get access to improved inputs in the form of seeds and chemicals but only work on the land they provided themselves. Farmers were to be organized in farmer groups and had to show effort because of frequent visits by field agents (strategy change in 2016, see section 5.1). Also, IWAD offered to buy the harvest and acted as a trader between the producer and markets. The common procedure of selling the harvest in the project area is via trade agents who visit the villages after harvest or farmers sell themselves at regional markets. IWAD offered improved quality inputs and also sales opportunities.

The influences on household level could be a direct result from the intervention or a mid to long term result. If the households achieve higher yields and eventually crop variety, the assumptions drawn from the ToC can be that the nutritional status of household members improves because of a higher quantity and variety. However, the effect will occur with a time lag of one to two years. Farmers applying conservation farming practices are expected to have decent yield increases in the first years and improving over time with more experience.

The effect of water management and reduced flooding risk potentially also reduces the incidence of water related disease. In contrast, the presence of irrigation and water storage in the reservoir could also worsen the presence of water-borne diseases as, e.g. Malaria. The outcomes will be part of the later analysis.

As a focus of the FFS lies especially in motivating women to participate, it can be assumed that this can also result in the empowerment of women concerning decision making on farming, nutrition, education and expenditure. Improved anthropometric measures of children, the intra-household decision making processes and expenditure patterns can be affected by women's engagement in income generating activities or higher contributions to household consumption.

The influence of the intervention on schooling outcomes was unclear and there has not yet been much research done on the effect of improved farming methods on education. The assumptions can go in either direction: More intensive agricultural practices and higher yields can either result in higher or lower school enrolment and school attendance. School enrolment is usually higher than actual school attendance. Because of higher income (more) children can enroll in school and pay for fees and books (also longer, e.g. proceed to secondary school). But as more labor effort has to be invested when CA is applied, children might also be needed to conduct other household activities as watching their siblings when the mother is working or collecting firewood and water. Therefore, this dimension has been included in this impact evaluation.

3.2 Identification Strategy

The *Treatment Group* is represented by a sample of farmer groups using irrigation (beneficiaries planned: 150 farmers) and farmers receiving training in FFS and later inputs for credit (beneficiaries planned: 3000 farmers). The *Control Group* is not part of the current program but might benefit in the future. However, all communities lie in an area which has been identified to have the potential of being selected for the scaling up of the program. During the investigation and planning of the project, IWAD had identified areas where it would be possible to scale up the program. These areas serve as a sampling unit for selecting the control group villages because they face similar savannah agro-ecological conditions. Based on this, we selected villages in the four districts: West Mamprusi, Mamprugu Moaduri, Builsa South and North Gonja. A second condition for the sampling was the population size of communities which was used as an indicator to match control villages to treatment villages. The treatment and control communities will firstly be similar with regard to savannah agro-ecological conditions and, secondly, be similar with regard to population size. All households examined have farming as the main source of income.

The major challenge in conducting this evaluation and measuring changes in outcomes was that neither the irrigation block nor the FFS locations were allocated randomly. For the irrigation block, a random allocation was not feasible due to technical and natural requirements of irrigation (i.e. having an accessible source of water (river) nearby). Also, construction works started long before the evaluation started. Therefore, households participating in the program might differ systematically from households not participating in the program.

For the FFS treatment, a pure random assignment was not possible because 13 treatment communities in the program area were already chosen for the first year of training sessions in 2014. Additionally, to the 13 treatment villages selected previous to the baseline survey, another nine villages were selected as potential treatment villages for 2015 and onwards. In eight of these villages treatment with FFS sessions teaching CA took place as

planned, in one village farmers were not willing to participate and cooperate. In total, there are 21 treatment villages and 28 control villages to analyze the impact of the intervention.

3.3 Sampling and sample size power calculations

3.3.1 Original Sample

In the ideal evaluation, the rollout of the project, i.e. conservation farming training and access to irrigation, would be distributed randomly among all potential beneficiaries and treatment would be assigned according to the random choice, not any other selection strategy. Any other selection strategy than randomness might cause biased results but being aware of this bias ex-ante enables us to control for several factors. Therefore, we applied the following sampling techniques:

A two-stage clustered random sampling was applied with the first stage being a cluster on the village level and the second stage on the household level. To make the sample population more homogenous and decrease variance, the sample was stratified on agriculture as the main source of income in the second stage, i.e. excluding households which are not engaged in farming as the main source of income (e.g. traders, fishers and craftsmen).

For the first stage all villages in the four survey districts (West Mamprusi, Mamprugu Moaduri, North Gonja and Builsa South) were listed and respective population size data was collected from the Ghana Statistical Service in Tamale and in district offices. By using information on population size of the treatment villages, the control villages were matched using propensity score matching, however only on the one indicator population size. The primary sampling units were 266 villages out of which 192 could be matched to the 23 treatment villages based on population size. All 23 treatment villages (four irrigation and 19 FFS) were eligible for the survey and out of the 192 potential control villages 27 were selected randomly as control villages. The number of control villages exceeds the number of treatment villages to increase statistical power[4].

The second stage sampling was based on full household listings in all treatment and control communities. The full household listing in 50 villages was conducted in February 2015. During the listing the following indicators were collected: First, the name of the household head and second, whether farming is the main source of income of the household in order to make stratification possible. After the listing process, one village was excluded from the

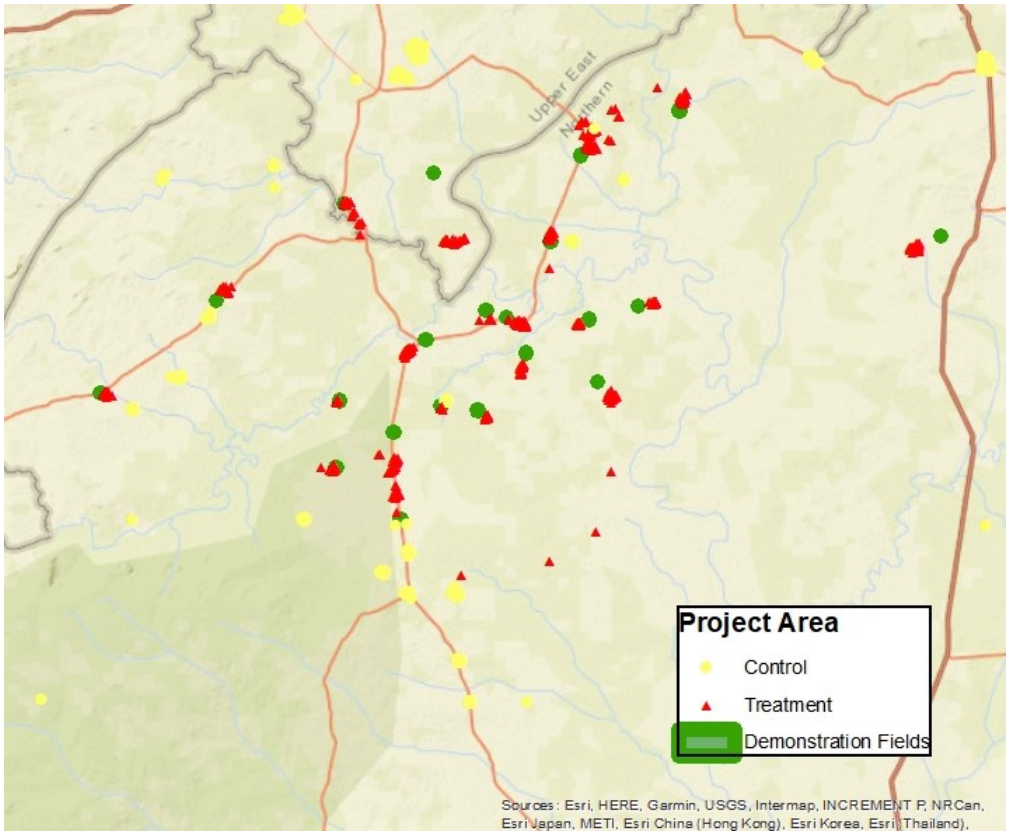
[4] The power (or statistical power) of an impact evaluation is the likelihood that the study will detect a difference between the treatment and comparison groups, when in fact a difference exists. Power calculations indicate the smallest sample size necessary for an evaluation to detect a meaningful difference in outcomes between the treatment and comparison groups. By increasing the sample size, statistical power can be improved.

list of control villages because all households' main source of income was fishing and not agriculture. Therefore, only 26 control villages remained.

The study sample, therefore, comprises 48 communities in four districts with a total population of approximately 30.000 individuals and 1360 sampled households. Based on power calculations[5] we derived a necessary sample size of approximately 1500 farmers interviewed in 49 communities to be able to detect an effect.

Figure 2 shows the project area. Treatment households are marked in red, control households are marked in yellow. The location of the demonstration field for the FFS are highlighted in green.

Figure 2 Project area



Source: GPS data of IWAD follow-up survey. GPS data of demonstration fields provided by IWAD.

[5] For the power calculation effect sizes for FFS on conservation farming we used figures of studies investigating Integrated Crop Management (ICM) practices. These studies find that ICM practices increased from 18% to 31% after the FFS. We assumed a power of 90 percent, alpha 0.05 and intra-cluster correlation of 0.40 (assumptions based on David and Asamoah, 2011, for Ghana and Erbaugh, 2010 for Uganda and Waddington et al. 2014). For the comparison of the irrigation farmers we found no adequate study but as an increase in yields by 100 percent is expected due to a second harvest (instead of only one before) we decided to oversample the villages with access to irrigation to increase statistical power.

A comparison between the treatment and control group at baseline (see Annex C) shows that both groups are equal for the majority of indicators and, therefore, the applied difference in difference approach is valid.

3.3.2 Additional Samples

In the impact measurement risk assessment in the baseline report, it was described that uptake of the program is the result of the farmers self-selecting themselves into the treatment group and the selection decision of IWAD. First, farmers have to follow the FFS, second, sign up for the IWAD input package and third, IWAD needs to admit the farmers to the program. Although the uptake rates were representative for the sample and the population at baseline, the general uptake was found to be quite low in the first year. Therefore, the research team decided to interview all farmers and their households that received IWAD treatment in 2015. A supplementary sample was collected of 180 households so that all 252 farmers (living in 230 households) that received treatment in 2015 (see Table 4 in section 5) have a fully filled out questionnaire. In the original sample, we had already 50 farming households (CA and irrigation).

Throughout the report, we will refer to the additional sample households as the supplementary sample. It will be used to analyze in which characteristics treated and not treated farmers differ. For the impact estimations in section 5, this sub-sample will not be considered as it is not part of the representative random sample.

As the project had a strong gender dimension from the beginning, the research team decided, during the follow-up survey, to additionally do a small survey among the 200 women working for IWAD as casual workers after the follow-up survey.

3.4 Qualitative and Quantitative Data Collection Tools

For the PPP institutional and empirical analysis several quantitative and qualitative data collection tools were applied forming a mixed methods approach. Both teams developed the guidelines for the analysis together and shared knowledge. Specific questionnaires were shared before the individual field trips.

For the institutional assessment data was collected through a triangulation of sources: semi-structured interviews (see question in Annex A), analysis of secondary sources (project documentation, progress reports, newsletters), and personal observations. All interviews were transcribed, and the results coded. The results of the interviews were complemented by a short questionnaire administered to the partners assessing the perception of the results and the added value of the PPP (questionnaire is provided in Annex A). The first round of interviews was held in 2015 for the baseline study, followed up by intermediate and short follow-up interviews in 2016 and 2017, and a final round in 2018. The final semi-structured interviews were held with all of the contractual partners, for a total

of 7 interviews in 2018. This small *n* approach was used to probe more deeply into the contextual issues, the processes and the interaction in the PPP, and the values, motivations and aspirations of the partners in the PPP[6]. This approach is complementary to the approach taken in the impact section of this report. The team executed a document review in the baseline and follow up phases. It was the intention to attend partner meetings, but the partnership never held any, so it was not possible to observe the nature of the interaction in that manner.

In order to measure the potential evaluation outcomes quantitatively and to verify the impacts outlined, several data collection tools were applied: Focus group discussion (FDG), semi-structured interviews with operational partners and experts, and structured interviews using household and village questionnaires (see Annex D, E and F). For the baseline survey, FGDs were conducted in four villages in January 2015. Two villages were already participating in the project in 2014 and two were potential control villages. A further round of FDGs was conducted in March 2018 in three CA treatment communities and in one irrigation community. Results of the FDG are used to verify and support the interpretation of the results of the impact measurement in section 5.

The principal tool for measuring impact is the structured household questionnaire, see Annex D. This questionnaire included questions on socioeconomic household characteristics (size, education, health, nutrition and financial situation) and agricultural practices (use of chemicals, planting techniques…), land holding, harvest and sales of harvest. As the project has a special gender component to foster the role of women in agriculture, the questionnaire also included a module on intra-household decision making with regards to daily expenditure, agriculture and children's schooling. The modules of the questionnaire were mainly taken from the Ghana Living Standard and Measurement Surveys and Demographic and Health surveys and were adjusted for the purpose of this study. This ensures that questions meet international standards. For all parts of the questionnaire, answering these questions was voluntary and households were informed that the data will be treated anonymously. Interviews were conducted by male and female enumerators.

With the village questionnaire (see Annex E), information about regional and village specific characteristics was collected. The questionnaire was usually conducted with the village chief and a group of elders who represent the local authority. It included questions on infrastructure access and quality, local economic and agricultural conditions such as crops, cooperatives, aid projects, employment opportunities, migration and prices.

[6] This small *n* approach was specifically chosen. As the objective of the assessment was to analyze the relationship between partners and it contribution to outcomes, the decision was made to focus on understanding the relationship and the partnership from the perspective of the partners, the parties with intimate knowledge of the partnership. Discussions with external parties revealed less knowledge of the nature of the partnership; this also pertains to the understanding of the governance structure and relations as detailed later in this section.

For the sample of the 200 female casual workers, a small survey tool including questions on intra-household decision making, earnings, savings and use of the money earned was developed, see Annex F.

3.5 Survey Implementation

For the implementation of the baseline and follow-up survey, a team of Ghanaian, Dutch and German researchers collaborated. The roll out of the survey was planned by the supervisors and the other team members. IWAD supported the research team in providing information on the geographical location of villages and helped in finding accommodation for team members.

The baseline survey then took place from March 2nd until March 27th 2015. The follow-up survey was conducted in the same period from March 5th to March 29th 2018. The surveys were conducted in this period because it is the time of the year when farmers are not time constrained. The last harvest (usually beans) is finished in January and February and the next farming season only starts in May or June, depending on the rains. Farmers appreciated this procedure.

The data entry was done in the field in an installed data entry center to guarantee fast feedback to the survey team in case of inconsistencies. The accuracy of the entered data was checked and final revisions were made by the research team.

3.6 Estimation Strategy

A common method used to support internal validity is to make observations over time using the difference-in-difference (DiD) approach, as it has two advantages: the use of two time periods, namely before and after an observed treatment took place, and the comparison of a treatment group to a (similar) control group or counterfactual. Any correlation between treatment status and observed or unobserved time-invariant village characteristics is neutralized by applying the DiD approach. The source of bias influencing the treatment outcomes thus will be reduced. We will observe the impact indicators over time with the baseline (2015) and follow-up (2018) data.

The advantage of the study design is that we can measure both, the intention to treat (ITT) and average treatment effect on the treated (ATE). The ITT group are all households living in treatment villages and all have the potential to be treated. The ATE group are only those households in treatment villages who signed up for inputs from IWAD. The FFS were open to anyone in the village and farmers could gain knowledge on the cultivation of the five different crops (see section 2 for details). All farming inputs, however, are not exclusively distributed by IWAD but

are available on the markets as well. Thus, farmers could obtain knowledge but purchase the improved inputs by themselves and cultivate crops with the improved methods. Therefore, we estimate two DiD impact equation containing measures of interest:

(1) $Y_{ijt} = \alpha + \beta_1 Time_t + \beta_2 CA_j + \beta_3 Time_t CA_j + \gamma_1 X_{it_0} + \varepsilon_{ijt}$

Equation (1) contains the typical DiD components measuring the ITT: A binary variable *Time* to measure the time period of the baseline =0 and follow-up =1. The treatment of CA FFS on village level CA_j is interacted with the *Time* variable to measure the ITT effect in β_3. The ITT also shows whether there is a diffusion of knowledge on the taught farming practices outside the FFS. For estimating equation (1) we include the whole sample in treatment and control villages while the second equation is estimated only with those households in treatment villages who participated in the FFS and went under IWAD contract to receive inputs for farming.

(2) $Y_{ijt} = \alpha + \beta_1 Time_t + \beta_2 CAP_i + \beta_3 Time_t CAP_i + \gamma_1 X_{it_0} + \varepsilon_{ijt}$

The ATE treatment is measured by the variable CAP_i. In equation (2), the interaction of CAP_i with *Time* estimates β_3, the ATE, thus the effect of receiving IWAD inputs and supervision on different outcome measures (farming practices, yields, sales, see section 5). The rational of measuring two equations is that otherwise, those households in treatment villages that did not receive IWAD inputs would be considered as the control group coded with 0 in CAP_i. In equation (2), those households are excluded.

X_{it_0} in both equations includes some control variables at baseline to account for heterogeneous treatment effects. The included control variables are whether the household head has primary education completed, the age of the household head and household size.

4. Institutional Assessment

4.1 Introduction

The objective of the institutional assessment is to evaluate the (formation of the) relationship between the partners, to analyze the contribution of this relationship to the outcomes of the project and to ascertain the added value of the PPP. The focus of the assessment was on the *perception* of the partners of the outcomes and added value.

This section provides key information on the background of the partnership and the objectives of the project, the setup (the allocation of roles and responsibilities and governance structure) and how these have changed over

the length of the project. It outlines any challenges and risks as perceived by the partners and how partners have overcome these. Finally, it reflects on the perceptions on the part of the partners of the outcomes, as well as the added value of the partnership.

4.2 Background and objectives of the project

Wienco (Ghana) Limited (WGL) was established in 1979, as a joint venture Ghana-Dutch company involved in businesses in the agricultural sector. WGL specializes in the importation and distribution of fertilizers and crop protection agro-chemicals including insecticides, pesticides, herbicides and fungicides, primarily for the cocoa, maize and cotton sectors in Ghana (RMG Concept SA/ Wienco sites)[7]. The company has been working in Ghana since the beginning to enhance the productivity of the Ghanaian farmers, mostly small-scale farmers, to ensure high yields and to secure small farmer's revenues. WGL also strives for the improvement of sustainability and market access (Appendix 1: Project Plan, 2012)[8].

Wienco took the initiative to approach the Government of Ghana, represented by the Savannah Accelerated Development Authority (SADA), to take part in a PPP promoting sustainable agricultural practices in the Northern Region. Wienco saw this project as attractive as it fits into SADA's mandate. As a governmental institution, SADA's mandate is to develop the local economy and the agricultural sector in Northern Ghana and to provide an environment, which is conducive for private agricultural investment in the zone.

Wienco took the lead in submitting the proposal and, in doing so, approached a number of other partners. The objective was to involve partners that had complementary knowledge and skills and would provide complementary services in the partnership (various interviews with project partners, and Project Plan 2012). Table 1 below lists the current project partners and the type of contribution they give for the PPP.

For the purpose of the project, Wienco Ltd. established a legal entity, a branch named Integrated Water and Agricultural Development (IWAD) Ghana Ltd. Wienco transferred parts of its rights and obligations for the project to IWAD. IWAD Ghana Ltd joined the PPP as a separate company for the coordination and operational aspects at field and local level. IWAD's role is to act as the project coordinator, responsible for organizing construction, operation and management of the irrigation infrastructure, delivery of irrigation water and the production of crops. (Progress Report Result 1, IWAD 2015, and Partnership Agreement)

[7] http://www.wienco.com/ accessed 18 December 2015 and http://www.afigfunds.com/rmg-concept-ltd-announces-partnership-with-wienco-ghana/ accessed 18 December 2015.
[8] Appendix I: Project Plan Sustainable Water Fund (October 2012). Title: Integrated Water Management and Knowledge Transfer in Sisili Kulpawn Basin (FDW/12/GH/02)

IWAD's vision was to expand commercially viable irrigation practices in the Sisili Kulpawn Basin through the delivery of high-quality irrigation support, new technology development and knowledge transfer, promoting water use efficiency and sustainability and securing farmer's revenue for both Smallholders and Nucleus Estates[9].

Table 1 SK Project PPP structure[10]

Partner	Sector	Strategic role
Wienco Ghana Ltd.	Private	Coordinator
Integrated Water and Agricultural Development Ltd. (IWAD)	Private	Coordinator and Implementation
Savannah Accelerated Development Authority (SADA)	Public	Governmental representation, facilitation of processes
Wageningen University and Research Centre – Alterra	Research	Capacity building, training and research, knowledge development
RebelGroup International BV	Private	Transaction advice and scaling up of the project

SADA is a government agency, a statutory body with the mandate to promote the comprehensive and long-term development of the Northern Savannah Ecological Zone in Ghana. For related matters, SADA provides strategic guidance to the Government of Ghana, development partners and the private sector related to the implementation of the accelerated development strategy. SADA's interest in this project was to support and promote the project in the context of the local economic and agricultural goals (FDW proposal, IWAD 2015).

Wageningen University and Research Centre (WUR), represented by the Alterra Research Institute, came on board to manage the capacity development component of the project and to provide capacity building services to the farmers. The organization specializes in and is coordinating projects in sustainable soil and water management in Africa to enhance crop production, including projects in Ghana.

RebelGroup International BV: RebelGroup is a financial-economic advisory firm specialized in development and optimization of large public-private investment projects. Wienco approached RebelGroup to provide advice on the set up of the partnership, with a special view to the future scaling up of the project. Their contribution to the project related to the financial structuring and analysis (Rebel 2015).

[9] http://african-tiger.com/bedrijven/iwad-ltd/

[10] The Ministry of Foreign Affairs defines a PPP as follows: "A form of cooperation between government and business (in many cases also involving NGOs, trade unions and/or knowledge institutions) in which they agree to work together to reach a common goal or carry out a specific task, jointly assuming the risks and responsibility and sharing their resources and competences" (see IOB, *Public-Private Partnerships in Developing Countries*).

The Integrated Water Management and Knowledge Transfer in the SK Basin Project was approved in April 2013. On 31 March 2014, the partners signed a Partnership Agreement which defined the organization of the project, the roles and responsibility of the partner, communication flows, the governance structure, distribution of finance and subsidies, the rights to knowledge and project results, conditions for termination and liabilities, etc. (Partnership Agreement, 2014). The duration of the agreement was to be from April 2013 to December 2017 and included the flagship-phase from April 2013 onwards and the start of the scaling up phase from 2015 onwards[11].

In the proposal, the total project costs were calculated at EURO 11.7 million; the subsidy was to contribute 60% of the total budget (EURO 6.9 million). The remaining 40% of the budget was to be covered by the partners.[12]

At first sight, looking at the structure of the partnership and the elements outlined in the Partnership Agreement and the Project Plan, the partnership appears to have met the 5 criteria of developmental PPPs as defined by the IOB (2013:17). The partnership had both public and private partners (criterion 1), there was a clear agreement on the goals of the PPP (criterion 2), the project was financed by a mix of public and private funds (criterion 3), there was a clear agreement on the sharing of resources and tasks (criterion 4), and there was a distribution of risks between the public and private partners (criterion 5).[13]

Objectives of the project and the partners

The project proposal states the following about the goal of the project. The purpose of the project is to *"foster smallholder and private sector led growth through the promotion of integrated water management practices and the development of irrigation in the Savannah Agro - ecological zone in the North of Ghana, with emphasis on partnership, investment, capacity development, profitable crop value chains, and accountability." (page 2)*[14]

In the eye of respondents, the Sisili Kulpawn scheme provided a unique opportunity to combine commercial and development goals. Interviews revealed an interest on the part of the partners to develop a business model for sustainable and socially responsible agriculture. As is indicated above this project not only was intended to support

[11] The Ministry of Foreign Affairs defines a PPP as follows: "A form of cooperation between government and business (in many cases also involving NGOs, trade unions and/or knowledge institutions) in which they agree to work together to reach a common goal or carry out a specific task, jointly assuming the risks and responsibility and sharing their resources and competences" (see IOB, *Public-Private Partnerships in Developing Countries*).
[12] Please note, that the final information on the financial status of the project will be made available in June 2019.
[13] *Public-Private Partnerships in Developing countries. A systematic literature review*. IOB Study no. 378. Ministry of Foreign Affairs of the Netherlands. April 2013.
[14] Appendix I: Project Plan Sustainable Water Fund (October 2012). Title: Integrated Water Management and Knowledge Transfer in Sisili Kulpawn Basin (FDW/12/GH/02)

large scale farmers, but also (and specifically) the small farmers, helping them grow and use more advanced farming practices (Multiple respondents 2015, 2018).

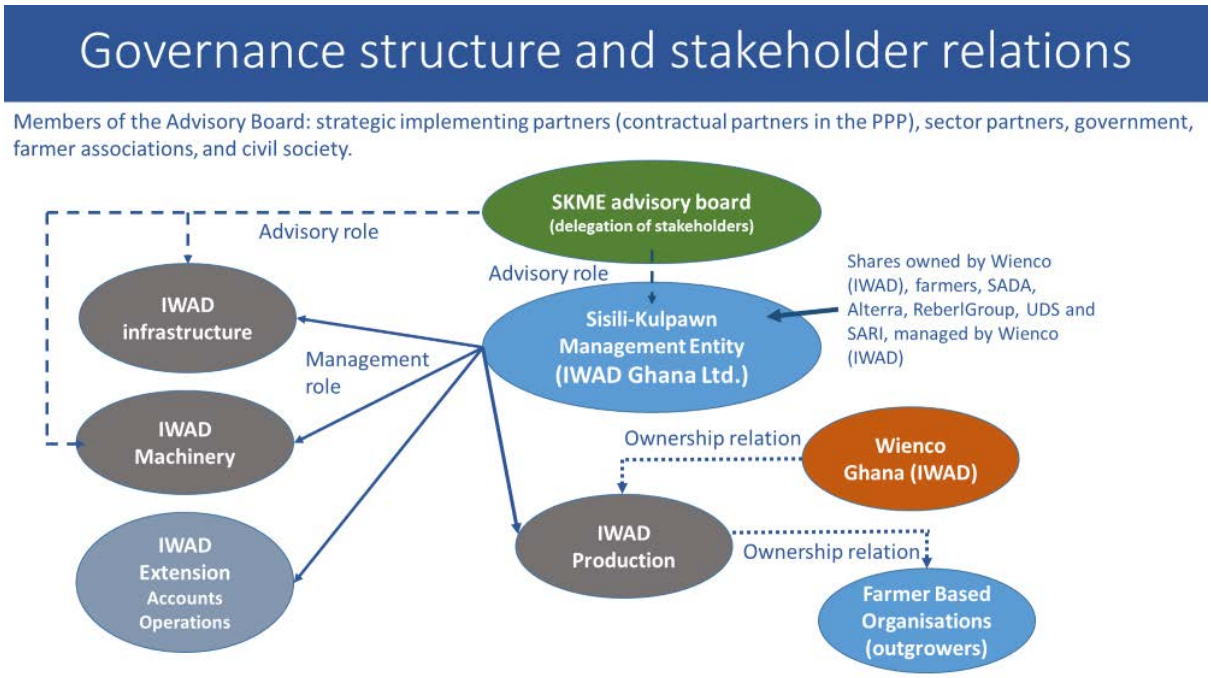
The project also, linked to the mandate of SADA, aimed to contribute to economic growth and to achieve a variety of spin offs.

"The project will help to develop an irrigation and agricultural practice in northern Ghana which is not yet there. This will also unlock a series of economic effects which are very valuable. Instead of people having the insecurity of water, they are able to use water more effectively. This will then increase the agricultural yield in the zone and create from that all the various agricultural spin offs. The project is by nature very technical but is also expected to have an (indirect) influence on health issues, for instance, the incidence of illnesses in children." (Rebel 2015, Alterra and IWAD similar 2017, 2018 respectively).

4.3 The project set up, roles and responsibilities (governance structure)

In the proposal, the governance structure was to be as provided below. Figure 3 focuses on the ownership and institutional relations in operational aspects in Ghana, as they relate to Wienco and IWAD.

Figure 3 Governance structure and stakeholder relations as defined in the proposal



Of note is the fact that the partners and the beneficiaries were expected to own shares in the management entity, IWAD. The governance structure assumes an input in decision making on the part of a wide range of partners.

The section below looks at the changes in to the partners in the partnership, in the roles and in the governance structure. In effect, the ownership and institutional relations did not develop as conceived in the proposal.

Change to partners in the partnership

Since the baseline report there have been some changes in the composition of the partners in the partnership. For one, the owner of Wienco, African Tiger Holding Ltd. (ATH), sold its shares in Wienco and took over the ownership, in other words, 100% of the shares of IWAD.

". . . Initially IWAD was to be part of the Wienco group. Wienco was sold. It was always planned to have the operational unit structure as limited liability company; a separate entity. That happened. From that partnership relation, the ownership that was supposed to be a sharehold between Wienco and African Tiger Group[15]; this became 100 percent ATH, which means that IWAD Is 100 percent ATH. So, Wienco, that has been active in support for the first 2 years, [its role] was taken over by ATH and IWAD 100 percent; that is a major change; this is documented". (IWAD 2018)

IWAD is supervised by a board. Interestingly, SADA is to become a 20% shareholder of IWAD. The discussions have been ongoing for several years, the final documentation is still with the lawyers and has yet to be signed (IWAD, SADA 2018).

In terms of its main contribution to the PPP, SADA's role has been to facilitate project activities and plans with supporting documents and letters, and to provide infrastructure on the ground: sanitation, water, power and electricity. The organization also has a role in financing part of the project (IWAD and SADA 2015 and 2018).

SADA is also undergoing a substantial transformation as an institution, for the past year and a half, the organization has been transforming into the Northern Development Authority (NDA). The newspapers outlined that as one of three Development Authorities, NDA is meant to accelerate development, with an annual allocation of USD $275 m, and to focus on the three Northern regions of Ghana: Upper East, Upper West and the Northern Region.[16] This implies that the organization has been busy with its mandate and developing its new policy and strategy (IWAD, SADA 2018) in recent years. This change has not impacted the financial participation of SADA in the project, though there is some consensus on the part of the private partners that this process has influenced the availability of SADA for this project (different priorities).

At project inception, the intention was to set up a project committee, containing one representative of each party. Each partner would have one vote when making decisions and decisions in the committee would be made with majority vote. This project committee has never met. In addition, in the original project design, IWAD was to be supervised by an Advisory Board, which was to include 1) representatives of all key stakeholders (the local chiefs,

[15] Note that this respondent refers to the African Tigers Group, the official name is African Tigers Holding Ltd.
[16] https://www.myjoyonline.com/politics/2017/october-5th/northern-devt-authority-needless-sada-rebranding-minority-picks-fight-over-npp-promise.php

the district assemblies, government agencies, such as the Ministry of Food and Agriculture, Irrigation Development Authority, representatives of the farmers (the direct beneficiaries), UDS, SARI and 2) the contractual partners, IWAD, SADA, Rebel, and Alterra. This body has also never met, though as was the case during the baseline phase, contact with all members is fairly frequent, taking place during regular reporting periods and when necessary. Communication takes place via IWAD.

Other than that, the roles of Alterra and Rebel Group have not changed.

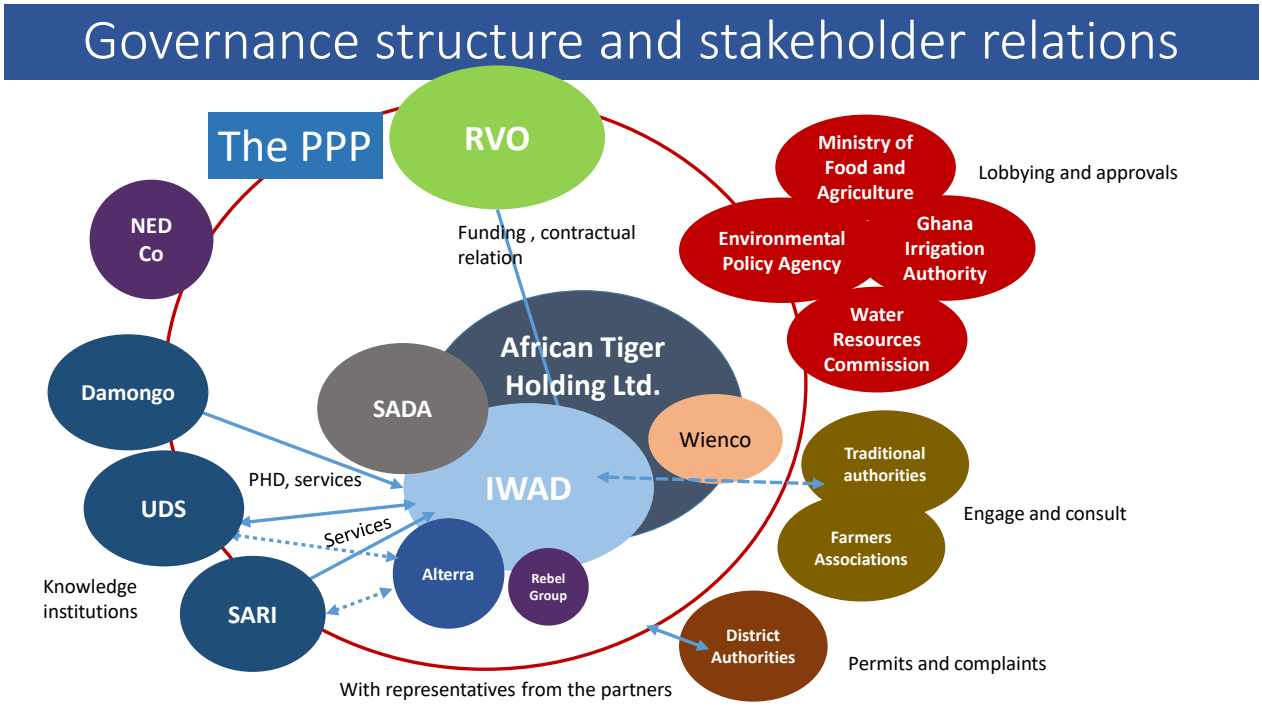
One interesting aspect of the PPP is how the partners perceive[17] the final governance structure of and institutional relations in the PPP. To get a sense of these perceptions, respondents were asked to draw the organisational relations in the PPP. The Venn diagram below provides a graphic of key organisations in the PPP and gives an indication of those partners that were central and contractual partners and those with an important function, but perhaps more peripheral.[18]

Figure 4 reflects the central role of IWAD, the private company owned by ATH, and its relations to SADA, Rebel and Alterra. These parties are bound contractually, but in contrast to the original set up in the proposal, do not have a share ownership in the company. The figure also shows that national government agencies have played a distant but important and influential role in the project. The same is true for the traditional authorities and the farmers' associations. One private respondent described RVO as one of the public partners in the PPP, and one public respondent commented on the important financial contribution of RVO to the PPP (sharing of risk), so the figure shows RVO straddling the edges of the partnership. The figure also demonstrates the complexity of relations and interactions; the PPP and the (success of the) outcomes of the project have been affected by a series of players outside of the contractual relationship.

[17] Perception is an important construct. Actors use their perceptions, the lens through which people views and make sense of the world, to assess problems, create responses and evaluate outcomes. Refer to Kickert, W. J. M., E. H. Klijn and J. F. M. Koppenjan (1997). Managing Complex Networks: Strategies for the Public Sector (London: Sage).

[18] This report differentiates core partners (the key players) and peripheral actors as important participants. Core partners are those formally involved in the process, who interact 'on the substance and process of the project' they were bound by a signed agreement. Peripheral actors are those who may have an interest in the process, are included in the interaction, but often not on a consistent or systematic basis. This report sees peripheral actors as important to the process, as they may exercise influence over decisions. Refer to Klijn, E.-H. and G. R. Teisman (2003). 'Institutional and Strategic Barriers to Public-Private Partnership: An Analysis of Dutch Cases.' Public Money & Management 23 (3): 137-146.

Figure 4 Governance structure and stakeholder relations during the project



Partners interviewed no longer perceived Weinco as a partner after the sale of shares. However, the organization is included in the figure, albeit in a more reduced role. Formally WIENCO still has a role in the project as a potential takeoff partner.

Of note, is the fact that all coordination of the project goes via IWAD. Partners do not have bilateral relations.

IWAD interacts frequently with the University for Development Studies (UDS) and the Savannah Research Institute (SARI), two local institutions subcontracted as knowledge institutions. They have been involved in the training program, with Alterra; two PhDs from UDS have completed their research in the project area; and IWAD has commissioned UDS to provide some technical advice. UDS has been involved in the thinking on the scaling up of the project. SARI has been involved in the experimenting with seed production, a potential market for the project. (Project documentation and interviews Alterra 2017 and IWAD 2018)

IWAD recently signed a MoU with a knowledge institution new to the project, Damongo Agricultural Training College, to begin skills development in farming technology (IWAD 2018).[19]

Of interest is that, 4 years ago, a District Assembly (DA) was established in Yagaba. When the project started, and there was little in the town. Yagaba has now grown as investments have taken place. The DA is now well

[19] IWAD newsletter 2018.

established and acts effectively as the local government institution. IWAD goes to the DA for permits and to lodge complaints (IWAD 2018).

In 2016, the project set up the Sisili Kulpawn Farmer's Association that involved the smallholder irrigation farmers and rain-fed farmers. This association has grown to 549 members (registration still pending).[20] As end users of the project, this body is an important component of the 'extended' governance structure of the project. Even with the registration still pending, the body is taking a key role ". . . *the association is fully operational with its executives elected, commissioned and functioning. Technical committees have been formed in the association which sees to it that issues raised by members of the association are analyzed and forwarded to IWAD smallholder irrigation unit and management for discussion and resolution.*" (IWAD Final Report 2018: 6) This body is an important body for making decisions and communicating with IWAD as the coordinator.

The PPP's final report reveals another interesting perception of the partnership relations and the roles of different parties. The section on Progress on Outcomes mentions that "*the change of actions, activities and relationships of groups/associations*" is important for the outcomes of the project. The partnership has been monitoring the performance of certain 'partners' that are "*considered important to realize the changes required to achieve impact"* (IWAD Final Report 2018:14). The bodies considered important are: the Farmer's Association, the Worker's Association, the Traditional Authorities and the District Assembly (the beneficiaries of the project).[21] The terminology in the report is interesting, as opposed to simply being the beneficiaries of the project, these parties are now cited as 'partners'. Their role and significance for the project has shifted, and they are now recognized as essential to the outcomes.

On the other hand, discussions during the FGDs demonstrated that the farmers, traditional authorities and the DA are not aware that the project has a PPP structure and who are the other partners involved.

The figure shows the shift in relations as the project matured and partners (IWAD) adjusted relations. Partners asked to draw the relations, themselves admitted to the complexity of the relations. A PPP is made up of partners working to achieve outcomes, but it is necessary to recognize the role of peripheral bodies whose roles are essential for making the project work.

4.4 Challenges, risks and coping mechanisms

As stated before, one key characteristic of PPPs is the sharing of risk. This section focuses on the risks and challenges the partners faced and the mitigation measures they used to deal with these. A simple classification of

[20] IWAD Final Report 09/05/2018.
[21] Ibid.

risks is used here: those that are internal and those that are external. Internal risks are risks that are related to the project and the PPP. External risks are risks over which the project team has limited control; these include political risks, economic/market risks related to recessions and real estate crashes, and social-cultural risks. The assumption in a PPP is that these risks are shared, allocated to the partner that can best bear them. The public sector would for instance be allocated the political risks of the project, also perhaps the risks related to acquisition of land or to resettlement processes should these be subject to substantial community resistance.

The scanning of the project documentation revealed 7 major categories of risk broken down into 32 more specific risks.[22] The table in the final report (see reproduction of this in Table 2 below) did not specify to whom these risks were allocated or how they were shared.[23] The evaluation team was able to ascertain this, to a certain extent, from the interviews.

The majority of the risks were identified as internal project-related risks (21 of 32) with their attending mitigating measures. Some of the risks were identified as internal with an indication of some external influences (total of 8). These risks related to access to and the use of land, access to services outside of the scope of the project, and market-related risks. Of interest is that the PPP was interested to mitigate and make investments in these risks, understanding that mitigation was also dependent on external forces. Three of the risks identified were external: 1) the risk of a (ir) responsible political involvement by different actor groups (no. 23) and 2) access to improved essential services: health, water and sanitation (no. 27) and 3) access to educational and cultural services (no. 31). Most mitigating measures have been implemented, with the exception of activities to improve access to essential services (no 27). Some are still underway.

The interviews were used to confirm the risks found in the project documentation.

Project related risks: Respondent interviews underlined that there were substantial and ongoing project related risks. This confirms the focus of the Table 2 on internal risks. Respondents mentioned the challenge of getting the project up and running, its infrastructure, the equipment (Alterra 2017, Rebel 2018). Respondents also emphasized that most irrigation projects of this kind have not managed to overcome risks, and to become operational: this project is an exception (IWAD, Alterra, SADA 2015, 2017 and 2018).

[22] IWAD Progress reports, as well as IWAD Final Report 09/05/2018, Table: *Updated ICRS Risk Analysis Table*, pg. 23 – 29.
[23] *Public-Private Partnerships in Developing countries. A systematic literature review*. IOB Study no. 378. Ministry of Foreign Affairs of the Netherlands. April 2013.

Table 2 Risks and mitigation measures

No.	Risk	Descriptions	Internal/External	Mitigation measures
1	Organizational governance	1. Corporate governance (focus on activities to aid in decision-making)	Internal	▪ Site project office, M and E system
2	Human rights	2. Discrimination, vulnerable groups (gender) 3. Economic, social and cultural rights 4. Fundamental principles and rights at work 5. Human development / training in the workplace	Internal Internal/external Internal Internal	▪ Gender equity/anti-discrimination policy ▪ Access to water, infrastructure, credit, village fund ▪ Setting of rights: workers, attendance at schools ▪ Capacity building and training
3	Labor rights	6. Employment 7. Occupational health and safety 8. Social dialogue	Internal Internal Internal	▪ Establish good employment conditions ▪ Health and safety policy, training, facilities ▪ Promotion workers and farmers associations
4	Environment	9. Land acquisition and compensation 10. Loss of biodiversity 11. Soil stability and conservation 12. Land use access/grazing 13. Solid waste management 14. Sanitation 15. Water availability in river 16. Waterlogging 17. Salinization 18. Impact on surface water quality and pollution prevention 19. Impact on groundwater 20. Impact of chemicals 21. Sustainable resource use	Internal/external Internal Internal Internal/external Internal/external Internal Internal Internal Internal Internal Internal Internal Internal	▪ Community consultations, village trust fund ▪ Physical interventions (integral to the design of the project) ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions ▪ Physical interventions
5	Fair operating procedures	22. Anti-corruption policy 23. Responsible political involvement (SADA, traditional authorities, district assembly) 24. Respect for property rights 25. Good quality of input supplies 26. Fair farm gate prices	Internal External Internal/external Internal/external Internal/external	▪ No bribing policy, enforcement, training ▪ Sustainable Peace Initiative (SADA), transparent management systems (also financial) and communication ▪ Land use change with consent of land owners, trust fund ▪ Purchasing from certified and trust suppliers ▪ Transparent pricing and payment systems
6	Consumer issues	27. Access to essential services	External	Investments in wider access to health, water, sanitation
7	Community involvement and development	28. Sensitization and training of local farmers 29. Resettlement and compensation 30. Community health and safety 31. Education and culture 32. Emergency situations (prevention)	Internal Internal/external Internal External Internal	▪ Capacity building and training ▪ Compensation program ▪ Prevention of malaria, site safety activities, training ▪ Support to local systems ▪ Preventative measures: physical and procedural

Source: adapted from *Updated ICRS Risk Analysis Table*, pg. 23 – 29

Interviews revealed more detail on operational challenges and project risks. For one, from a farming point of view, the project has suffered years of drought, pests and flooding: substantial external risks. In addition, another major risk related to the productivity of the labor force. The farmers showed up on an irregular basis, so it was difficult to have full attendance at the training/on the site. In addition, there was limited participation of men, who '*prefer to sit under the trees and talk politics, to lie down*.' Most of the workers were women, who were committed but often had multiple obligations. The concern has been that the work force is not reaching its full potential. IWAD has been seriously thinking about importing labor to the villages (IWAD 2018)[24].

Related to getting the project up and running, the risks mentioned in the interviews revolve around four major elements, the weather and plagues (external risks), acceptance of irrigation, interest and willingness to take part in the project, and irrigation costs as inputs to the project costs (see below). IWAD has been working to deal with these issues, through training, and through introducing innovations, such as mechanization and investments in solar panels.

There were differing perspectives on this, but security of land tenure was regarded by some respondents as an issue that remains for the small scale farmers.

Financial risks: Irrigation costs have been high because of the costs of petroleum to run the generators to pump water from the river to the reservoir. This constitutes a substantial financial risk. In addition, the irrigation system is not being used to capacity; the local farmers seem to prefer to farm in the rainy season only. To mitigate this, the PPP has been installing a solar system to reduce costs. Cost reductions will only start to take effect in the next 2-4 years (IWAD 2018).

Interviews also revealed a significant risk related to the delays in funding allocations and to the cash flow of the project. As was the case at the time of the baseline, and one that still remains, a key challenge has been getting SADA to fulfil its financial obligations on time (Multiple respondents 2015 and 2018). SADA has not been able to come up with the last €300,000 of their €800,000 obligation to the project. The release of funds has been slow, and this amount was still outstanding at the end of the project. This has had serious impact on the cash flow of the project and forced IWAD to adjust the planning of the project. This was a substantial risk to the project. **Of note:** since the completion of the project, the Ghanaian Ministry of Fisheries and Agriculture allocated a G-CAP contribution of USD 450,000 to the project (RVO 2019).

[24] Please refer to the section 4 for confirmation of these details.

The challenges in making this project viable implied continuous financial risks to the project: the project was not able to show return on investment (RoI) in the project period[25]. IWAD and partners are still working towards the best business model to achieve this. One strategy to improve on the financial sustainability of the project was to move to the planting and production of rice. Another was through increasing the scope of production via scaling up. The partners are currently looking closely at options: the scope of the initiative and the location is still to be determined (Rebel, IWAD 2018).[26] [27]

A public respondent commented on the plans for scaling up. The current 'extension' envisioned is a project in another location, to be executed by several private sector partners, and will most probably not involve SADA as the public partner. This implies that SADA's involvement in the PPP will be limited to the Yagaba project and its future outputs. These unresolved issues still pose some risks, time and delays imply additional financial risks.

He mentioned that concrete discussions on the transition process (post Dutch funded activities) have not yet taken place in the form that meets SADA's expectations. This includes discussions on the management and ownership of the assets, and the maintenance of developmental benefits for the community (SADA 2018).

The risk borne by the project partners has also been affected by the fee rates that the FDW program allows. These have been below market rates and imply that some of the partners, in addition to making cash or in-kind contributions, are subsidizing the project through accepting lower than normal rates (Rebel 2018). These input costs will also be an issue in the scaling up phase.

Other (political) risks stemming from different interests / perspectives and unresolved issues:

One IWAD respondent was critical of the attention given by SADA to the project. The comments made by this respondent also underlined the importance of SADA to the project, and the risk of their lack of participation.

"The government role, SADA, has been important but not very active. Even for them, I do not think they fully grasped the importance of what they have in Yagaba. They were more concerned about their strategy document and attracting new funding, talking with the donors . . . I think they have not realized how good things were in Yagaba for them . . . They were required to put in €800,000, so they could have

[25] The financial figures will be provided during the sustainability assessment in the summer of 2019. This information was confirmed during interviews with partners.
[26] As the scope of scaling up was not clear at the time of the report, it is difficult to reflect on the nature and sustainability of future plans.
[27] IWAD Final Report 09/05/2018: page 2

been much more involved in the maintenance of the roads, the energy part. The last 2 rainy seasons, the [roads were] cut off. [SADA was] involved in a project that was DFID funded. So, there they could have easily made sure there was a bit more money spent under that project for our road; they could have been fully involved in issues. They have basically been absent on the operational part. With us constantly trying to move forward together with them . . ." (IWAD 2018).

This quote refers to the accessibility and flooding issues faced by the project, and the influence of these on the activities of the project. Seasonal flooding (under environment in Table 2) limited access to the site and the participation of the farmers. The quote describes what this respondent sees as a missed opportunity on the part of SADA, a lack of attention to the day to day issues, and therefore a negative influence on the project. Finally, it also refers to other interests diverting SADA's attention and influencing its involvement. This project is one of many of SADA's activities, implying that it has had to compete with other initiatives for SADA's time commitment and attention to operational activities. This type of risk is not uncommon to PPPs, perhaps underestimated by the partners and it is not dealt with in Table 2.

SADA committed to sharing financial risk. However, SADA's perspective on the governance structure resulted in some perception of risk and reticence related to its involvement. As demonstrated in the section on governance structures, the organizational form chosen differed from the original design, also influencing the 'voice'; of the partners in day-to-day decisions.

". . . The understanding was, in this partnership, although the project would be executed by the private partner, that the oversight over the project would be joint. So, there would be an entity where all parties would sit at this table with almost equal powers, guiding where the project would go. And I think for SADA this was ok. It was not going into a commercial agreement to make money; it was simply supporting a process that would have developmental benefits . . . Now, the entity became IWAD, and this entity, IWAD, was not an entity controlled and owned by all the partners. It was an entity owned by one of the partners, which is the private partner that would execute the project and be the accountability mechanism, also for the project." (SADA 2018).

SADA has been interested to participate under the condition that it would have effective voice in the management of the project, on the board of IWAD. This condition was also motivated by the need for SADA to be accountable to the Ministries with regards to its participation. The negotiations, ongoing since 2015, have resulted in an in-principle agreement that the government would come up with 20% of the equity.

SADA was also clear on types of political risks that influenced the project, with which SADA has had to deal. These stemmed from the environment in which SADA works, and the differences in opinions amongst public actors (various ministries) of the rationale for and acceptability of SADA's involvement in this PPP.

A SADA respondent commented on the political risk in justifying the PPP: people from Ministry of Food and Agriculture wonder how SADA was able to justify using government money to fund an international private sector player. '*Why are you not passing this same money to other local commercial farmers, trying to make irrigation work? How do you justify that?'* This has affected the involvement of SADA in the project, influencing its real commitment (in terms of real time spent and actions taken) (SADA 2018).

Interviews confirmed the importance of project-related risks and the efforts made by the partners, with particular reference to IWAD, to overcome these. Interestingly, much of the focus of the respondents was on the financial aspects of and challenges in the project, the circumstances causing the financial risks and the implications of the financial risks. The perspective of the respondents added a richness to the information gleaned from the documentation review.

Table 2 did not identify financial risks (access, delays, height of prices as input), though these were substantial during the project period.

Finally, the focus was on the project / political risks related to (the different perspectives on) the involvement of the public partner - its voice in the governance structure, its financial contribution and the attention awarded to the project, as well as the political climate it has to face. The views on the participation of the public partner demonstrated the differences in interests and priorities on the part of the partners, also influencing the negotiations that have taken place. These were captured more in interviews, when respondents reflected on the nature of the relationship. The differences in interests were more visible in discussion with the two primary public and private partners: IWAD and SADA, the two partners taking the largest portion of the risk. Some of the issues remain unresolved.

4.5 Perceptions on the results of the project and the PPP

This section refers to the results achieved by the project, but in particular by the PPP. The purpose is to look more closely at the contribution of the PPP relationship to the outcomes of the project[28]. First, we refer to what is provided in the documentation, but then focus on the perception of the partners of the results and how the relationship contributed to these. Respondent referred to both the collective and individual efforts of partners.

These results are complemented with the results of a short questionnaire.

[28] We see here an important distinction: the contribution of the PPP relationship to the outcomes versus the contribution of the project to the outcomes. We refer to the former.

The PPP's final report provided a detailed report on the outputs, outcomes and some initial indication of the impact of the project.[29] Outcomes were categorized under knowledge and research capacity gained and available, the efficient use of water for agriculture, improved access to clean drinking water and sanitary facilities, and sustainability indicators (FIETS: financial, institutional, environmental, technical and social). The text also refers to and describes specifics such as the fact that[30]:

- The project has been implemented and IWAD has been established and is a stable company
- Flooding has been reduced
- There is secure access to irrigation water
- There is success access to farm inputs
- There is increased participation of women in the farmer's groups
- There is increased productivity for smallholders and out-growers
- Improved land and water management technologies have been introduced
- There is now access to high quality agricultural extension services
- Up to date knowledge and research capacity is available in Northern Ghana

Interviews confirmed the points above. Respondents concurred with the results listed and the concrete results on the ground, something that could ultimately be the basis for scaling up and that could have meaningful impact in this region in northern Ghana. (IWAD, Rebel, SADA, Alterra 2015, 2017, 2018).

In the interviews on outcomes and achievements of the project, the respondents demonstrated different priorities related to the outcomes, linked also to the differences in their objectives and institutional interests. IWAD (and Rebel) have been (and still are) in the project for commercial gain (still to be achieved) while SADA places a priority on the developmental benefits of the project, from its perspective, the most important achievement of the project. Interesting, however, is the complementarity of the interests.

"The thing is, the project has serious developmental benefits. Serious, even as a model for irrigation, it is showing that you can do irrigation differently. When the role of the state and the private sector will be more clearly defined. So, we can scale this up. When we are trying to encourage other investors, we want to show that it is possible to do it in the dry part of Ghana, northern Ghana. We take them to IWAD. And the developmental impact is huge. And that is the only thing the state is entitled, especially with agriculture, to expect." (SADA 2018)

One developmental benefit of the project relates to Yagaba, the town in which the project is located. The respondents concurred that the investment on the part of IWAD in facilities and accommodations, couple with the investment in access to the area on the part of SADA, acted as a leverage for other investments,

[29] IWAD Final Report 09/05/2018, various sections, also table on Output, Outcomes and Impact, pg. 30 – 36.
[30] Please refer to the following sections of the outcome and impact assessment for more detailed measures of outcomes/impacts.

in a hotel, stores and a bank. The town has grown, changing the nature of Yagaba and its position in the region. The growth has produced jobs, and the more of the local community are employed (Interviews and project documentation 2015, 2018).

For Alterra, the organization was interested in the nature, quality and amount of capacity built, as well as research executed/knowledge created. Alterra was positive on the results, with particular respect to the contribution of capacity building to project outcomes, stating that there was more demand for training and capacity building than could be met, and that the project had helped to develop knowledge and research capacity in Ghana (Alterra 2017, 2018). Other respondents were positive on the results but more critical of the role of Alterra.

One private respondent referred to the success of the model developed by the partners. This was an idea put together prior to the grant and was developed to apply for grant funds:

"It was a great opportunity to promote the use of an instrument that the private sector can use more. Our model is important if the subsistence farmer is to have the chance to develop into a semi-commercial farmer. . . This model allows us to work with a large group of farmers, where we also said. "Ok, we are on your land, everyone is invited, but you have to follow our recipe". And because we have the grant, we are able to train them more. We established the demonstration plots where farmers could learn, and this was especially in relation to the farmer conservation practices. It was never out intention to get a credit package for that one. It was about the demonstration project, learning and then applying the technology in the field." (IWAD 2018)

The outcomes were achieved because of the ability of the partners to adapt. The partners recognized the difficulties faced; as well as the need of the project to be flexible in the face of many challenges. One private respondent commented on the need to adapt the model and the innovations planned: the model, innovations and the technology, though relatively simple by European standards, was too complicated for the farmers to grasp. That coupled with the variety of other risks mentioned before, required making adjustments and a shift to conservation farming (IWAD, Alterra 2015, 2017, 2018). The partnership was able to adjust to these.

A short questionnaire was used to complement the qualitative aspects of the interviews; it probed into the partner's satisfaction with results of the PPP, and the extent to which the goals of their organizations were met by the PPP. Please see Table 3 below (points 1 and 2). Respondents were asked to rate on a scale of 1- 5, 5 being the highest. The result provided are a simple average of results.

The results demonstrate that the partners, for the most part, gave a high score when referring to the goals of their organization being met. However, there was some reticence when referring to the results of the collaboration, on both the public and private side.

Table 3 Outcomes of the PPP and Added Value of the PPP

	Outcomes	Mean
1	I am satisfied with the results of the collaboration/project	3.90
2	The goals of my organization were met by the partnership	4.10
	Added value	
3	The partnership led to additional investments than would not have occurred if my organization had worked alone	4.75
4	The collaboration created a number of innovative ideas, concepts and plans	3.70
5	Working together reduced the amount of risk borne by each of the partners	3.63
6	Working closely together led to improved cooperation between partners	3.67
7	Working closely together led to improved coordination of project elements	3.60
8	Working in partnership led to long processes of decision making and additional transaction costs	2.00

Respondents were also asked to reflect on the benefits or added value of the PPP (statements 3 -8). The added value often cited in the literature is that working closely together in a PPP can result in innovative ideas, extra investment of resources by the partners, reduction in risk borne by partners, and improved cooperation/coordination. What is also often argued is that the very fact of working together adds to time, delays and added transaction costs (negative aspects), also tested in the last statement (8). These benefits are discussed further in the next section.

4.6 Value added of the PPP

The added value of the PPP[31], as argued by the partners, stemmed from the complementarity of the expertise that the partners contributed to the project (which was then argued to ultimately lead to improved outcomes on the ground). A respondent at IWAD stated that the partners of the PPP were able to bring on board expertise that was not available within IWAD. From IWAD's perspective, this brought about value for money, namely saving on project costs (by reducing) duplication of tasks/duties that could be carried out by partners (IWAD 2015, 2018, Rebel similar 2015, 2018). Other partners mentioned the benefit derived from the mix disciplines and skills, the added valued to the execution of the project (Multiple respondents).

The proposal argued the complementarity of partners as a benefit:

[31] What was achieved by the PPP in contrast to what would have been achieved if parties had worked separately

"The roles and mandates of the partners in the PPP are complementary, with Wienco [IWAD] being responsible for the overall management of the PPP. SADA will have a largely facilitating role in engaging with all regulatory and licensing authorities of Ghana to ensure that the project operates within the scope of the law.[…] Alterra will bring in the latest expertise on water and agriculture and contribute to the field operations and to the development of the local capacity in watershed management and irrigation practices. RebelGroup's role will be to provide financial and planning expertise not only for the execution of the project, but also to develop financial and contractual interfaces for the up-scaling of the project, in support of the ambition of the Government of Ghana to use PPP's as a model for the delivery of infrastructure projects" (Project Plan, p. 6)[32]

The partners still concurred with the definition of the roles in the proposal and the added value that came from the bundling of knowledge and skills. IWAD was/is perceived as having been the central and driving force behind the partnership; but also, as a capable, local entrepreneur that has brought together the consortium ('the linking pin'). Respondents also underlined the importance of the long-term presence and commitment of IWAD to the venture, bringing stability beyond the length of the FDW project (Rebel, Alterra 2017, 2018). From the beneficiaries' point of view, for instance, IWAD is the only implementing agency of the project.

The added value of the role of Alterra was perceived in a capacity dimension, namely that without the knowledge transfer the farmers would not be provided with skills necessary to implement the project. The focus was on building the institutional, organizational and technical capacity to execute innovative irrigation solutions, to enhance practical skills on the part of the farmers, and to improve the research capacity of the Ghanaian education institutions, as long-term support to the project. The opinions on the role of Alterra were mixed, some respondents were critical of Alterra, stating that the organization did not understand the reality on the ground, could have done more, taking a more integrated perspective. Of importance here is the fact that capacity building, via the FFS, was regarded as an essential aspect of the project, and that in the long run, the role of the local knowledge institutions grew.

Rebel brought the project is financial know-how, transaction and upscaling advice.

Despite the issues with financial obligations, SADA's role as a public institution was crucial. Some respondents stated that the project could not have been done without the institution (Rebel, Alterra, 2015, 2017, 2018). SADA took a lead role in facilitating relationships and reducing bureaucracy. As an example, with reference to the imports of irrigation equipment and machinery (i.e. tractors), SADA facilitated the process by granting the partnership custom exemptions under its development agenda. IWAD was able to

[32] Appendix I: Project Plan Sustainable Water Fund (October 2012). Title: Integrated Water Management and Knowledge Transfer in Sisili Kulpawn Basin (FDW/12/GH/02)

clear equipment without paying taxes: SADA is by law exempt from tax, and this benefit therefore attributed to IWAD as a partner. It is within SADA's mandate to facilitate the private sector in the northern zone and when needed, SADA was able to apply laws that empower it to make certain decisions. Institutionally, moving forward was made easier for the partnership and this kept transaction cost lower (Interview IWAD 2015, 2018).

SADA also took the lead in facilitating relations with other government institutions such as the Ministry of Fisheries and Agriculture (MoFA) and the Ghana Irrigation and Development Authority (GIDA). Whereas IWAD would normally have unilateral relations with these organizations, with the partnership, SADA handled much of the communication with these institutions. In addition, SADA was able bring certain issues to the attention of the MOFA and GIDA. When there have were challenges, IWAD depended on SADA to channel concerns and to ensure they were addressed (Interview IWAD 2015, 2018).

Respondents confirmed that this contrasts to projects in which the government agency was not a partner, namely that the reduction in bureaucracy, the time it takes, and the related transaction costs would not have been achieved without the involvement of SADA (Multiple respondents 2015, 2018).

With regard to the PPP stimulating innovation, an aspect seen as an added value of a PPP, some respondents interviewed concurred that the partnership led to innovation, mostly on the private side (Multiple respondents 2018). Two private respondents and one public respondent indicated that they would have expected more innovation (IWAD 2018). The score from the questionnaire (3.7) reflects these perspectives.

When assessing whether working together stimulated more investment that was originally anticipated, respondents agreed that both the public and the private sector made additional investment that would not have occurred without the PPP. This is evident in the unanticipated investment by the private sector in solar, in the housing and accommodation, and the opening up of some roads. The government as well, invested in roads, bridges and to bring in the grid power to Yagaba, all unanticipated investments. (IWAD, SADA, Rebel 2015, 2018). Alterra also stated that IWAD was willing to invest an extra amount in research and knowledge development than was originally planned (Alterra 2017). These perspectives are confirmed in the results of the questionnaire (4.75)

When asked on the added value of the PPP, some answers focused on the growth in the relationship, the ability to interact, even when facing adversity. This was then cited as an added value: the ability to negotiate and make decisions effectively were argued to lead to better outcomes and lower transactions costs (Rebel 2018). One private sector and one public sector respondent stated that the relationship was/is

'cordial', even if partners do not agree, they are still working together and working things out. (IWAD, SADA 2018). Another respondent further described the benefit of a relationship where the partners came to know each other (as individuals) and have developed a way of working together (improved cooperation), with knowledge of each other competences (Rebel 2018). This was argued to aid in the execution of activities.

The questionnaire asked the respondents to comment on whether working closely together led to improved cooperation and coordination between partners (one would expect this is in an effective interaction, as mentioned above). The results of the questionnaire were inconclusive (3.76, 3.6); in particular, the public sector was very critical of the coordination with the private sector, while was not quite so critical of aspects of cooperation (SADA 2018). When asked whether working in partnership led to long processes of decision making and additional costs, the responses were also mixed. One private respondent commented, in particular, on the time it took for others to respond to communications as something that influenced decision making, causing time delays (IWAD 2015, 2018).

With reference to sharing of risk, one aspect argued to be a major added value of PPPs, though respondents agreed that the project could not have been possible without the sharing of the risk (also the risk taken by RVO), they also all concurred on the fact that risk was at time unevenly distributed. IWAD was, as in previous section had particularly strong feelings on this point. These results are mirrored in the questionnaire (3.63 in Table 3).

The conclusion is when looking at the results of the interviews that the benefits revolve around 1) the bundling and sharing of expertise, the interdependence between partners, the amount of additional investments made. More mixed responses related to improvements in coordination / cooperation, and reduction of transaction costs as a result of the PPP. Increased innovation was also mentioned in the form of the new technology that IWAD brought with it.

4.7 Views on the sustainability of the intervention and the results.

Section 2.41 of the project plan[33] refers to the sustainability of the intervention and the results of the PPP. The sustainability indicators used follow the FIETS criteria (financial, institutional, ecological, technical and social). [34]

[33] Appendix I: Project Plan Sustainable Water Fund (October 2012). Title: Integrated Water Management and Knowledge Transfer in Sisili Kulpawn Basin (FDW/12/GH/02), pg. 32

[34] Please note that the issue of sustainability will analyzed further in 2019. These are initial conclusions from the documentation and interviews.

The financial sustainability of this venture has been central to project activities. The work plan refers to the role of Wienco as a stable entity in Ghana as being essential and to a business model that will guarantee profitability after 10 years. The information provided in previous sections underline the struggles to create a stable financial situation. Progress Reports and the Final Report[35] use as one of the FIETS indicators the number of farmers that have reached break-even and confirm that all maize famers made losses in 2017, while 54.3% of irrigation and rain fed farmers made a profit in 2017. However, as stated before, the position of IWAD and its commitment to developing and continuing with this endeavor over the longer term, to test out different models (rice production) as well as innovations (solar) in reducing input prices to the production process, have all contributed to the potential, future financial sustainability of the project. The role of the project partners, in capacity building and knowledge development as well as strategies to scale up have also contributed to creating a model that will function in the future (multiple interviews 2018).

Institutionally, the original work plan refers to the need for policy support and to the governance structure and institutional relations as shown in Figure 3 as factors to achieve sustainability. Progress reports refer to the national policies (PPP, employment water, industry, seed and land policy) as being supportive policies that also ensure sustainability. Respondents also confirm SADA's role in facilitating institutional relations and approval processes, something that is expected to continue in the future. As mentioned before, the institutional set up has altered, and the nature of SADA's participation in IWAD is still to be finalized. As participants in the PPP, however, all of the partners are interested to continue to take part over the longer term. This provides institutional stability. One respondent commented on the need to perhaps search for another entity (as opposed to Alterra) within Wageningen University to manage the capacity building and knowledge development component. The local knowledge partners have developed but have room to grow. They remain important partners for IWAD in the field. Project partners also confirmed that the current institutional set up (farmers associations, etc.) of the beneficiaries of the project will be maintained and developed over the longer term.

Ecological and technical sustainability have both been key elements of the project design and execution. The work plan refers explicitly to the potential environmental risks, these has also been taken up in the progress and final reports along with the measure to mitigate these. The same is true for the technology in the project. The work plan refers directly to the technology to be used and the activities needed to put this technology into use. Management systems at different levels, capacity building as well as financial

[35] IWAD Final Report 09/05/2018, page 32

sustainability are regarded as essential to make the technology effective. The project has, in fact, put all these in place, though there have been some reservations, even with capacity building, about the ability of the farmers to grasp and put to use the technology provided. Keeping up with long term maintenance costs will be essential[36].

The work plan underlines the need for change in attitudes to achieve social sustainability. Capacity building (also in gender sensitivity) and a participatory approach, as well as membership in farmer associations were seen as essential to achieving attitude change and creating the interest among farmers to participate in the scheme. Interviews confirm that social change, acceptance and commitment have been a challenge to date, and still remain so. The partnership has instituted a monitoring and evaluation process, including outcome mapping to monitor social change in key stakeholders. The outcome mapping (of the famer's associations, worker's associations, traditional authorities and the District Assemblies as essential actors needed to achieve sustainable results) has recorded some progress in achieving change, with substantial room for improvement.

A more detailed sustainability analysis will take place in the summer of 2019.

5. Results

A first assessment of the impact results shows the analysis of the project uptake and the characteristics of smallholder farmer households to measure the direct outcomes of the intervention. In a second step, intermediate and mid- to long-run impacts measuring the impact of the project on target indicators, will be analyzed and discussed using the DiD estimations.

5.1 Measuring Outcomes

The two different interventions, irrigation and FFS, had a technical, construction-related component and a capacity building component.

The development of irrigation infrastructure through the building of an irrigation dam, pumping station, bulk water infrastructure and irrigation systems was finished on time in summer 2015 to start the rainy season with first trails of crops.

The knowledge transfer program in form of FFS training already started in the farming season 2014. Eight treatment villages were added in the 2015 farming season. One originally planned village (total 23) was

[36] More extensive financial analysis to be provided later in 2019 as part of the sustainability assessment

never treated because it rejected IWAD to be active in the village. This village was dropped from the sample, so that 48 villages remain.

A restructuring of the FFS took place in 2016 when IWAD decided to deviate from the plan of supporting the cultivation of five different crops to now focusing on rice only. In 2014 and 2015 both, rice and maize farming, were promoted. The other three crops (soya, sorghum and cotton) were never grown by CA farmers.

A further strategy change was that in both interventions, irrigation and CA, farmers were supposed to organize themselves in groups and form farm cooperatives for knowledge transfer and establishing an agriculture business. However, experience of IWAD in the first years showed that an individual based approach is more feasible because farmers are not willing to form groups and share risks.

In 2016, the number of treated FFS villages dropped substantially (see Table 4). IWAD attributes this to a restructuring process that started by then. As the numbers show, before 2016 fewer farmers were treated in more villages. After 2016, more farmers were treated in fewer villages. Since 2016, farmers of FFS were trained only on cultivating rice because farmers had more experience and marketing prospects were better. The program supporting maize cultivation was handed over to Masara N'arziki Farmers Association (MAFA). This is a farmer cooperation program initiated in 2005 by Wienco (Ghana) Ltd., initially also a partner of this project, financed by the Dutch Sustainable Entrepreneurship and Food Security Facility (Sustainable Maize Program in Northern Ghana). Masara N'arziki is active in 10 treatment villages and 12 control villages in 2018.

Despite the restructuring process, the total number of 810 IWAD treated farmers is far from the goal of 3000 farmers benefitting from the project. The numbers in parenthesis show the individuals and households represented in the analyzed household sample. Worth mentioning is that sometimes two household members participated in the IWAD training and also requested inputs. However, the number of households in this category is too small to do a separate impact measurement.

Nevertheless, the FFS were open to anyone and farmers might have gained knowledge on the five crops in the FFS in 2014 and 2015. Farmers can use this knowledge to grow these crops on their own fields. Therefore, measuring the treatment by village (intention to treat =ITT) is reasonable and we will also include maize for impact maize measurement. Additionally, the analysis will measure the impact on the actually treated farmers (average treatment effect on the treated =ATE). Those farmers will have followed the training by IWAD and received inputs for credit to be paid back in form of produce.

The treatment of villages is distributed as follows over the years 2014 to 2017:

Table 4 Distribution of FFS treatment over the years

Year	2014	2015	2016	2017	Total
Number of FFS villages	13	21	3	10	21
Total IWAD treated farmers with FFS (individuals in sample/households)	0	186 (57/46)	188 (10/8)	436 (48/36)	810 (108/82)
Total treated farmers with irrigation in four irrigation villages (individuals in the sample/households)	0	66 (4/4)	118 (18/14)	86 (11/10)	266 (22/18)

First, the question arises how farmers signing up for the IWAD intervention differ from those farmers not signing up. Therefore, we will take a look at basic household and farming characteristics at baseline and compare these characteristics between uptake and non-uptake farmers in the 21 treatment villages. For this purpose, we will make use of the supplementary sample to analyze different characteristics using more observations. This sheds light on the dissimilarities between effectively treated and not treated households.

Table 5 Comparing characteristics of treated and not treated households in treatment villages

	Not treated	Treated CA	p-value difference	Treated Irrigation	p-value difference
Farming characteristics					
Number of crops planted	3.07	3.96	0.00	2.86	0.01
Number of crops harvested	2.79	2.56	0.29	1.68	0.00
Land cultivated in acres (1 acre=0.4 hectare)	12.49	12.73	0.82	11.25	0.23
Women in HH that have farming as a main or secondary activity	0.64	0.70	0.59	0.57	0.41
HH cultivates maize	0.96	0.99	0.01	0.98	0.89
HH that harvested maize	0.95	0.94	0.84	0.98	0.32
HH cultivates rice	0.23	0.41	0.09	0.05	0.00
HH that harvested rice	0.20	0.36	0.11	0.02	0.00
Use of improved seeds	0.03	0.67	0.00	0.48	0.00
Use of any kind of chemical	0.87	0.98	0.00	1.00	0.00
Use of fertilizer	0.46	0.79	0.00	0.84	0.00

Use of herbicide	0.73	0.96	0.00	0.93	0.02
Use of pesticide	0.59	0.77	0.01	0.82	0.00
Household characteristics					
Household size	7.62	9.44	0.00	9.18	0.04
Age of household head	44.25	46.59	0.26	41.27	0.01
Basic education of household head	0.06	0.07	0.59	0.09	0.07
Female household head	0.03	0.03	0.71	0.07	0.00
Annual food expenditure	5,378.09	3,929.9	0.00	4,356.5	0.07
Total annual expenditure	7,020.24	6,056.4	0.06	6,174.2	0.11
Top two quintiles of asset index	0.35	0.22	0.034	0.21	0.07

Source: FDW Ghana baseline survey 2015 including the supplementary sample.

Table 5 shows the numbers of CA treated farmers in the left panel and irrigation treated farmers in the right panel. There are considerable differences between households that signed up for the program (CA and irrigation) and those who did not. Treated households have more practice in farming with all chemicals, fertilizer, herbicides and pesticides and the use of improved seeds instead of traditional seeds kept from the last harvest. Also, CA treated farmers have more experience in rice farming while irrigation treated farmers have less experience. For the CA treatment the numbers confirm the selection strategy of IWAD as the program aimed to work with more experienced farmers in rice cultivation.

In terms of household characteristics, the two groups do not differ substantially, but treated farmers live in larger households, have lower expenditure in general and on food, and do not belong to the group of wealthier households. In irrigation farming households, on average, household heads are a bit younger and more educated.

These first results on the uptake are important to be kept in mind for the following analysis on intermediate and long-run impacts of the project.

5.2 Intermediate Impact

This section reports the results on the link between the project and the intermediate impacts of the project. For all dimensions, the DiD regression coefficients β_3 of equation (1) and (2), the ITT and the ATE, are presented in the first two columns. The latter four columns show the mean values in the treatment and control group at baseline and follow-up, respectively. The quantitative empirical findings will be supported by the findings of the qualitative interviews of the FGDs conducted in March 2018.

We report the results of the two major crops in the area: maize and rice. The analysis on cotton, soya and sorghum, which were promoted crops by IWAD in the beginning, will not be reported as there were no

significant changes in the cultivation, processing or selling activities among the farmers. No farmer in the sample cultivates cotton and the numbers for soya and sorghum cultivation are very low.

5.2.1 Farming characteristics

In this section, results on the basic farming characteristic, land allocated to the crops maize and rice are presented. We analyze crop cultivation on a more aggregate level before turning to single crops.

With regard to the number of crops planted and harvested in total, there is no significant effect for either the ITT villages or ATE households. In general, farmers in treatment villages report less agricultural shocks (drought, flooding, pests and insects) in the last year, but there is no particular project effect for treated households, see Table 6.

Concerning land holdings in general and land allocated to maize and rice, there is an increase in land used for maize cultivation in treatment villages but not for treatment households specifically. The land indicator is measured in acres, the standard unit of land measurement in Northern Ghana, and farmers cultivate on average around 12 to 16 acres, representing around 5 ha. This is a representative size for smallholders in general.

On further farming characteristics as crops like maize and rice cultivated and harvested, we do not find any changes. Farmers farming under a contract of the project, which was supporting maize and rice, seem not to change cultivation practices. Anyway, the growing of maize is widely practiced among almost all farmers, while rice is grown only by about a quarter of the sample. Nevertheless, the mean values show that rice cultivation is increasing among all groups, but there is not a significant effect of the change in treatment villages or households.

Table 6 Farm characteristics

	DiD ITT	DiD ATE	Control	Control	Treatment Village Level	Treatment Village Level	Treatment Household Level	Treatment Household Level
			Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Number of crops planted	0.075	0.051	3.22	3.21	3.33	3.16	3.96	3.27
Number of crops harvested	0.052	0.062	3.15	3.22	2.71	2.90	2.56	2.91
Number of agricultural shocks in the last year	-0.652**	-0.912	2.85	3.07	2.64	2.58	1.98	2.73
Loss due to agric. shock (GHC)	-416.201	-405.563	2,940.47	2,540.64	3,508.85	2,920.59	2,896.81	3,036.78

Land cultivated (1 acres=0.4 hectares)	0.987	1.320	11.90	13.79	12.56	15.86	12.73	17.30
Acres maize cultivated	1.018*	0.955	7.27	7.91	7.53	8.94	8.07	9.08
Acres rice cultivates	-0.765	-1.109	3.72	3.00	6.58	6.37	6.15	7.39
HH cultivates maize	-0.006	-0.023	0.92	0.95	0.97	0.98	0.99	0.99
HH that harvested maize	-0.016	-0.024	0.89	0.92	0.95	0.95	0.94	0.95
HH cultivates rice	-0.028	-0.010	0.13	0.19	0.29	0.32	0.41	0.45
HH that harvested rice	-0.001	0.082	0.10	0.15	0.25	0.29	0.36	0.42

Notes: The column "DiD ITT" and "DiD ATE" display the coefficients from the difference-in-differences estimation, controlling for baseline characteristics of the household (see Section 4.6 for details). ITT is the intention to treat effect, ATE is the average treatment effect on the treated. Robust standard errors are clustered at the village level. *, **, *** represent statistical significance at the 10, 5, and 1 percent level, respectively. The treatment mean values are presented for all households in treatment villages and respective treatment households. *Source*: FDW Ghana household surveys 2015 and 2018.

5.2.2 Farming Practices

Next, we turn to the results on farming practices. We show whether farmers have changed their farming and cultivation behavior in the course of the project. This is the first link in the chain to be a successful farmer practicing improved farming methods.

The first block in Table 7 reports results on the use of improved inputs in general, namely seeds, fertilizer, herbicides and pesticides. In treatment villages and for treated farmers, there is an increase in the use of improved seeds and the use of fertilizer. There are no significant effects for herbicides. Besides the general use of the chemicals, we created a variable that measures whether the farmers use chemicals recommended by the IWAD FFS. Often farmers use chemicals but not the appropriate ones. Here there are some interesting findings for pesticides. In treatment villages, farmers reduce the use of any pesticides but start using recommended pesticides. This holds for the treated villages and the treated farmers, respectively. The use of any other pesticides decreases in treatment villages in general.

The second and third block of Table 7 show the results on farming practices for maize and rice. With regard to the farming practices for the specific crops, there is a positive and significant effect on the use of fertilizer for maize cultivation in treatment villages and for treated farmers. For rice, farmers in treatment villages use more improved seeds, and thus reduce using traditional seeds. Farmers under IWAD contract increase the use of all chemicals for rice while for maize only the use of fertilizer increases.

Concerning the impact of the project on clearing fields after harvest we find no impact. Still more than 80 percent of farmers see `pile and burn´, as the appropriate method to clear the fields after harvest. Only 17 percent of farmers in treatment villages see mulching as the adequate method. This value did not change

over time (results not reported). Pile the remains of the harvest to burn them is still widely practiced among all farmers in the sample.

Table 7 Farming practices

	DiD ITT	DiD ATE	Control	Control	Treatment	Treatment	Treatment Household Level	Treatment Household Level
			Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Use of improved seeds for any crop	0.08***	0.13**	0.10	0.15	0.23	0.18	0.67	0.24
Use of any kind of chemical	-0.018	-0.03	0.74	0.84	0.91	0.96	0.98	0.97
Use of fertilizer	0.20***	0.20***	0.48	0.61	0.56	0.82	0.79	0.86
Use of recommended fertilizer	0.005	0.001	0.01	0.02	0.09	0.02	0.28	0.02
Use of herbicide	-0.036	-0.033	0.52	0.60	0.80	0.78	0.96	0.79
Use of recommended herbicide	0.004	0.005	0.03	0.04	0.04	0.06	0.03	0.06
Use of pesticide	-0.14**	-0.072	0.23	0.55	0.64	0.78	0.77	0.84
Use of recommended pesticide	0.06***	0.17***	0.01	0.03	0.01	0.10	0.01	0.14
HH used improved seeds for maize	0.034	0.029	0.07	0.10	0.17	0.10	0.46	0.14
HH used fertilizer for maize	0.20***	0.188**	0.51	0.63	0.53	0.81	0.65	0.83
HH used herbicides for maize	-0.019	-0.021	0.55	0.60	0.78	0.75	0.93	0.78
HH used pesticides for maize	0.021	-0.012	0.04	0.48	0.18	0.55	0.39	0.58
HH used improved seeds for rice	0.099*	0.137	0.03	0.07	0.28	0.17	0.57	0.21
HH used fertilizer for rice	0.155	0.256**	0.17	0.15	0.42	0.45	0.62	0.55
HH used herbicides for rice	0.176*	0.251**	0.55	0.43	0.74	0.74	0.88	0.80
HH used pesticides for rice	0.217**	0.418***	0.03	0.11	0.30	0.38	0.51	0.45

Notes: The column "DiD ITT" and "DiD ATE" display the coefficients from the difference-in-differences estimation, controlling for baseline characteristics of the household (see Section 4.6 for details). ITT is the intention to treat effect, ATE is the average treatment effect on the treated. Robust standard errors are clustered at the village level. *, **, *** represent statistical significance at the 10, 5, and 1 percent level, respectively. The treatment mean values are presented for all households in treatment villages and respective treatment households. *Source*: FDW Ghana household surveys 2015 and 2018.

5.2.3 Production

In this section the results of the farming output, namely the crop production, are presented. To determine the effect of the project on productivity, we include both, output in tons and the output per acre of land.

There is a significant increase in the production of maize and rice for both treated villages and treated households. Maize production increases in treatment villages but the effect also stems from the treatment of Masara N'arziki reported in section 5.1. As an evaluation of the details of the Masara project is beyond the scope of this study, we see increases in maize production in general in these villages but cannot connect the results to the specific inputs of the project (use of chemicals or other farming practices …).

The second block of Table 8 reports the results of rice farming activities. Both the ITT and ATE are significant for general rice production measured in tons. Especially the ATE effect for rice is large. Farmers farming under a contract of IWAD produce about 2.3 tons more rice per season and almost half a ton more per acre than the control group. Also, other, non-contract, farmers in treatment villages produce about one ton more than the counterfactual, shown by the positive and significant ITT effect. There is also an increase in productivity as the coefficient on tons of rice produced per acre is positive and significant.

The ATE is always larger than the ITT, indicating that the project is effective in increasing output for farmers under contract. This increase in output is mainly the result of intensification in agriculture, i.e. the use of improved inputs, mainly chemicals, especially for rice. For maize the increase in yields is a mixture of the use of improved inputs and the extension of land (see Table 6 and 7).

Table 8 Farm production

	DiD ITT	DiD ATE	Control	Control	Treatment	Treatment	Treatment Household Level	Treatment Household Level
			Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Maize								
Tons of maize harvested	0.61***	0.91***	1.21	1.28	1.23	1.88	1.77	2.41
Tons of maize harvested per acre	0.043	0.127**	0.19	0.21	0.26	0.25	0.47	0.34
Rice								
Tons of rice harvested	0.93**	2.34***	0.68	0.59	1.34	1.81	1.86	2.23
Tons of rice harvested per acre	0.185**	0.46***	0.22	0.22	0.53	0.41	0.91	0.53

Notes: The column "DiD ITT" and "DiD ATE" display the coefficients from the difference-in-differences estimation, controlling for baseline characteristics of the household (see Section 4.6 for details). ITT is the intention to treat effect, ATE is the average treatment effect on the treated. Robust standard errors are clustered at the village level. *, **, *** represent statistical significance at the 10, 5, and 1 percent level, respectively. The treatment mean values are presented for all households in treatment villages and respective treatment households. *Source*: FDW Ghana household surveys 2015 and 2018.

5.2.4 Valuing Production

In this section, the results on the monetary value of the harvest, sales and its utilization for home consumption and payment for labor are presented. All values are self-reported by farmers as the collection of market prices showed very inconsistent price patterns between the different sources of data collection (Ministry of Food and Agriculture, Ghana Statistical Services, University of Development Studies Tamale, IWAD). Therefore, we decided to stick to the self-reported values of farmers (the price average for the maize 100 kg bag is GH₵ 77 in 2015 and GH₵ 102 in 2018; the price for the rice 100 kg bag are GH₵ 70 in 2015 and GH₵ 94 in 2018).

In general, there is a positive impact of the project on the total value of all harvested crops, maize and rice. We also include the numbers on the total harvest as there might be spillovers, as e.g. the use of chemicals,

of the FFS to other crops. In project villages, there is a positive impact on sales of maize, but not for farmers contracted under IWAD. Labor payment in terms of all harvested crops and for maize specifically increase for contracted farmers, probably because they have to employ labor to work on their other fields as they have to work on the IWAD farmland. Rice kept for home consumption increases for CA farmers as well. Another issue is that, with the sample the number of treated farmers who reported to have harvested and sold rice in the last farming season is only about 40 farming households, so halve of the total treated farmers (see Table 4). Other farmers kept the whole harvest for home consumptions, as it is typical for subsistence farmers. Therefore, the estimates lack statistical power to find a significant impact and just give an idea about possible numbers.

The question arises, why there are no increases in sales for IWAD farmers although production has increased? For answering this question, we will make use of the information given in the quantitative survey but also the qualitative results of the FGDs. There are several reasons which can explain this result: Although farmers have increased yields (see Table 8) which increases the value of the harvest (Table 9), they have to repay inputs in form of produce. For rice this was 24 small 50 kg bags in the 2017 season equal to 920 GH₵, i.e. one bag worth 38 GH₵. As reported in the FGDs, sometime farmers didn't produce enough on the IWAD contracted fields to repay the credit, so they remained indebted. In this case, IWAD founded a buffer account and the farmer started with a deficit in the next season because repayment in cash was not appreciated by the farmers. Additional produce could be sold to IWAD for a price of 35 GH₵ per 50 kg bag and farmers made use of this instrument. But obviously the price per bag offered by IWAD is low, even lower that the price IWAD used when inputs were paid.

However, the 35 GH₵ paid per small bag of rice, is a rather lower bound price, according to the (rather inconsistent) price data we collected from other sources. The market price for a small bag of rice is according to the different data sources between 50 to 60 GH₵ (depending on which market it was sold, e.g. Tamale is rather 60 GH₵ but also transport costs are higher).

Expectedly, farmers were not happy with the price offered by IWAD but sold anyway. This is not necessarily rational but shows that most farmers, in general, were satisfied with the work of IWAD. In the FDGs, farmers indicated that they sold to IWAD because they felt liable as IWAD also *"did something for them"*. i.e. providing knowledge and inputs.

The price farmers had to pay for inputs (number of harvested bags) and the offered price by IWAD for selling the produce is quite a conflict-prone topic among farmers: Farmers complain that the price paid for inputs after harvest (in bags of produce) and in case of sales of produce was not communicated by IWAD

to them at the beginning of the season. However, IWAD reported that at the beginning of each season a document indicating all costs and prices was handed out to farmers. Although farmers might have received the document with the cost details, farmers did not really understand the repayment system. Most farmers are illiterate; hence, they may not fully understand the terms in a document or bill. Solely handing over a document or bill does not mean too much to farmers, especially if the payment will be realized in the future and not immediately. Farmers need to be sensitized on the content of documents.

The price of one bag of maize or rice paid by IWAD might have been slightly lower than the market price farmers would have gotten if they had sold on the open market. IWAD justifies the lower market price with the risk they have to bear, own transport and storage costs, which is a reasonable objective. Another issue is that farmers might get higher prices if they sell themselves, but they also have to pay for transport, which they often don't take into account when thinking about sales prices. Moreover, farmers use the time at the market also for other things, not only selling their produce (purchasing goods for themselves, socializing with friends and family). A further issue is that farmers seem not to be aware at the beginning of the farming season that there is a time lag between the harvest and reception of payments by IWAD. IWAD collects the yields immediately after the harvest is done, but pays farmers only a few weeks or months later, once the company realized sales. This issue really disappointed farmers and made them skeptical towards working with IWAD in the future.

In general, changes in farming behavior are visible, especially the (appropriate) use of chemicals has increased. This increase in chemical use likewise translated into an increase in production of maize and rice and also increased productivity measured as output in tons per acre. However, the improvements did not convert into increased sales as farmers have to repay inputs in form of produce. In one FDG farmers stated that they feel they *"only work for IWAD"* and don't have time for their other fields.

Table 9 Harvest utilization in GH₵ values

	DiD ITT	DiD ATE	Control	Control	Treatment	Treatment	Treatment Household Level	Treatment Household Level
			Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Total harvest (GHC)	45,620.643**	131,274.716**	75,091.80	91,798.39	70,660.26	137,126.83	90,431.55	192,567.26
Total harvest sold (GHC)	6,705.968	18,827.714	23,819.83	24,377.80	16,016.24	26,498.48	12,532.13	34,033.11
Total home consumption (GHC)	3,777.443	11,592.530	21,238.71	30,686.97	18,081.85	31,595.90	21,783.01	38,401.69
Total labor paid in-kind (GHC)	440.195	3,607.163**	3,068.45	4,991.28	6,150.01	7,204.62	9,763.56	8,987.96
Maize								
Maize total harvest (GHC)	20,830.797**	32,246.294***	22,308.82	29,303.41	21,231.20	48,671.88	35,334.83	65,715.86
Maize Sales (GHC)	4,058.155**	3,699.527	4,394.10	3,809.79	2,342.37	6,410.47	3,206.34	8,475.08
Maize kept for home consumption (GHC)	3,267.531	2,425.716	8,182.02	13,265.97	8,668.55	16,556.99	13,578.85	20,184.84
Maize in-kind labor payment (GHC value)	432.662	1,101.946*	589.92	1,139.87	1,079.35	1,846.92	2,037.99	2,483.35
Rice								
Rice total harvest (GHC)	16,901.541***	33,216.162***	7,565.41	4,059.68	16,082.62	25,656.17	23,398.95	32,225.08
Rice sales (GHC)	6,939.941	8,976.034	935.09	2,920.84	4,704.31	12,559.84	6,058.76	12,712.32
Rice kept for home consumption (GHC)	1,996.965	5,512.629*	2,957.64	2,617.45	3,810.34	5,277.93	4,014.68	6,488.65
Rice in-kind labor payment (GHC value)	1,729.272	3,469.796	1,253.98	1,127.72	4,141.98	2,762.58	8,052.64	2,655.76

Notes: The column "DiD ITT" and "DiD ATE" display the coefficients from the difference-in-differences estimation, controlling for baseline characteristics of the household (see Section 4.6 for details). ITT is the intention to treat effect, ATE is the average treatment effect on the treated. Robust standard errors are clustered at the village level. *, **, *** represent statistical significance at the 10, 5, and 1 percent level, respectively. The treatment mean values are presented for all households in treatment villages and respective treatment households. *Source*: FDW Ghana household surveys 2015 and 2018.

5.3 Mid- to Long-run Impacts

In this section, we represent the results of mid- to long-run impacts on expenditure and wealth, nutrition and anthropometrics and gender roles. However, as there are very few intermediate impacts, it is not very likely to find long-run impacts.

5.3.1 Expenditure and Wealth

Table 10 reports results on several wealth and finance related aspects. The mean values show an overall increase in expenditure and savings and a drop in poverty, measured as the population in the bottom two quintiles of the total expenditure distribution. The uptake of loans is very low ranging from 2 percent in the control to almost 5 percent in the treatment group in 2018. This is due to the very low coverage rate with banks and other financial services.

The reason why there are no effects of the project on expenditure and wealth is that there were no effects of the project on sales of harvest. Without additional money from the harvest, household cannot improve their wealth position. The coefficients have a negative sign which also partly stems from a slight reduction in food expenditure (see section 5.3.2).

This indicates that the project had no effect on income or poverty.

Table 10 Expenditure and use of financial services

	DiD ITT	DiD ATE	Control	Control	Treatment	Treatment	Treatment Household Level	Treatment Household Level
			Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Total annual expenditure	-55.737	-229.238	7,137.42	7,600.50	6,736.84	7,509.46	6,056.42	7,784.62
HH that has savings	0.046	0.055	0.11	0.14	0.11	0.20	0.16	0.29
HH that has loans	-0.011	-0.044	0.03	0.03	0.06	0.05	0.05	0.06
Poor HH (two bottom quintiles of expenditure)	-0.061	-0.088	0.27	0.20	0.33	0.19	0.31	0.15

Notes: The column "DiD ITT" and "DiD ATE" display the coefficients from the difference-in-differences estimation, controlling for baseline characteristics of the household (see Section 4.6 for details). ITT is the intention to treat effect, ATE is the average treatment effect on the treated. Robust standard errors are clustered at the village level. *, **, *** represent statistical significance at the 10, 5, and 1 percent level, respectively. The treatment mean values are presented for all households in treatment villages and respective treatment households. *Source*: FDW Ghana household surveys 2015 and 2018.

5.3.2 Nutrition and Anthropometrics

Table 11 reports results on nutrition-related outcomes. Food scarcity is a combined index, ranging from 0 to 1, of whether the household or any members had to skip meals or whether the household had to sell different assets to buy food. We see a drop in food scarcity in treated villages. The ITT is significant for the number of meals a household had in the last two days, the mean value of the treated households in 2018 is 5.9 within 2 days, so almost 3 meals per day. This effect can be the result of the increased amount of rice kept for home consumption.

On the child anthropometric measures, there are no significant impacts, but a decline in all scores can be seen. Food expenditure in the last week stays more or less constant over time but slightly decreases, however, the effect is not significant.

Table 11 Nutrition, anthropometrics and food expenditure

	DiD ITT	DiD ATE	Control Baseline	Control Follow-up	Treatment Baseline	Treatment Follow-up	Treatment Household Level Baseline	Treatment Household Level Follow-up
Food supply and nutrition diversity								
Food Scarcity	-0.073*	-0.125	0.26	0.22	0.23	0.15	0.18	0.16
Count of number of times household had meals in the last two days	0.059	0.246**	5.67	5.53	5.81	5.68	5.92	5.77
Anthropometrics								
Children in HH wasting	-0.028	-0.100	0.20	0.17	0.20	0.12	0.27	0.13
Children in HH stunting	-0.027	-0.004	0.34	0.33	0.41	0.39	0.41	0.45
Children in HH underweight	-0.001	-0.052	0.29	0.24	0.29	0.26	0.33	0.29
Food expenditure								
Food expenditure in Ghc for the last week	-7.241	-18.595	105.01	101.81	94.63	95.60	75.58	98.01
Market value of crops kept for home consumption	-256.395	-49.753	1,069.34	1,684.86	1,284.09	1,774.99	1,081.83	1,937.97

Notes: The column "DiD ITT" and "DiD ATE" display the coefficients from the difference-in-differences estimation, controlling for baseline characteristics of the household (see Section 4.6 for details). ITT is the intention to treat effect, ATE is the average treatment effect on the treated. Robust standard errors are clustered at the village level. *, **, *** represent statistical significance at the 10, 5, and 1 percent level, respectively. The treatment mean values are presented for all households in treatment villages and respective treatment households. *Source*: FDW Ghana household surveys 2015 and 2018.

5.3.3 Intra-household decision making and female roles

In this section we will discuss the impact of the project on the role of women. From the beginning on, the project supported women to become part of the contracted CA farmers. IWAD employed one social worker to encourage women to become an IWAD farmer and to strengthen their roles in general. The social worker visited treatment villages on a regular basis and supported women in forming female farmer groups and other associations. Also, the social worker participated in recruiting new villages for IWAD and supported activities concerning the village entry.

Table 12 shows that this strategy was effective as there is a significant increase in the number of women whose major or secondary working activity is farming, instead of a housewife or having no secondary activity. By increasing women's engagement in farming, women also tend to contribute more to farming-related decisions. However, this did not translate into an expected higher contribution of women to annual food expenditure.

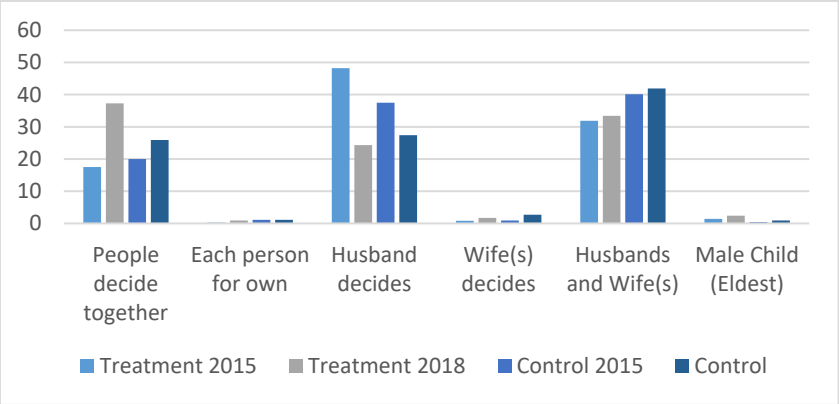
Table 12 Female roles

	DiD ITT	DiD ATT	Control Baseline	Control Follow-up	Treatment Baseline	Treatment Follow-up	Treatment Household Level Baseline	Treatment Household Level Follow-up
Women in hh that have farming as a main or secondary activity	0.527***	0.752***	1.07	1.24	0.66	1.36	0.70	1.50
Share of female contribution to annual food expenditure	-0.127	-0.065	0.25	0.51	0.30	0.40	0.37	0.42

Notes: The column "DiD ITT" and "DiD ATE" display the coefficients from the difference-in-differences estimation, controlling for baseline characteristics of the household (see Section 4.6 for details). ITT is the intention to treat effect, ATE is the average treatment effect on the treated. Robust standard errors are clustered at the village level. *, **, *** represent statistical significance at the 10, 5, and 1 percent level, respectively. The treatment mean values are presented for all households in treatment villages and respective treatment households. *Source*: FDW Ghana household surveys 2015 and 2018.

With regard to intra-household decision making, we will first look at farming related decisions before turning to nutrition-related decisions. Concerning land use decisions, i.e. decisions about buying, renting or selling land, there is a significant drop in the husband being the sole decision maker, see Figure 5. In treatment villages in 2018, the land decision is rather made by the members of a household together compared to control villages where it is rather a decision of husband and wife. This does not point to a higher female participation in land decisions, but at least these decisions seem to be rather made collectively.

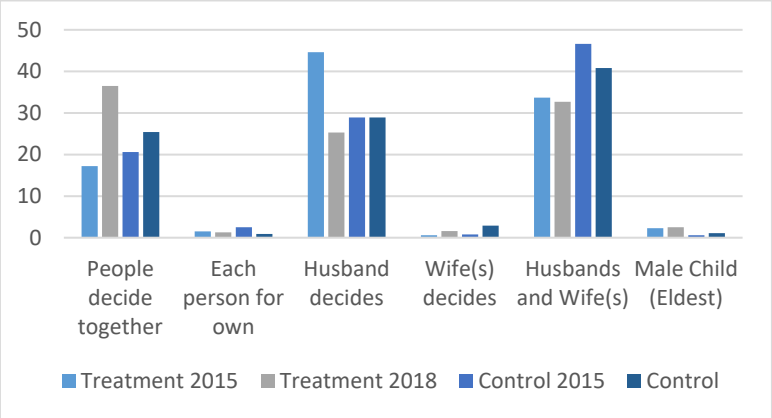
Figure 5 Decision about land use (rent, buy, sell)



Note: Mean values in percent. Source: FDW Ghana household surveys 2015 and 2018.

With regard to crop farming decisions there is a similar pattern, see Figure 6: There is a clear drop of the husband, usually the household head, being the only decision maker towards the crop decision being made commonly by the household members.

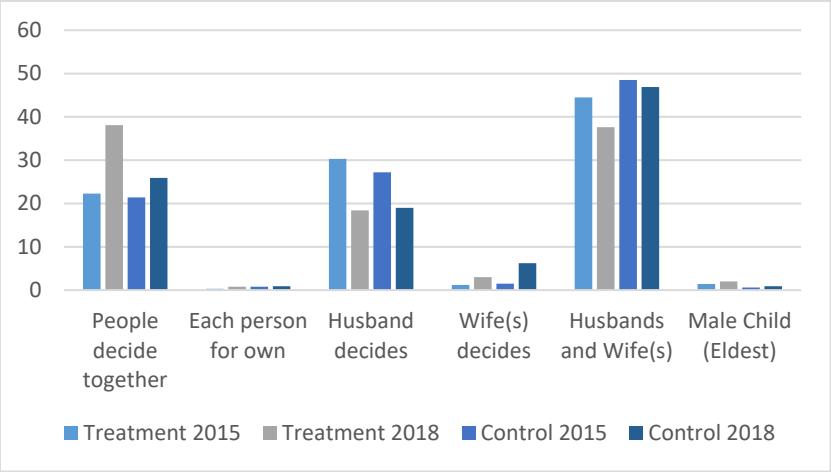
Figure 6 Cropping decisions



Note: Mean values in percent. Source: FDW Ghana household surveys 2015 and 2018.

The same changes can be noted for food expenditure decisions, see Figure 7. There is a clear increase in this decision being made by the people collectively in the households. This pattern is mainly seen in the treatment group, not the control group. This indicates that the project has been effective in changing gender roles to such a degree that the husband as a single decision authority has been replaced by collective decision authority. This strengthens women's position insofar that they are now part of the decision-making process and not excluded from it.

Figure 7 Food expenditure decisions



Note: Mean values in percent. Source: FDW Ghana household surveys 2015 and 2018.

The same pattern, a reduction in the husband decision making power towards more collective decision-making regarding farming and nutrition intake, is visible in all discussed decisions. Therefore, we consider the project being effective in making social changes but strengthening gender roles is a long process and will most likely not change after a short period of three years. Permanent activities need to be conducted to change gender roles, and women need to be part of these activities as well as men.

Section 5.5 shows, that improving income generating activities for women can contribute to improve the decision-making power of women.

5.4 Irrigation Villages

As the number of farmers working on the irrigated land of IWAD is very small in our sample, we will make use of the supplementary sample. We have information on 44 farmers of the total 286 irrigation farmers in the period 2015 to 2018 (see Table 4). The impact analysis remains descriptive because the sample size is too small to produce robust impact estimates. We will focus on the mean values of variables in the four villages having access to the irrigation scheme and compare households with irrigation experience on the IWAD farm with households not having any CA or irrigation relationship with IWAD as the control group. Additionally, we can make use of the FGD conducted in Yagaba in March 2018. In this section we will also report results on schooling activities and health in the irrigation villages, as an impact on these indicators can rather be assumed in villages having access to irrigation (and CA for schooling). Schooling data was only collected in the four villages having access to irrigation because of financial constraints of the evaluation project (collection of daily school attendance in 49 villages was beyond the scope of this study). For the analysis of water-borne diseases we compare the four irrigation villages with all other villages in the sample. The analysis on health outcomes

makes sense, especially, for the four irrigation villages as these had a change in surface water appearance during the project period because of the presence of a water reservoir and the irrigated land, occasionally flooded, of the irrigation scheme. We will compare the irrigation villages to all other villages in the sample and also compare households working on the irrigated land with households not working on the scheme within these villages.

5.4.1 Irrigation farming households

In general, farmers have a positive opinion about irrigation and see it as interesting, new technology and opportunity. Farmers working on the irrigation scheme appreciated the training they got from IWAD and told the research team that they got interesting new information about farming.

Taking a first look at the basic household characteristics at baseline shows no difference between households cultivating on irrigated fields and household not cultivating on these fields, see Table 13.

Table 13 Descriptive statistics irrigation villages

	Not treated households		Treated irrigation		p-value difference	
	baseline	follow-up	baseline	follow-up	baseline	follow-up
Household Characteristics						
Household size	7.01	8.05	9.18	9.91	0.07	0.14
Age of Household Head	45.26	48.68	41.27	46.17	0.15	0.26
Female household head	0.04	0.09	0.07	0.10	0.10	0.73
Women in hh that have farming as a main or secondary activity	0.58	1.26	0.57	1.27	0.94	0.96
Farming						
Number of crops planted	2.84	3.10	2.86	2.98	0.94	0.56
Number of crops harvested	2.50	2.76	1.68	2.43	***0.06***	***0.03***
Number of agricultural shocks in the last year	2.59	2.38	1.66	2.73	0.17	0.10
Loss due to agric. shock (GH₵)	4,525	2,228	3,095	2,964	0.50	***0.06***
Land cultivated (1 acre=0.4 hectares)	10.30	14.28	11.25	17.14	0.64	***0.01***
Farming Practices						
Use of improved seeds for any crop	0.01	0.21	0.48	0.34	***0.01***	***0.04***
Use of any kind of chemical	0.88	0.97	1.00	1.00	***0.03***	***0.02***
Use of fertilizer	0.42	0.90	0.84	1.00	***0.01***	***0.01***
Use of recommended fertilizer	0.01	0.04	0.07	0.00	***0.05***	0.11
Use of herbicide	0.79	0.75	0.93	0.75	***0.09***	0.96
Use of recommended herbicide	0.05	0.08	0.07	0.16	0.45	***0.03***
Use of pesticide	0.63	0.76	0.82	0.89	***0.08***	0.14
Use of recommended pesticide	0.01	0.12	0.02	0.23	0.10	***0.09***
Maize production						
Maize						
HH cultivates maize	0.96	0.98	0.98	1.00	0.77	***0.01***
HH that harvested maize	0.95	0.97	0.98	0.98	0.61	0.68
Acres maize cultivated	7.03	10.12	7.12	11.45	0.89	***0.04***
HH used improved seeds for maize	0.01	0.11	0.49	0.31	***0.01***	***0.02***

HH used fertilizer for maize	0.42	0.91	0.86	1.00	***0.00***	***0.04***
HH used herbicides for maize	0.78	0.72	0.93	0.74	***0.06***	0.83
HH used pesticides for maize	0.07	0.54	0.56	0.74	***0.00***	0.14
Tons of maize harvested	0.89	2.17	2.94	4.24	***0.00***	***0.01***
Tons of maize harvested per acre	0.15	0.26	1.37	0.70	***0.01***	***0.02***
Rice Production						
HH cultivates rice	0.07	0.11	0.05	0.23	0.49	***0.00***
HH that harvested rice	0.07	0.10	0.02	0.20	0.30	***0.00***
Acres rice cultivates	16.11	5.37	31.50	8.05	0.16	***0.02***
Tons of rice harvested	1.03	1.71	0.90	2.61	0.66	0.12
Tons of rice harvested per acre	0.11	0.32	0.11	1.18	0.95	***0.09***
HH used improved seeds for rice	0	0.29	0	0.5	***0.00***	***0.07***
HH used fertilizer for rice	0.33	0.65	0.50	0.75	0.60	0.61
HH used herbicides for rice	0.89	0.65	0.50	0.88	0.50	0.42
HH used pesticides for rice	0	0.41	0	0.375	1.00	0.88
Harvest						
Total harvest (GH₵)	72,188	165,753	139,50	388,24	***0.05***	***0.00***
Total harvest sold (GH₵)	13,705	26,576	29,089	59,726	***0.01***	***0.08***
Total home consumption (GH₵)	13,430	36,134	35,503	52,581	***0.01***	***0.05***
Total labor paid in-kind (GH₵)	5,979	7,687	10,237	18,695	***0.02***	***0.00***
Maize						
Maize total harvest (GH₵)	11,967	62,506	96,504	113,02	***0.01***	***0.05***
Maize Sales (GH₵)	3,570	8,087	7,183	26,209	***0.08***	***0.01***
Maize kept for home consumption (GH₵)	5,612	20,249	20,230	32,828	***0.00***	***0.01***
Maize in-kind labor payment (GH₵ value)	548	2,265	1,790	4,250	0.12	***0.02***
Rice						
Rice total harvest (GH₵)	19,048	26,128	3,241	22,670	0.30	0.71
Rice sales (GH₵)	7,936	24,852	2,000	5,052	0.38	0.11
Rice kept for home consumption (GH₵)	7,716	3,910	1,080	4,661	0.41	0.27
Rice in-kind labor payment (GH₵ value)	1,504	7,731	360	2,018	0.35	0.37
Income and Wealth						
Total annual expenditure	6,686	8,048	6,174	8,975	0.56	0.46
HH that has savings	0.05	0.24	0.23	0.55	***0.02***	***0.00***
HH that has loans	0.05	0.06	0.07	0.02	0.45	0.42
Health						
HH members Malaria	0.30	0.72	0.41	0.75	0.12	0.76
HH members eye infection	0.08	0.06	0.00	0.16	***0.04***	***0.08***
HH members vomiting	0.19	0.04	0.05	0.11	0.34	***0.06***
HH members having a fever	0.23	0.19	0.16	0.43	0.43	***0.05***
Observations	196	185	44	44		

Source: FDW Ghana household surveys 2015 and 2018.

On the IWAD irrigated land, maize and rice were grown by farmers. A more detailed look on farming output shows some interesting results. In general, there are no differences in the number of crops planted but irrigation farmers caught up in the number of crops harvested and seem to have fewer failing crops. All households grew on average 3 crops and harvested around 2.5 crops in the last farming season. Households farming on the irrigation scheme report that they cultivate on average 17 acres of land while other households

cultivate only 14 acres of land, but this difference exists already in the baseline survey. While almost all farmers use any chemical for production, the use of fertilizer, herbicides and pesticides is more often practiced by irrigation farmers. While there is no clear pattern for chemical use in maize farming, irrigation farmers growing rice seem to adapt the improved farming methods and are aware that these are also used on the irrigation scheme. Farmers report in the FDG that IWAD managed the application of chemicals on the irrigated land and the farmers' task was mainly weeding. Some farmers report that they saw IWAD workers spraying the fields, other say that they are not aware when and which chemicals were applied. The staff of IWAD also confirmed that chemicals were applied by themselves and not by farmers.

With regard to the amounts in tons of maize and rice harvested and sold, there are clear increases of the output of maize and rice farming. Farmers cultivating maize on the IWAD farm have higher maize yields in 2018 (4.24 vs. 2.17 Tons) but they also started off with a higher production in 2015. Irrigation households significantly have a higher value of the maize harvest, maize sales and keep more maize for home consumption. Again, this difference existed at baseline and there is a general trend of improved maize production in the irrigation villages.

In terms of sales, IWAD farmers seem to make fewer profits from rice sales compared to other farmers. This was also reported by farmers in the FGD. Most farmers had to give all the remaining harvest to IWAD to pay for inputs and it was nothing left to sell or keep for home consumption, except what they had produced on their own farms.

Concerning income and wealth, there are no large differences between the two groups. However, households farming for IWAD had the possibility of accumulating more savings than other households in the villages and have on average higher total annual expenditure.

A higher burden of Malaria is found among all households in irrigation villages and the difference between the two groups is not significant. But, in particular, irrigation farmers additionally report more symptoms related to water-borne diseases as eye infections, vomiting or having a fever (see Table 13). A comparison between the irrigation villages and the rest of the sample will be made in section 5.4.3.

5.4.2 Schooling

The effect of the project on school enrolment and attendance could have gone in either direction, decreasing attendance due to more workload on cultivated land or increasing because of a positive income shock. In total we followed 399 children's school attendance in the 2015/2016 school year and 316 students in 2017/2018.

About 20 percent of students dropped out of school within these 3 years. Most children stop going to school after finishing primary school. The average age of children in 2015 was 10 years and 13 years in 2018.

In 2015, significantly more children were enrolled in households receiving any IWAD treatment (CA or irrigation) in the four irrigation villages, while there is no significant difference in 2018. However, there is no difference in school enrollment between treatment and control villages in the whole sample, see Annex C.

We find no effect of the project, either being a CA or irrigation farmer on school attendance, see Table 14. In general, school attendance decreases from 2015/16 to 2017/18 for both groups, but there is no significant difference between groups.

As the effect of the project on income from farming, i.e. sales, is rather small, there is no impact on schooling being a more mid-to long run measure.

Table 14 Enrollment and school attendance

	2015	2018
Enrolled students per household		
No treatment	1.46	1.57
Any treatment	2.31	1.84
p-value	0.00	0.33
Attendance in days		
No treatment	109.68	106.87
Any treatment	122.91	115.03
p-value	0.109	0.270

Source: FDW Ghana household surveys 2015 and 2018, and data on school attendance.

5.4.3 Health

For the analysis of water-borne diseases we compare the four irrigation villages with all other villages in the sample. Only these four villages had a change in surface water appearance during the project period because of the presence of a water reservoir and the occasional flooding of the irrigated land. Information on diseases only was asked for the last two weeks prior to the survey to avoid recall bias. This is common practice in health surveys as, e.g. the Demographic and Health Surveys.

The project implementers expressed fears at baseline that the irrigation scheme and the reservoir could have negative impacts on the prevalence of water borne diseases in the villages close to the irrigated area. We asked all household members present during the household interview whether they suffered from any water-borne diseases such as Malaria, Hepatitis, intestinal worms or diarrhea.

There was no significant change in most of the diseases we asked for but we find a significant increase in the prevalence of Malaria. There is also an increase in the other villages from 0.3 to 0.5 household members suffering from Malaria within the last two weeks. However, in the irrigation villages the prevalence of Malaria doubled, see Table 15. It has also to be kept in mind, that the survey was conducted in the dry season, a time when usually malaria incidence reduces. Furthermore, a higher burden of Malaria is found for irrigation villages in particular but irrigation farmers additionally have a higher burden of symptoms related to water-borne diseases, see Table 13.

This finding clearly raises the question of whether IWAD did everything possible to prevent the spread of water-related diseases. The reservoir is neither covered nor were preventative measures taken to reduce e.g. larvae spread. It happened by coincidence that fishes arrived in the reservoir through the pipe system but the fish population was not managed actively. If larvae contaminated water is spread on the irrigated land, mosquitos are distributed across 400 ha. This issue clearly needs attention by IWAD in the future because of the negative externalities on health of the project.

Table 15 Malaria prevalence in irrigation and non-irrigation villages

	DiD	No irrigation baseline	No irrigation follow-up	Irrigation baseline	Irrigation follow-up
Number of persons with Malaria in household in the last 2 weeks	0.232***	0.34	0.49	0.32	0.69

Notes: The column "DiD" displays the coefficient from the difference-in-differences estimation, controlling for baseline characteristics of the household (see Section 4.6 for details). We compare irrigation villages with non-irrigation villages. Robust standard errors are clustered at the village level. *, **, *** represent statistical significance at the 10, 5, and 1 percent level, respectively. *Source*: FDW Ghana household surveys 2015 and 2018.

5.5 Female work force survey

In this section we report on some information from a small survey collected among female casual farmers on IWAD's nucleus farm. Since the start of the project, IWAD struggled to find reliable casual workers. After a while it turned out that women, instead of men, are much more reliable and willing to work on a more permanent base for IWAD. In total more than 500 casual workers are registered with IWAD, but men turned out to show up less steadily, also because they are responsible for their own fields. In the last farming season, IWAD employed approximately 200 casual workers per day of which 98 percent are women.

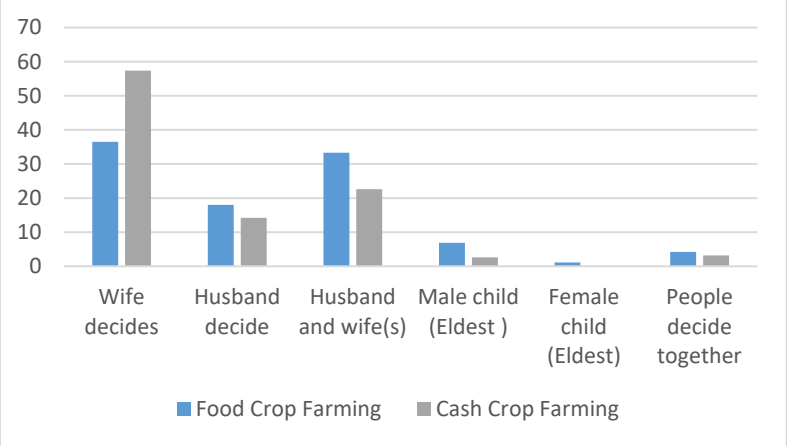
All casual workers receive a signed contract explaining the working situation. Workers have a day of 8 working hours and receive GH₵ 10 per day, slightly higher than the national daily minimum wage (GH₵ 8 in 2017). Attendance, checking in and out of workers, is recorded on a daily base. In most cases payment is made onto

an account at the Builsa Community Bank (BOCU), which recently opened up in Yagaba. This is easier and more secure for IWAD than dealing with cash amounts each day.

Working for IWAD brought considerable changes to these women. Women in the area around Yagaba now have the possibility to earn money independent of the household farm. All women interviewed opened a bank account at BOCU bank in Yagaba and receive the money directly to the account. Women earned on average GH₵ 400 during the months November 2017 to April 2018. 56 percent of women reported they used the money to buy cloths, 40 percent reported that they bought agricultural inputs (fertilizer, herbicides or pesticides) and 29 percent paid for school fees of their children. 75 percent of women were not able to save any of the earnings, but 25 percent of women report that they accumulated savings. These savings are mainly kept to pay for possible household shocks (agricultural or social) or to a lesser extent to buy clothes, pay school fees or for funerals and ceremonies.

With regard to intra-household decision making, women of the IWAD labor force report much more often that they themselves are the ones who take decisions about which crops to grow, see Figure 8. About 97 percent of women interviewed report that their role in the household in making general and financial decisions changed because they now earn their own salary. This shows that increasing women's financial power also increases their decision-making power.

Figure 8 Decisions about farming activities



Source: FDW Ghana female labor force survey 2018.

6. Discussion and conclusion

This final evaluation report of the SK project analyzed, based on a developed ToC, the outcomes and impact of the project on institutional level and beneficiary households. The impact evaluation methodology mixed-

methods approach analyzes the institutional and beneficiary dimensions. The quantitative part applied a difference-in-difference approach using a treatment and a control group and comparing indicators of interest over time. Additionally, FGDs, interviews with experts and stakeholders of the PPP were held during the baseline and the follow-up phase. Thus, the qualitative work was used to underline the main quantitative findings with discoveries of the qualitative document review and interviews. The findings of the qualitative and quantitative data collections were presented throughout this report and will be summarized, connected and discussed in the following paragraphs.

The intervention had several components: the building of irrigation infrastructure on 400 ha in the area around the district capital Yagaba and the cultivation of maize and rice using CA farming methods which were part of a training of smallholders in FFS. FFS were held in 21 treatment villages where farmers rely on rain-fed agriculture. IWAD additionally has a nucleus farm on the irrigation scheme where the company grew trails of different crops as cowpeas, sorghum and groundnuts and the farm work was done by casual workers.

IWAD and the partners of the PPP made great effort to implement the project with its technical and social components and to find a commercial model for agriculture in the Norther Region of Ghana that can also survive economically. There were many challenges during the planning and implementation of the project and IWAD had to find innovative ways of building infrastructure and social relations with the population. Many aspects had to be adapted to reality once difficulties were encountered and project activities were not implemented as planned.

The objective of the institutional assessment was to evaluate the (formation of the) relationship between the partners, to analyze the contribution of this relationship to the outcomes of the project and to ascertain the added value of the PPP. The comments below summarize key learning from the analysis and draw some conclusions.[37]

Of note, however, is how the partners worked in the PPP. They worked 'together but separately'. IWAD was clearly the central figure and 'linking pin', coordinating all the partners. IWAD was result oriented, focused on the sustainability of the venture. Partners were loosely bound, working individually to fulfil their roles as defined in the contract. Communication was on a need basis through IWAD, and there were no bilateral relations. There were no `partner meetings´ as these were not deemed necessary.

[37] The evaluation team will be performing cross case analysis as part of the contract, later this year (5 projects in 3 countries). From these we will be able to generalize and derive 'do's and dont's of PPPs. This section includes reflections on this case only.

Regarding an added value commonly mentioned, namely the sharing of risks and returns, the partners were more critical. IWAD took a disproportionate amount of the risk, and the project has not yet shown returns. The contribution of the PPP to this will be more evident in the coming years, also with upscaling.

On the other hand, it was the bundling of finance (including the additional investment generated) that made the project possible, no single partner could have taken on this initiative on its own. Partners also accept that the project could not have been done without the support of the grant. The grant was seen as leverage funding, allowing the commercial parties to undertake non-profit oriented bits in the project to make it operational.

One aspect concerning the quantitative impact evaluation is that since the project started in 2014, certain changes in the strategy and roll out of the CA part of the project happened: IWAD decided to focus on rice farming because of better local and national market prospects and stopped the promotion of different crops (rice, maize, soya, sorghum and cotton) which would be necessary to follow the CA approach to fulfil requirements concerning diversification of crops and crop rotation. In 2015 and 2016, CA farmers grew maize and rice, but afterwards only the cultivation of rice was promoted under an IWAD contract. Therefore, the subject maize was handed over to Masara N'arziki in 2016, and IWAD specialized in promoting rice cultivation among CA farmers. Additionally, the project was active in fewer villages than planned but treated more farmers per village.

This change in the project structure also has an influence on the evaluation because the content of the project changed and this makes it impossible to analyze other crops than rice and maize or issues of crop rotation. In total, around 800 farmers were treated under the CA intervention, instead of the initially planned 3000. This makes an impact measurement more difficult, because the treatment group stays smaller and estimates lack statistical power to find significant effects. However, the FFS conducted by IWAD were open to anyone in the years 2014 and 2015 and the impact estimations were thus done for two groups: the ITT group, which are all households living in treatment villages and the ATE on the treated which are only those households who signed up for inputs. We found positive spillovers in maize and rice chemical use and production of the project to households who did not sign-up to receive IWAD inputs for credit but who probably visited the FFS.

IWAD is a private entrepreneur whose aim is to make profits, so farmers face real market conditions which lower their success rates (in the beginning). In general, there were positive changes initiated by the project concerning improved farming practices as the use of chemicals and irrigation which also convert into higher yields of maize and rice. Especially rice output increased by more than 50 up to 400 percent, maize output almost doubled. This is especially true for irrigation farmers who achieved higher maize and rice yields. When it comes to sales and profits as an income generating activity for farming households the results were rather

modest. Irrigation farmers increased sales of maize but not of rice. This is quite similar for CA farmers who had a higher production of maize and rice, and also improved productivity in rice cultivation, but no increases in sales of crops. The payment for inputs and prices to sell the harvest at the lower bound offered by IWAD reduced the farmers' profits. Thus, there is also no impact on income or poverty.

For the future, IWAD needs to develop a (re-)payment scheme that allows farmers to be more successful in terms of profit making. Currently farmers repay in form of produce and if production is low, farmers give the whole harvested yields to IWAD. In this way, farmers are demotivated, and the system will fail. Distributing invoices at the beginning of the season to farmers is not transparent in an environment where most of the adults cannot read and write. The (re-)payment scheme must be made understandable to everyone, and this will clearly be time consuming. The irrigation scheme with large scale infrastructure will clearly not be an outlet for single smallholder farmers to cultivate crops as the financial contribution and risk is too high. But this system has the potential to hire local farmers and give employment opportunities in an area which is characterized by subsistence farming, especially to women.

In terms of food security, farmers had a higher production of rice and maize and also kept more rice for home consumption. Although there is no direct impact of the intervention on income and poverty, food scarcity decreased and availability of food in terms of number of meals per day increase slightly towards three meals per day (or six meals within the last 2 days). The nutrition effect did not (yet) transform into anthropometric effects on children's development.

Women in the project area, especially in the four irrigation villages, gained from the project's effort to strengthen the role of women. More women work in agriculture and are more engaged in the intra-household decision making process, especially when they get the chance to work on the nucleus farm as casual workers with a family-independent income.

With regard to health, there were some findings which confirm general concerns with irrigation infrastructure: we found a clear increase of water-borne disease symptoms and Malaria in irrigation villages. The incidence of Malaria almost doubled in irrigation villages and in households where members farm on the irrigated land more symptoms describing water-borne diseases were reported. This issue should be addressed by the project stakeholders.

Another aspect that has to be mentioned before is that the follow-up phase of the impact evaluation took place already three years after the project effectively started and thus questions on sustainability cannot to be fully addressed. This is a very short time period and results might look different in a five to 10-year period. The impact of the project on farmer households is small and it is unclear whether this is a result of the project or

the short time horizon in which difficult weather conditions prevailed. This project aimed to change the farming behavior of the population which is a system of habits and traditions, so three years are a very short period to have an impact on behavior.

The empirical findings from the survey are supported by the analysis reported in the institutional analysis. Financially, the project was not as successful as partners expected and did not deliver RoI. As well as for the beneficiary farmers, returns were minimal. IWAD had the possibility to focus on the training of smallholders, because they were supported by the FDW grant. The grant made this design of the project possible, but it is unclear whether such a design with a strong social component will be implemented in the future because of the high pressure to break even.

In terms of scaling up the project no final decisions had been made by the stakeholders at the time of the report, therefore, it is difficult to reflect on the nature and sustainability of future plans. IWAD and partners were still working towards the best business model and looking closely at options as the scope of the initiative (which crops to grow) and the location for scaling up to 10 000 ha.

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Annexes

Annex A List of questions semi-structured interviews and questionnaire

See separate file

Annex B Evaluation indicators

See separate file

Annex C Baseline household characteristics

	Sample mean		Control Group		Treatment Group		p-value difference
	coef	se	coef	se	coef	se	
Household Characteristics							
Household size	7.39	(0.216)	7.06	(0.219)	7.74	(0.370)	0.12
Age of Household Head	44.07	(0.563)	43.71	(0.624)	44.44	(0.930)	0.52
Household Head ever attended school	0.19	(0.019)	0.20	(0.026)	0.18	(0.028)	0.72
Female household head	0.03	(0.006)	0.03	(0.007)	0.03	(0.010)	0.91
Women having farming as a main or secondary activity	0.85	(0.058)	1.07	(0.062)	0.63	(0.064)	0.00
Number of students in household	1.79	(0.103)	1.70	(0.137)	1.88	(0.154)	0.37
Total annual expenditure	7,066.80	(231.964)	7,137.42	(309.414)	6,988.42	(345.128)	0.75
Food security							
Share of female contribution to annual food expenditure	0.26	(0.013)	0.25	(0.021)	0.27	(0.016)	0.30
Food expenditure in GHC for the last week	104.67	(3.383)	105.01	(4.599)	104.30	(4.976)	0.92
Food Scarcity Measure	0.26	(0.019)	0.26	(0.026)	0.25	(0.027)	0.79
Count of number of times household had meals in the last two days	5.72	(0.045)	5.67	(0.077)	5.76	(0.039)	0.28
Any child of the HH wasting	0.19	(0.022)	0.20	(0.035)	0.18	(0.025)	0.61
Any child of the HH stunting	0.38	(0.028)	0.34	(0.035)	0.42	(0.042)	0.16
Any child of the HH underweight	0.29	(0.023)	0.29	(0.035)	0.30	(0.029)	0.87
Farming characteristics							
Number of crops planted	3.16	(0.061)	3.22	(0.089)	3.09	(0.075)	0.26
Number of crops harvested	2.98	(0.076)	3.15	(0.101)	2.80	(0.090)	0.01

Land cultivated in acres (1 acre=0.4 hectares)	12.27	(0.647)	11.90	(0.865)	12.66	(0.967)	0.56
HH cultivates maize	0.94	(0.014)	0.92	(0.026)	0.97	(0.006)	0.07
HH that harvested maize	0.92	(0.016)	0.89	(0.029)	0.95	(0.008)	0.03
Tons of maize harvested	1.11	(0.078)	1.21	(0.126)	1.01	(0.086)	0.21
Tons of maize harvested per acre	0.18	(0.009)	0.19	(0.014)	0.16	(0.008)	0.05
Acres maize	7.23	(0.290)	7.27	(0.467)	7.20	(0.340)	0.89
HH cultivates rice	0.19	(0.031)	0.13	(0.029)	0.25	(0.056)	0.05
HH that harvested rice	0.15	(0.026)	0.10	(0.023)	0.21	(0.049)	0.04
Tons of rice harvested	0.80	(0.085)	0.68	(0.140)	0.86	(0.103)	0.31
Tons of rice harvested per acre	0.18	(0.023)	0.22	(0.048)	0.16	(0.021)	0.28
Acres rice	6.20	(1.070)	3.72	(0.890)	7.48	(1.358)	0.03
Use of improved seeds	0.07	(0.012)	0.10	(0.016)	0.04	(0.012)	0.00
Use of any kind of chemical	0.81	(0.027)	0.74	(0.044)	0.88	(0.017)	0.00
Use of fertilizer	0.47	(0.032)	0.48	(0.051)	0.46	(0.038)	0.81
Use of herbicide	0.63	(0.033)	0.52	(0.038)	0.74	(0.034)	0.00
Use of pesticide	0.41	(0.044)	0.23	(0.038)	0.60	(0.049)	0.00
Commercial activity							
Total harvest sold (GHC)	21,124.54	(3,134.992)	23,819.83	(4,975.196)	18,292.26	(3,635.779)	0.37
Maize total harvest (GHC)	3,246.39	(594.752)	4,394.10	(815.386)	2,096.69	(851.045)	0.06
Rice total harvest (GHC)	3,263.66	(923.745)	935.09	(289.762)	4,379.03	(1,297.957)	0.01
Observations	1365		711		672		

Annex D Household Questionnaire

See separate file

Annex E Community Questionnaire

See separate file

Annex F Female labor force questionnaire

See separate file