Interventions Impact Analysis: Rainfed Season 2019-2020

APSAN-Vale project

CLIENT Agência de Desenvolvimento do Vale Zambeze (ADVZ)

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Preface

The APSAN Vale project has as its overall aim to increase climate resilient agricultural productivity and food security, with a specific objective to increase the water productivity and profitability of smallholder farmers in Mozambique, prioritizing small (family sector) farmers to increase food and nutritional security. This project will demonstrate what the best combinations are of adoption strategies and technological packages, with the largest overall impact in terms of Water Productivity, both at the plot-level, sub-basin as well as basin level.

This report evaluates the preliminary impact of the different field interventions that took place as part of the APSAN-Vale project in Mozambique. This was done by comparing the trained and adopted interventions by farmers against the yield and water productivity data. Goal of this analysis is to gain insight in successfulness of different interventions on the crop and water productivity of the farmers. The results can be used to select the most successful interventions when scaling up to new areas.

Summary

This report evaluates the preliminary impact of the different field interventions that took place as part of the APSAN-Vale project in Mozambique during the rainy season 2019-2020. This was done by comparing the trained and adopted interventions by farmers against the yield and water productivity data, and by using a crop simulation model to determine the theoretical impact of interventions. Goal of this analysis is to gain insight in the successfulness of different interventions on the crop and water productivity of the farmers. The results can be used to select the most successful interventions when scaling up to new areas.

The following interventions, relevant for the rainfed season, were studied as part of this analysis: land preparation, staggering, crop residue retention, mulching, plant density and spacing, crop rotation, use of inputs (fertilizers and seed varieties) and pesticides and disease control.

The overall approach for the analysis of the impact of interventions is two-fold. One part focusses on the analysis of the theoretical impact by using scenarios of the field and simulating the impact by comparing scenarios including and omitting selected practices. The second part focusses on the observed impact using results from the field on adoption of practices, crop yield reports, and water productivity reports. The theoretical impact of the interventions is estimated using the crop simulation model AquaCrop. In total six different interventions are analyzed namely: fertilization, hybrid seed variety, mulching or plant rests, planting density, planting date, and runoff management (e.g. soil bunds). For the observed impact we focused on six key practices: land preparation, incorporating plant rests in and on soil (incl. mulching), crop rotation, management of plagues and diseases and use of inputs (including use of fertilizer and improved seeds).

Some key conclusions that can be drawn from the theoretical impact analysis are:

- Mulching or plant rests is the only intervention that reduces the evapotranspiration component
- Agronomic interventions (fertilizers and seed variety) have the highest impact on yield and water productivity
- Planting date needs to be adjusted better to local information. Two weeks earlier is potentially not reasonably especially when planting depends on the rain forecast
- Impact of runoff management largely depended on the soil type. All districts have different soil types

The analysis of observed impact demonstrated the relevance of using this approach for determining the effect of various interventions. The PPCs adopted various of the practices, therefore effect of individual interventions was less pronounced. By comparing farmers that adopted the interventions with those that did not adopt the intervention, for four selected interventions, an increase in crop yield score was observed for three interventions: land preparation, soil and water management, and additional inputs. The intervention crop rotation had a slight negative impact. However, crop rotation is an intervention that encompasses multiple seasons therefore the impact will likely be observed at a later stage. Overall, the interventions had a positive impact on the crop yield scores and water productivity scores. In addition, high crop yield scores also generally aligned with the water productivity values.

The approach for determining the theoretical and observed impact of field interventions, is demonstrated as being relevant and suitable for the APSAN-Vale project and will be used and refined in the continuation of the project. The scoring system provides the relevant insight to compare the crop yield and water productivity results between districts and determine the interventions with higher impact or more successful implementation.

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1 Introduction

1.1 APSAN-Vale project

The APSAN-Vale project commenced end of 2018 and is a 3.5 year project with the objective to: 'Pilot innovations to increase the Water Productivity and Food security for Climate Resilient smallholder agriculture in the Zambezi valley of Mozambique'. Water productivity is used as an indicator to quantify the impact of the innovations on smallholder agriculture. These innovations can be technical packages (interventions and trainings), and adoption of lessons-learned through farmer-to-farmer communication. Information on water productivity needs to incorporate both temporal and spatial aspects. The temporal changes in water productivity indicates if an intervention resulted in an increase of water productivity. The spatial patterns in water productivity indicates if the knowledge is being adopted in the region and increased the overall water productivity of the locality, and district. Project activities take place in three districts namely: Báruè, Moatize, and Nhamatanda. Within each district, various localities are selected for piloting innovations. The location of the districts and current project activities are shown in Figure 1.

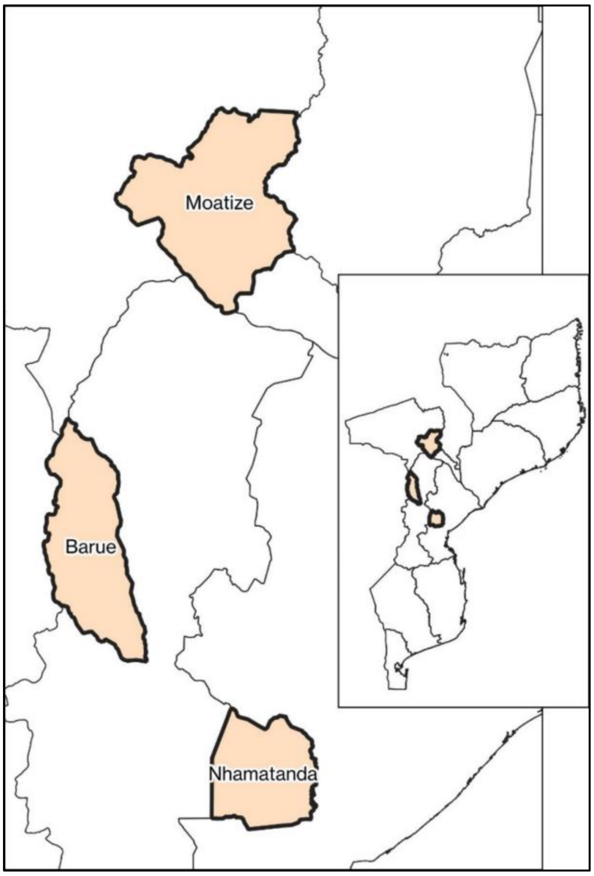

Figure 1 Location districts of APSAN-Vale project activities

1.2 Aim

This report evaluates the preliminary impact of the different field interventions that took place as part of the APSAN-Vale project in Mozambique. This was done by comparing the trained and adopted interventions by farmers against the yield and water productivity data. Goal of this analysis is to gain insight in successfulness of different interventions on the crop and water productivity of the farmers. The results can be used to select the most successful interventions when scaling up to new areas.

1.3 Reading guide

Chapter 2 elaborates on the different field intervention that took place as part of the APSAN-Vale project. The next chapter provides an overview of the methodology used for the analysis in this report. Chapter 4 provides the results related to the theoretical impact by analyzing the impact of several interventions using the crop simulation model AquaCrop. The observed impact by analyzing survey and yield data is elaborated in chapter 5. In chapter 6 the results are discussed and concluding remarks are given.

2 Field interventions

The following relevant interventions for the rainfed season were studied as part of this analysis:

- Land preparation
- Staggering
- Crop residue retention
- Mulching
- Plant density and spacing
- Crop rotation
- Use of inputs
- Pesticides and disease control

The different interventions will be explained in the parts below.

2.1 Land preparation

Through covachas, terraces, bunds, vegetative strips and heaping, runoff is reduced and there is increased soil fertility. In case there in inclination of the land, the farmers are advised to prepare the land perpendicular with the slope to reduce run-off and erosion. This will support facilitate infiltration by decreasing the velocity of the water. With areas with more inclination, some grass strips are introduced, as well as terrace forming. Covachas are implemented in areas that do not have inclination. Covachas and planting in lines provide guidance on the correct spacing and planting density (see also paragraph 2.5). Heaping is a water management practices where soil is moved from the sides to the plant. During the season this increases bunds. This increases soil humidity and provides support to the plant.

Figure 2 Images from left to right: land preparation in slopes (terraces), covachas, production perpendicular com slope and heaping/ridging

The decision on which type of land preparation was based on the farmers land preparation tool (hoe, tractor) and inclination of the land. The scheme below shows the factors influencing the personalized choice for a type of land preparation.

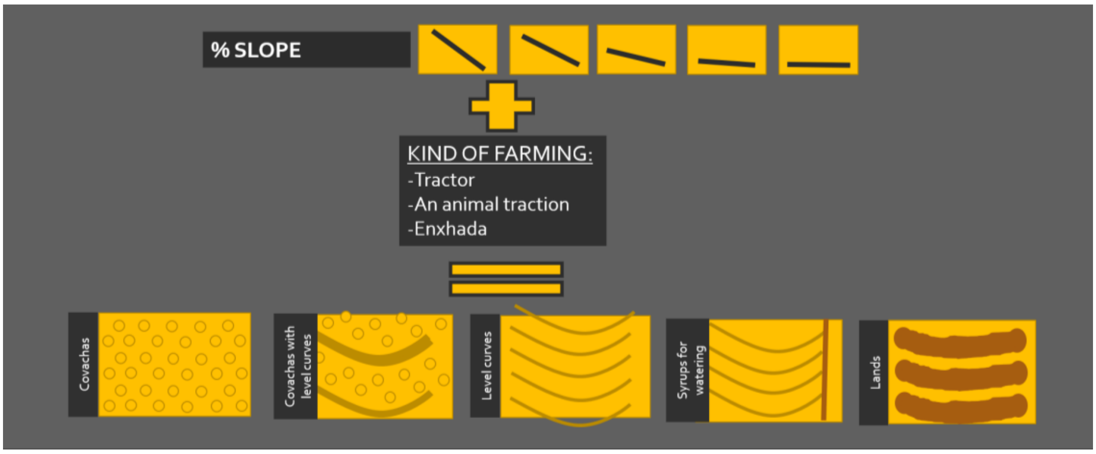

Figure 3 A decision making tool to choose the type of land preparation based on slope and field preparation tools

2.2 Staggering

Staggering is the practices to plant the field in phases, rather than to plant the whole field at the same time. The benefit of this practice is that it allows for the reduction of the labor peak demand, which in turn allows for the extension of the area produced. In addition, staggering will reduce risk to production losses caused by irregular precipitation intervals as a dry spell will not influence the whole production area.

2.3 Crop residue retention

Incorporation of plant rests in soil (crop residue retention) is done during the ploughing of the field. Instead of burning the plants that grew during the months that the field was not cultivated, the plants are incorporated and left in and on the soil. It is a practices that is commonly applied.

The benefits of remaining plant material in and on soil are the following:

- Reduces runoff effect v, improving infiltration rates
- Improves soil structure and texture and fertility
- Reduction of soil losses due to erosion
- Increase the microbial activities under ground
- Reduce the impact of rain drops
- It reduce the index of weed growth

Figure 4 A field in Báruè with plant rests before planting

2.4 Mulching

Mulch is a layer of material applied to the surface of soil. It is a more labor intense form of putting lifeless matter on soil surface in order to increase ground cover. The practice is effective to conserve soil moisture. The Technical Report of the rainfed season 2019-2020 shows that fields with mulch are far better in preserving soil moisture than fields without mulch, even after a week without rain, as will be shown in chapter 5.2. Mulching is labor intensive and requires access to sufficient dry grasses, therefore it is a resources decision for the farmer to implement this practice in the field.

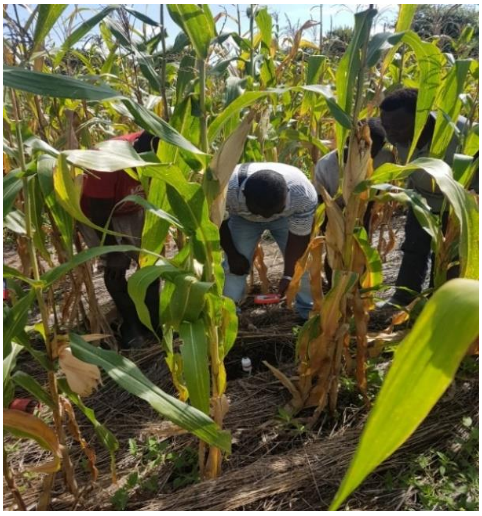

Figure 5 Mulching of a maize field in Nhamatanda

2.5 Plant density and spacing

In the field, the farmers often use 5 seeds per hole. The APSAN-Vale project shows the farmers to include 1-2 seeds per hole. The spacing between lines and between plants depend on several factors related to the environmental conditions of the region and the handling that is intended to be introduced. High sowing density, makes the number of plants per linear meter very high, increasing competition for water, light and nutrients, limiting the supply of carbohydrates to grain production. Lower sowing density is directly proportional to reducing competitiveness among individuals. High temperatures combined with higher sowing density can cause fungal diseases. Demétrio et al (2008) observed that the increase in corn population density increases the height of plants and the insertion of the first ear, and reduces the number of grains per ear. For Nhamatanda and Moatize we recommend lower density per unit area while in Báruè higher density according to technical recommendations.

Figure 6 Maize (variety PAN 53) sowing in a spacing of 0.5 x 0.8 meters with two seeds per cutting and in lines with fertilizer application in Mameme 2 Moatize

Figure 7 Corn (Pan 53) seeded in rows with spacing of 0.3 x 0.8, one seed per cutting with fertilizer use in Samoa, Moatize zeca marcelino field7

Figure 8 Maize (PAN 53) sowing without sowing spacing, with 3-4 seeds per hectare without fertilizer application

2.6 Crop rotation

Crop rotation is an agricultural technique that alternates, in an orderly and planned manner, different crops in the same area in a given period. This planting technique aims at soil conservation and the consequent reduction of its depletion. Therefore, the principles that guide the rotation of the crop obey the alternation of cultures of different families, different root systems, different capacities of atmospheric dinitrogenium fixation, production of different biomass, etc. The producers of APSAN-VALE are advised to design their fields in order to enable the process of crop rotation. This practice is considerably reducing the frequent outbreak of certain pests such as a funnel caterpillar.

Figure 9 From left to right, field in Zobue, Moatize sown in order to enable the process of crop rotation between corn and common bean. Field seeded to enable the rotation between maize and okra in Samoa, Moatize

2.7 Use of inputs

2.7.1 Fertilizers

The increase of nutrients in the soil through plant residues, manure, organic compounds and/or fertilizers depends on the financial capacity of producers and/or availability of animals. However, this practice is being adopted by most PPCs in an integrated manner depending on the availability of fertilizers and fertilizers. Of the 126 PPCs – Small Commercial Producers currently assisted, only 27 applied fertilizers before APSAN-VALE. In this practice, the needs of the crops in terms of nutrients are taken into account, the technical recommendations of the availability of each nutrient in the different fertilizers, and proportion of nutrients in fertilizers. However, it is recommended that the minimal application of the fertilizers is recommended as soil analyses are not included. This practice is increasing the yield of producers per unit of area when compared to the forecasts / estimates of the ministry that oversees agriculture. See in the first quarter report[1] the number of people who use fertilizers for the implementation of APSAN-VALE.

2.7.2 Seed variety

In general, all PPCs used limitedly improved seeds before APSAN-VALE. However, by June 2020 everyone fully uses the improved seeds. The willingness to use improved seeds was due to the activities of advisory service and promotion of fairs and markets approved by APSAN-VALE, facilitating services of availability of seeds and other inputs at the level of communities. See the quarterly report 1, 2020[1] the number of people using improved seeds. This practice is contributing to the increase of yield per unit of area, tolerance of pests and disease. This is a result of the improved seed varieties being adapted to local environmental conditions.

2.8 Pesticides and disease control

Regarding to the concept of integrated pest control, producers are trained in order to avoid:

1. Human intoxication;
2. Waste in food;
3. Elimination and extermination/extinction of species in biomes;
4. Groundwater contamination;
5. Contamination and killing of fish in rivers;
6. Contamination and consequently accumulation of residues in soils;
7. Resistance of insects - pests to insecticides, etc.

The training involves insect identification, defining the level of control, knowledge of insects, biological control, selectivity of insecticides, plant knowledge, calibration of sprayers, guidance on good ways of spraying and recording of data on the spray process, pesticide safety period, pesticide management, etc. See the numbers on people trained in this company in the first quarter 2020 report.

[1] Come, E., A. Teixera, J.D. van Opstal, M. de Klerk, N. Schepers, K. van Krieken, D. Levelt. 2020. APSAN-Vale Quarterly Progress Report Q1-2020.

3 Methodology

3.1 Approach

The overall approach for the analysis of the impact of interventions is two-fold. One part focusses on the analysis of the theoretical impact by using scenarios of the field and simulating the impact by comparing scenarios including and omitting selected practices. The second part focusses on the observed impact using results from the field on adoption of practices, crop yield reports, and water productivity reports. Both parts require a categorization of the practices beforehand and a scoring system for the evaluation of the impact. The various methods used for this approach are elaborated in the following sections.

Table 1 Overall approach of analyzing the impact of interventions

	Observed impact	Theoretical (simulated impact)
Step 1	Categorization of good practices	
Step 2	Collection of seasonal results: - Adoption survey - Crop yield reports - Water productivity reports	Simulation model runs: - Scenarios including and omitting the selected practices
Step 3	Scoring system: evaluation of impact and effect of the interventions	

3.2 Categorization

The impact analysis combines various types of data based on implemented practices. The data from these practices needs to be aligned with the crop stimulation model, data from the adopted practices survey, from the beneficiaries list (trainings), observations from the field and log-frame indicators. A categorization of practices is introduced to facilitate the analysis of these different datasets.

The various practices definitions come from the following data:

- The project gives 37 types of trainings, of which 23 trainings are related to agricultural production (the other 14 are related to health and nutrition). Each training represents a practice. Data about this is collected through the beneficiaries list and adopted practices survey.
- The AquaCrop model has specific simulations in the following categories: runoff management, specifically defined mulching, change in planting dates and plant density, seed variety and fertilizer inputs.
- The log-frame indicators mention specific interventions in specific categories (water management practices, crop rotation, mulching, integrated pest management, improved access to input/output markets.

FutureWater developed in the report “Guidance on Realizing Real Water Savings with Crop Water Productivity Interventions” an intervention framework (FAO and FutureWater, 2020[2]). In this report, they state about developing a structured framework where broader options can be derived into smaller ones that: “no universal categorization in options [practices] exist.” As there is no universal categorization, we focus on the log-frame indicators as the basis. As result, all the practices fall under the following three broader options: water and soil management, agronomical practices, and market.

Within these broader options, we identified six key practices: land preparation, incorporating plant rests in and on soil (incl. mulching), crop rotation, management of plagues and diseases and use of inputs

[2] FAO and FutureWater. 2020. Guidance on Realizing Real Water Savings with Crop Water Productivity Interventions. Wageningen. (in process for publication)

(including use of fertilizer and improved seeds). The table below shows the key-practices related to the categories.

It should be noted that the practices are focused on agronomical practices with the effect on production. This means that for this analysis, specific market practices such as improved market information and the formulation of a business plan have not been included in the analysis.

Type of practice	Log-frame indicator
1. Water and soil management	1.2
a. Land preparation	
b. Incorporating plant rests in and on soil	1.3.2
2. Good agricultural practices	
a. Crop rotation	1.3.1
b. Management of plagues and diseases	1.3.3
3. Market	
c. Use of inputs (fertilizers and improved seeds).	1.4.2

Figure 10 Practices in relation to project's log-frame

3.3 Theoretical impact

The theoretical impact of the interventions is estimated using the crop simulation model AquaCrop. Selected interventions are simulated that coincide with the categories as described in the section above.

3.3.1 Crop simulation model (AquaCrop)

A description of the AquaCrop set-up is provided in the water productivity report of the 2019-2020 season[3]. The flying sensor and field data from the rain season were used to calibrate the AquaCrop model. From each district two PPCs (small commercial farmers) were selected that were monitored with flying sensor during the season. A total of six PPCs are used to perform the theoretical impact analysis. For each PPC a simulation was performed for selected interventions (as elaborated in the next section), to determine the impact of the intervention.

3.3.2 Interventions simulated

Interventions were selected according the categorization as described in section 3.2. The AquaCrop parameters used to simulate the intervention are listed below:

- For land preparation category (1a) the simulated intervention was:
  - Runoff management by introducing 0.25m soil bunds
- For plant rests on soil category (1b) the simulated intervention was:
  - Mulching 80% cover with 50% effect on soil evaporation
- For crop rotation category (2a) the simulated interventions were:

[3] Van Opstal, J.D., M. de Klerk, A. Kaune, C. Nolet, J.E. Beard. 2020. Water Productivity Analysis: Rainfed Season 2019-2020. FutureWater Report 204.

- Change in planting date to 14 days earlier
- Change in planting density
- Combination of two crops is not possible in AquaCrop as it is not a farming system model but crop-specific

- For agronomic inputs category (2b) the simulations interventions were:
  - Seed variety by changing the crop growth coefficient in the crop module of AquaCrop
  - Fertilizer inputs

3.4 Observed impact

3.4.1 Survey adoption of practices

<u>Locations</u>

Interviews have been conducted in three districts being the districts of Nhamatanda, Báruè and Moatize. Differences in the social context and agroecological diversity between the locations suggests a difference in impact. Therefore, caution should be taken once averaging the results of the three districts.

Figure 11 Interviews were taken in Sofala, Manica and Moatize

<u>Structured interviews</u>

During three weeks, 108 project beneficiaries and 18 non-project beneficiaries have been interviewed. Data collection tools have been designed and reviewed by the consortium, according to the following criteria; use simple quick-to-understand language for respondents, use a mix of qualitative and quantitative data, create a comprehensive and simple too, that at the same time provides answers to the log-frame indicators. This data collection round focusses on the implementation of training topics by farmers. The interview is included in annex 1.

<u>Data analyses</u>

The outcomes of the interviews have been analyzed using descriptive statistics. Data is predominantly expressed in percentages to express how a (group of) producer(s) relates to the total group respondents. In addition, the adoption data of specific farmers is used for the impact analysis of this report.

3.4.2 Yield reports

<u>Locations</u>

Interviews have been conducted in three districts being the districts of Nhamatanda, Báruè and Moatize. Differences in the social context and agroecological diversity between the locations suggests a difference in impact; therefore, care should be taken once averaging the results of the three districts.

<u>Data collection</u>

This data collection round has been carried out to capture farm performance, household demographics and access to input/output markets. In a period of two weeks, 177 project beneficiaries and 44 non-

project beneficiaries are interviewed using the farmer recall method[4]. In collaboration with SDAE a control group of 44 "random" farmers, not linked to the Project, have been selected. These control farmers are located in the same districts (14 in Moatize and 15 in both Nhamatanda and Báruè.) as APSAN-Vale farmers and their socio-economic and agri-ecological situation is comparable.
This interview is targeting the logframe indicators, 1.1, 1.5, 1.6, and 1,7

- Indicator 1.1 Agricultural Yield for selected staple crop
- Indicator 1.7 ## farmers with improved access to input/output markets`
- Indicator 1.5 ##farmers with increased productivity
- Indicator 1.6 ## farmers with increased income

The workflow of data collection has been optimized using data collection tool Mwater and data storage and analyses tool Farmcollect. Using Farmcollect all interview outcomes linked to corresponding proof (PDF of full interview + pictures of field book) are stored directly linked to the beneficiaries.

Collection and conversion of yield data.

To capture farm performance, data is collected on items including the cropping patterns, labor, the yield of products along with their use and price. The data collection process is designed in structured interviews and copying the data from the farm field book. To analyze the production data a multitude of units has been used to express the volume of yield, an extensive translation table is made to absorb and compare all these differences.

For horticulture crops, no conversion is used. However, to express the volume of maize different units are used for different phases in the crop processing stage. When maize is expressed in Carroça, this is dry maize with husk and not threshed (Figure 12), and when the unit is in bags (sacos) and cans (latas) it means dry threshed maize (Figure 13). Furthermore, when the unit is saddlers, the maize is dried without husk and not threshed (Figure 14). When maize yield is displayed, this is always X kg of dry threshed maize (Figure 13).

Figure 12 Unshelled cobs with husk (nationalgeographic.org, 2020)

[4] Farmer recall method: http://www.fao.org/3/ca6514en/ca6514en.pdf

Figure 13 Threshed dry maize (nairaland.com,2020)

Figure 14 Non-threshed dry Maize without husk (adobe stock, 2020)

When the maize unit given by the farmer is not in bags (sacos) and cans (latas), meaning it is not threshed, we have applied a unit/quantity conversion to kg threshed with a correction factor, this is a common method used by the Mozambican government—as advised by Prof. Nhatumbo of ISPM in Chimoio (agronomy researcher).

Where: a) For maize with husk and not threshed (Figure 3), the correction formula is: Volume of the unit of measurement (which can be Carroça, saddler, etc.) * nr/quantity of the unit of measurement * 0.292 (correction factor). B) For shelled (Cob without husk) and not threshed maize (Figure 5), the correction formula applying the factor is: volume of the unit of measurement (which can be Carroça, saddler, etc.) * nr/quantity of the unit of measurement * •0.839 (correction factor).

We have specifically asked farmers about the maize yield in Carroça and the majority was able to provide this; therefore, the most used conversion for the production data has been; Maize yield in kg = Volume of Carroça * nr of Carroça obtained * 0.292 (correction factor).

In order to reach the best results, a quality check via telephone has been conducted with 70 producers making minor corrections or confirming their yield data.

Data analyses

Outcomes of the interviews have been analyzed using descriptive statistics to summarize data. Data is predominantly expressed in actual values or percentages to express how a (group of) producer(s) relates to the total group respondents. For this impact report, the production data of the specifically selected farmers is used for analysis.

Field cut

The yield was estimated separately for PPCs and PPEs. PPCs were calculated as recommended by CYMMIT- International Center for Corn and Wheat Improvement:

1: Collection of 5 corn samples per plot of each PPC (Each sample includes 10 meters times two lines);

2: Count of ears in each sample and mixture of samples;
3: Drying the ambient temperature of the ears with shirts;
4: Threshing and weighing;
5: Calculation of the weight of the degree per unit of area using the formula below (recommended by Emater).

Produtividade (toneladas/ha a 15,5% de umidade) = [(NE x P) / EM] /1000

NE: Número médio de espigas em 10m lineares
P: Peso médio de grãos por espiga corrigido para 15,5% de umidade, obtido pela média do peso de grãos de 3 espigas coletadas (gramas)
EM: Espaçamento entre linhas (m)

Figure 15 Corn threshing

Figure 16 Weighing the samples

PPEs: The yield was estimated by calculating the number of wagons times 400kg. And, weighing the threshing corn, in this case, there were few cases found given that, the producers after harvesting keep the corn in their barns.

Figure 17 Corn drying process

Figure 18 Example of a wagon used to transport corn from the machamba home

3.5 Scoring system

The observed impact of the practices on the crop yield and water productivity is evaluated using a scoring system. The relevance of applying a scoring system is two-fold. Firstly, a scoring system provides a unitless number (0 – 1 or 1 - 10) to indicate if the given crop yield or water productivity value is in the upper range or the lower range compared to the overall values. A score is more understandable than the results in crop yield and water productivity itself. Secondly, a scoring system also enables better comparison between districts and years. Both these aspects are highlighted in the description of the scoring system below.

3.5.1 Min max method

Below in Figure 19 an example is provided displaying the min-max method of scoring. For each district the minimum and maximum values of either crop yield or water productivity are taken. The minimum value indicates a score of 0 and the maximum value a score of 1. The results in crop yield or water productivity in between the minimum and maximum values are then put on the scale using the equation below.

$$Score\ [-] = \ (Value_{max} - Value)/(Value_{max} - Value_{min})$$

In Figure 19 it shows that the maximum score of 1.0 has different corresponding crop yield and water productivity values. This indicates that the maximum achieved in each district was different.

Crop yields (average all methods)	Scoring (all yields)	Water productivity	Scoring (WP)
2.0	0.0	0.44	0.0
2.3	0.3	0.44	0.0
2.1	0.4	0.43	0.0
2.6	0.6	0.44	0.0
3.0	0.8	0.51	0.5
2.3	0.0	0.49	0.6
1.5	0.0	0.51	0.7
1.9	0.3	0.51	0.7
2.3	0.5	0.52	0.8
2.6	0.6	0.52	0.9
2.7	0.9	0.52	0.9
2.1	0.4	0.54	1.0
2.6	0.5	0.57	1.0
2.7	0.7	0.53	1.0
3.2	1.0	0.57	1.0
3.2	1.0	0.57	1.0
3.0	1.0		
2.8	1.0		

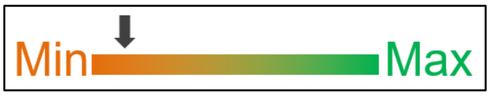

Figure 19 Example of min-max scoring for the crop yield and water productivity values.

3.5.2 Histogram

The histogram approach for scoring water productivity is commonly used and well-reported in the paper Bastiaanssen and Steduto, 2016[5]. Figure 20 below shows how the histogram of water productivity values can be divided into equal sections which all relate to a certain score. This method is applicable when a large group of results are available to establish a statistical histogram. For the current report, this method is excluded due to the limited number of values, but this could be used in future analyses.

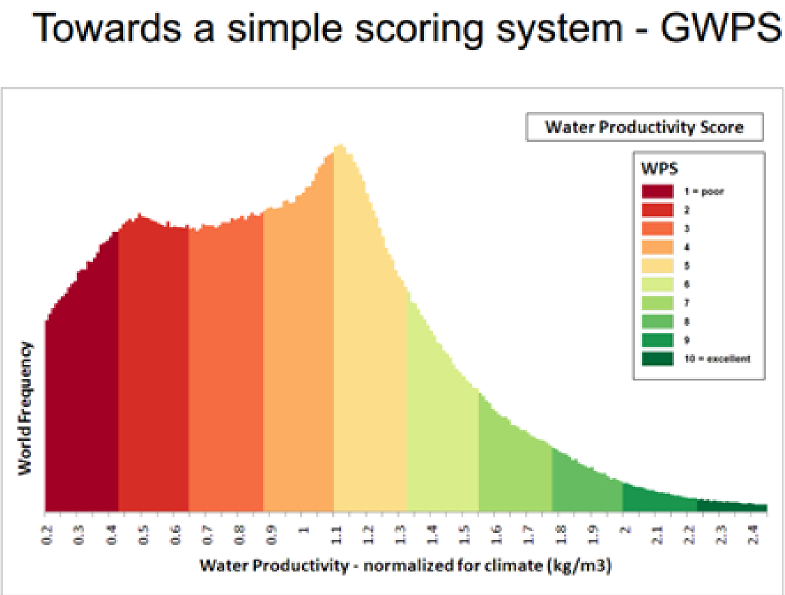

Figure 20 Example of scoring using a histogram of water productivity values

[5] Bastiaanssen, W. G. M., & Steduto, P. (2016). The water productivity score (WPS) at global and regional level: Methodology and first results from remote sensing measurements of wheat, rice and maize. Science of The Total Environment. https://doi.org/10.1016/j.scitotenv.2016.09.032

4 Theoretical impact

The impact of interventions is evaluated using the crop simulation model AquaCrop. In total six different interventions are analyzed namely: fertilization, hybrid seed variety, mulching or plant rests, planting density, planting date, and runoff management (e.g. soil bunds).
The results of this analysis with AquaCrop are presented in the following sections, discussing the impact on the overall water balance, evapotranspiration, crop yield, and water productivity.

4.1 Impact on water balance

Runoff management is one of the water management interventions introduced to the PPCs (small commercial farmers) in the APSAN-Vale project. It is expected that runoff management will have an impact on the distribution of the water balance components. This is simulated in AquaCrop and the results are shown in Figure 21. For each district the values are presented which are the average of the two farmers located in that district and used in this scenario simulation.
The input to the water balance, namely precipitation, is constant in both scenarios 'original' and 'runoff management'. The runoff component is zero for the 'runoff management' scenario; due to the soil bunds, runoff is prevented.
The impact of the runoff management intervention is different for each district as a result of the different soils. Báruè has mainly a clay soil, whilst in Moatize a sandy loam soil dominates, and in Nhamatanda a sandy clay soil. This gives differing results mainly in the infiltration, drainage, and runoff components. The (soil) evaporation component remains mostly unchanged. The transpiration component shows limited impact of the runoff management as indicated in the graph where the difference between the original and intervention scenario is negligible. The runoff in the original scenarios show that the runoff is meager in Moatize and highest in Báruè. Runoff is more characteristic for clayey soils. In addition, more precipitation occurs in Báruè region in comparison with Moatize and Nhamatanda. As a result of the small runoff component in Moatize, the impact on the infiltration and drainage components are limited. For Báruè and Nhamatanda, the infiltration and drainage components increased largely compared to the original scenario.

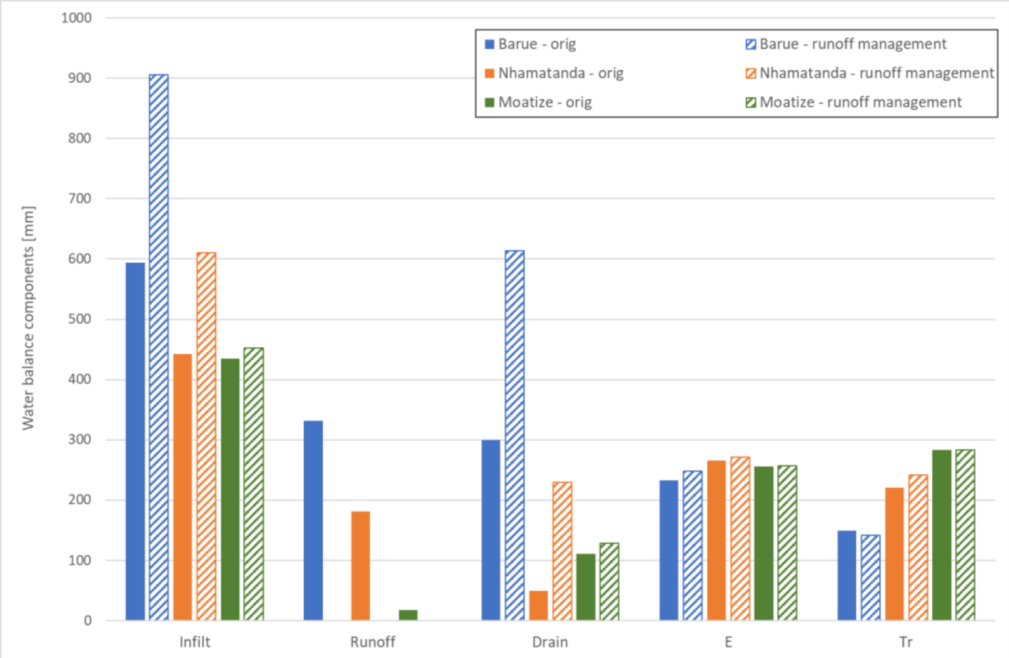

Figure 21 Impact of the runoff management intervention on water balance components: infiltration (Infilt), runoff, drainage, evaporation (E) and transpiration (Tr)

4.2 Impact on evapotranspiration

From the water balance components, the evapotranspiration is relevant for further analysis because it is the denominator of the water productivity calculation. The change in evapotranspiration between the original scenario and scenario with the intervention is presented in Figure 22 for the six interventions simulated with AquaCrop. Note that a positive difference (+%) indicates a higher evapotranspiration thus more water consumption.

Most interventions are aimed at increasing the crop production and therefore an increase in evapotranspiration is expected, as higher crop production equals higher transpiration. This is the case for the interventions: fertilization, seed variety (with the exception of Báruè), and planting density. The planting density intervention, however had limited impact. This could be due to the planting density already being at optimal or that a larger change is required to notice the impact. The seed variety shows the largest increase in evapotranspiration for Nhamatanda and Moatize. However, for Bárué a decrease in evapotranspiration is found in the results. This signifies that further fine tuning is needed to select suitable crop growth parameters, which are apparently different for Bárué than the other two districts.

The intervention that consistently reduces the evapotranspiration is mulching or leaving plant rests on the soil. This intervention aims at reducing the soil evaporation especially during the crop development stage before achieving full vegetation cover. The reductions in evapotranspiration that can be achieved are on average 10%.

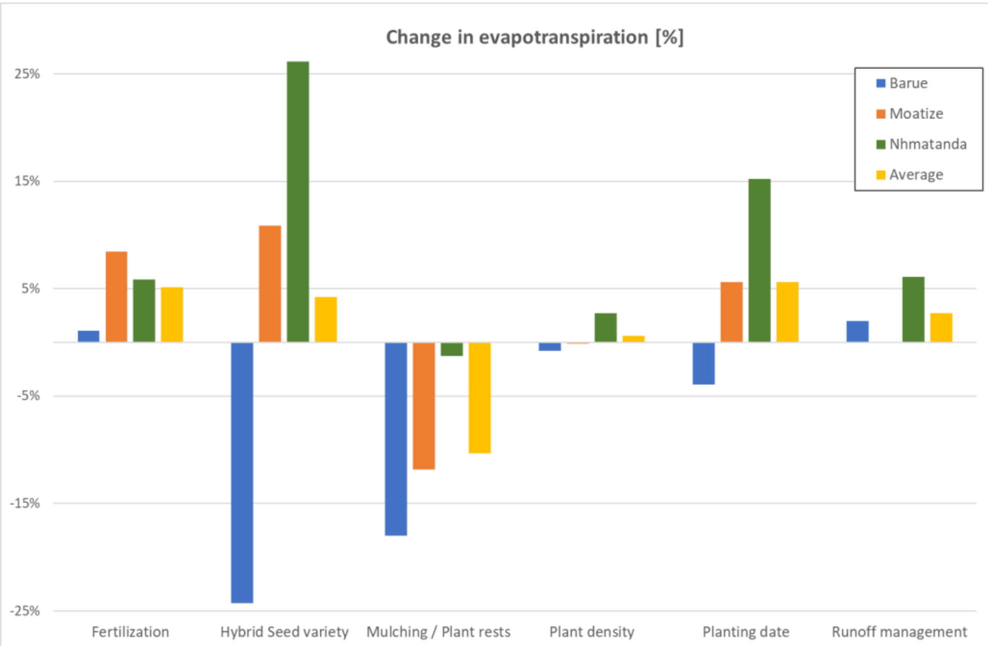

Figure 22 Impact of each intervention on evapotranspiration indicated as difference compared with a scenario without the intervention. Positive percentages indicate an increase in evapotranspiration

4.3 Impact on crop yield

The impact on crop yield was also simulated in AquaCrop for the six interventions. The results are displayed in Figure 23 indicating the change in crop yield compared to the original scenario. The crop yield increased for each intervention except for the planting date. Changing the planting date to 14 days earlier negatively impacted the crop production. This is likely due to the weather conditions being less favorable. Better tuning of the planting date and comparing with field decisions is required to improve the simulations of this intervention. The highest crop yield increases are perceived for the fertilization and seed variety interventions, particularly for Nhamatanda.

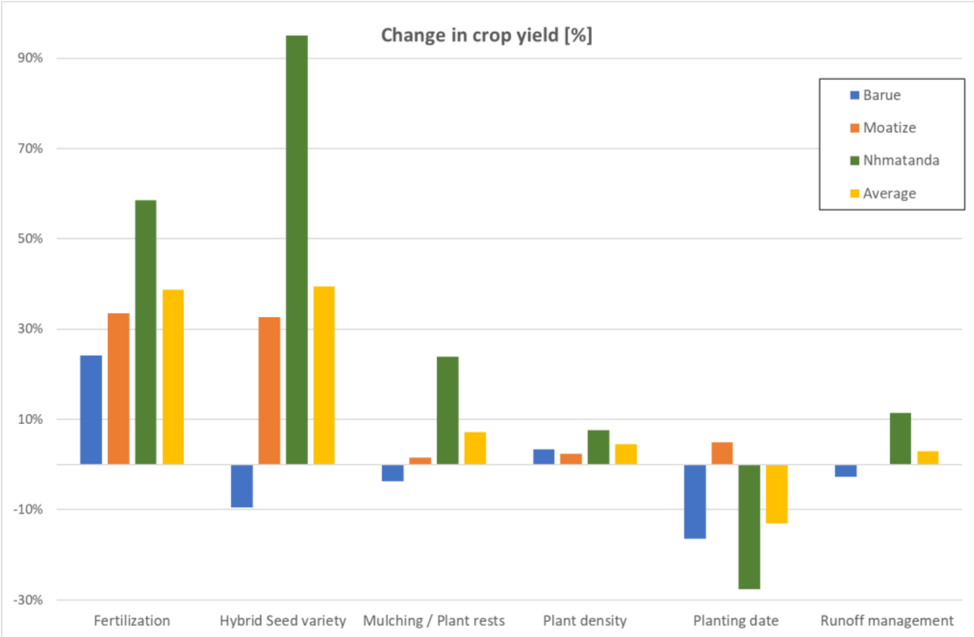

Figure 23 Impact of each intervention on crop yield indicated as difference compared with a scenario without the intervention. Positive percentages indicate an increase in crop yield

4.4 Impact on water productivity

The impact on water productivity combines the effects on evapotranspiration and crop yield as were explained in the previous sections. The results are presented in Figure 24 for the three districts and the six interventions. The three interventions giving notable positive impact on water productivity are fertilization, seed variety selection, and mulching or plant rests. The plant density and runoff management had limited effect on the water productivity and the planting date had a negative impact due to the decrease in crop yield.

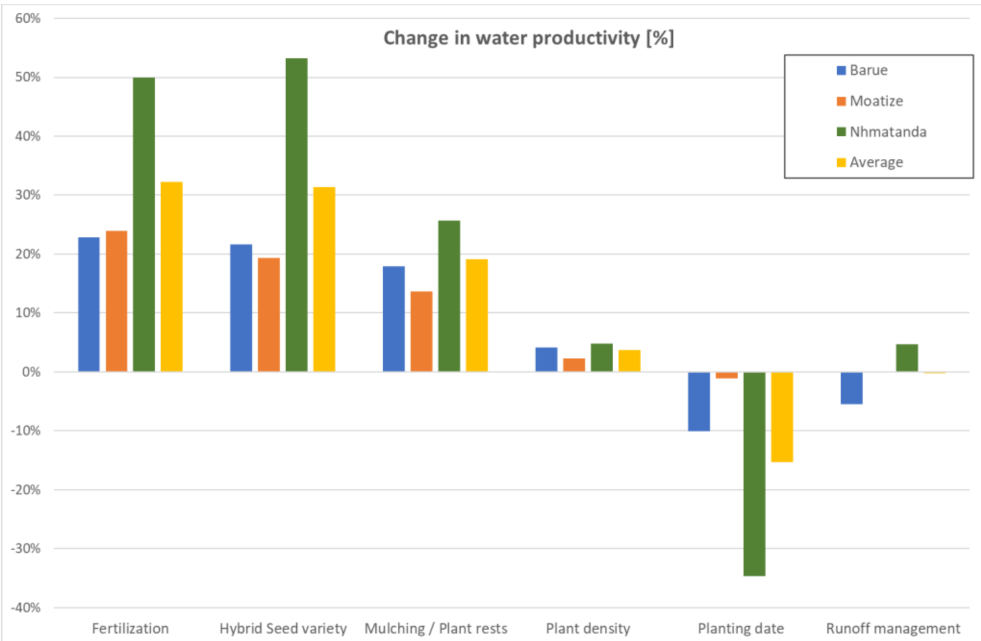

Figure 24 Impact of each intervention on water productivity indicated as difference compared with a scenario without the intervention. Positive percentages indicate an increase in water productivity

4.5 Overall results

A summary of the results comparing the different interventions, is presented in Table 2 providing the average for all districts.

Some key conclusions that can be drawn from the results of this analysis are:

- Mulching or plant rests is the only intervention that reduces the evapotranspiration component
- Agronomic interventions (fertilizers and seed variety) have the highest impact on yield and water productivity
- Planting date needs to be adjusted better to local information. Two weeks earlier is potentially not reasonably especially when planting depends on the rain forecast
- Impact of runoff management largely depended on the soil type. All districts have different soil types

Table 2 Simulated impact on ET (evapotranspiration), Y (yield), and WP (water productivity) for six key interventions

Interventions	Average change ET	Average change Y	Average change WP
Fertilization	5%	39%	32%
Hybrid seed variety	4%	39%	31%
Mulching / plant rests	-10%	7%	19%
Plant density	1%	4%	4%
Planting date	6%	-13%	-15%
Runoff management	3%	3%	0%
Overall (total)	**1%**	**13%**	**12%**

In general, further analysis and additional simulations are required to fine tune the interventions to better reflect the local implementation of interventions. However, the advantage of having simulation results and an analysis of the theoretical impact is that an outcome can be predicted without needing to make prior investments to implement the interventions.

5 Observed impact

5.1 Adoption of practices

The monitoring survey quantified the number of farmers adopting certain practices. The results of the survey are presented in Table 3 and Figure 25. The land preparation practice (consisting of runoff management) gave the highest percentage of adoption by selected farmers. This was followed by the collective practice of providing additional inputs such as fertilizers and seed variety selection. The other practices of plant rests, crop rotation, and pest management, were all adopted by more than half of the selected farmers and 70% or more from the farmers in general.

Figure 25 shows the individual practices with the color of the corresponding categories. Most practices were adopted frequently and usually by more than 40%. The practices that were lower are related to fertilizer management, which is a combined practice. The adoption of practices will likely relate to the trainings received by the farmers, the availability of demonstration plots or neighboring farmers adopting the practices, and the farmers' access to resources to implement the practices.

Table 3 Results from the monitoring survey on percentage of adoption of practices for each category

Practice	Logframe indicator	Adoption by farmers	Adoption by selected farmers
1. Water and soil management	1.2	72%	92%
a. Land preparation		79%	92%
b. Incorporating plant rests	1.3.2	No data	58%
2. Good agricultural practices			
a. Crop rotation	1.3.1	70%	62%
b. Pest management	1.3.3	74%	65%
3. Market			
c. Additional inputs (fertilizers, seed variety)	1.4.2	84%	81%

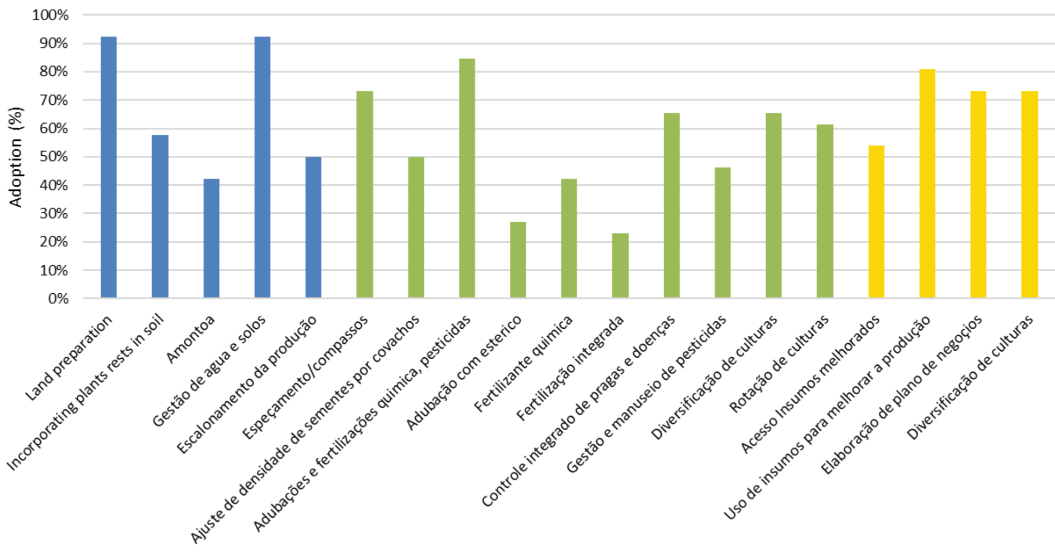

Figure 25 Results of the monitoring survey on the adoption of each practice as percentage of farmers from total surveyed

5.2 Results from field test of mulch on soil water availability

To test the effect of mulching on soil water availability, and to demonstrate this to the farmers, participatory field tests with a soil moisture sensor were performed in Nhamatanda and Moatize. Results show significantly higher soil moisture contents when mulching is applied as can be seen in Table 4. Fields with mulch are far better in preserving soil moisture than fields without mulch, even after a week without rain. Moreover, measuring this together with the PPCs and several PPEs while explaining the effect of mulching promotes the adoption of the practice.

Table 4 Effect of mulch on soil moisture content

Location (district)	Date	Average soil moisture content (n=5)		Last rain	
		Mulch	No mulch	Date	Amount
Mameme (Moatize)	3-3	24,7%	15,4%	27-2	0,5 mm
Lamego (Nhamatanda)	20-2	29,6%	10,3%	13-2	42,0 mm
Lamego (Nhamatanda)	10-3	19,5%	8,8%	3-3	11,0 mm

5.3 Results on crop yield and water productivity

The results of crop yield and water productivity are shown in Table 5 indicating the crop yield for the three different methods: farmer recall, crop cut method, and AquaCrop (model simulation), and the water productivity from AquaCrop. Between the methods of determining crop yield there exists some disparities in the results, when comparing for those farmers that all three methods were used. However, most are within the expected range of the crop yield and denotes the importance of reporting carefully the method of measurement of crop yield. The water productivity results are within the expected range for maize water productivity. There is limited variation between farmers in the water productivity results, due to the fact that most farmers have a commercial ambition and therefore already are expected to have a reasonably higher water productivity value.

Table 5 Results of number of practices adopted, crop yield (three methods) and water productivity

	Adoption of Interventions / Good practices Totals		Yield and water productivity data				
			Farmer recall	Crop cut method	AquaCrop	Average	Water productivity
District	Number of practices applied (/19)	Number of key practices implemented (/6)	Crop yield season 2019-2020 [ton/ha]	Crop yield season 2019-2020 [ton/ha]	Crop yield season 2019-2020 [ton/ha]	Crop yield season 2019-2020 [ton/ha]	Water productivity season 2019-2020 [kg/m3]
Moatize	5	5	3.20		2.38	2.79	0.57
Barue	14	5	3.38			3.38	
Nhamatanda	17	6	2.80			2.80	
Moatize	8	5	3.50		1.87	2.69	0.51
Nhamatanda	9	5	2.80		2.01	2.41	0.52
Nhamatanda	7	3	2.20			2.20	
Moatize	13	6	3.27	0.93	2.36	2.19	0.57
Nhamatanda	11	5	2.72	0.88	1.71	1.77	0.53
Nhamatanda	14	6	2.67	0.82	1.73	1.74	0.44
Nhamatanda	10	3	2.40	0.82	1.98	1.73	0.52
Nhamatanda	10	5	2.00	0.58	2.13	1.57	0.49
Nhamatanda	7	3	1.52			1.52	
Barue	10	4	3.40	0.99		2.19	
Nhamatanda	6	0	1.33			1.33	
Barue	8	1	2.00			2.00	
Moatize	6	6	1.44	0.92	2.37	1.58	0.57
Moatize	8	4	1.70	0.82	1.80	1.44	0.44
Nhamatanda	8	2	1.00			1.00	
Moatize	15	5	1.40			1.40	
Barue	17	6	2.40	1.00	1.28	1.56	0.43
Barue	16	6	2.33	0.78	1.54	1.55	0.54
Barue	16	6	1.94	1.14	1.56	1.54	0.52
Barue	13	5			1.46	1.46	0.51
Moatize	12	4	0.39	0.93	1.80	1.04	0.44
Barue	17	6	1.10		1.45	1.28	0.51
Nhamatanda	17	5	0.50			0.50	

5.4 Scoring of the crop yield and water productivity

The scores are provided for the crop yield and water productivity results to provide more clarity on the higher and lower values, as presented in Table 6. The scores are sorted from highest to lowest average crop yield per district. Overall, the highest crop yield also resulted in higher values for water productivity. They also coincide with high adoption of practices. However, Table 6 also shows that high adoption of practices is perceived for farmers with a lower crop yield score. This can be investigated in further detail to determine the impact and success of adopted interventions.

Table 6 Results for practices adopted and scores of crop yield and water productivity

	Adoption of Interventions / Good practices Totals		Yield and water productivity data				
			Farmer recall	Crop cut method	AquaCrop	Average	Water productivity
District	Number of practices applied (/19)	Number of key practices implemented (/6)	Scoring	Scoring	Scoring	Scoring	Scoring
Moatize	5	5	0.90		1.00	1.00	1.00
Barue	14	5	0.99			1.00	
Nhamatanda	17	6	1.00			1.00	
Moatize	8	5	1.00		0.13	0.94	0.54
Nhamatanda	9	5	1.00		0.73	0.83	0.89
Nhamatanda	7	3	0.74			0.74	
Moatize	13	6	0.92	1.00	0.97	0.66	1.00
Nhamatanda	11	5	0.97	1.00	0.00	0.55	1.00
Nhamatanda	14	6	0.94	0.80	0.06	0.54	0.00
Nhamatanda	10	3	0.83	0.80	0.66	0.54	0.89
Nhamatanda	10	5	0.65	0.00	1.00	0.47	0.56
Nhamatanda	7	3	0.44			0.44	
Barue	10	4	1.00	0.58		0.44	
Nhamatanda	6	0	0.36			0.36	
Barue	8	1	0.39			0.34	
Moatize	6	6	0.34	0.88	0.99	0.31	1.00
Moatize	8	4	0.42	0.00	0.00	0.23	0.00
Nhamatanda	8	2	0.22			0.22	
Moatize	15	5	0.32			0.21	
Barue	17	6	0.57	0.61	0.00	0.14	0.00
Barue	16	6	0.54	0.00	0.93	0.13	1.00
Barue	16	6	0.36	1.00	1.00	0.13	0.82
Barue	13	5			0.63	0.09	0.73
Moatize	12	4	0.00	1.00	0.00	0.00	0.00
Barue	17	6	0.00		0.63	0.00	0.73
Nhamatanda	17	5	0.00			0.00	

Figure 26 provides an analysis of the impact of the four selected interventions using the results of the monitoring and scoring. The farmers that adopted the interventions are compared with those that did not adopt the intervention. An increase in crop yield score was observed for three interventions: land preparation, soil and water management, and additional inputs. The intervention crop rotation had a slight negative impact. However, crop rotation is an intervention that encompasses multiple seasons therefore the impact will likely be observed at a later stage.

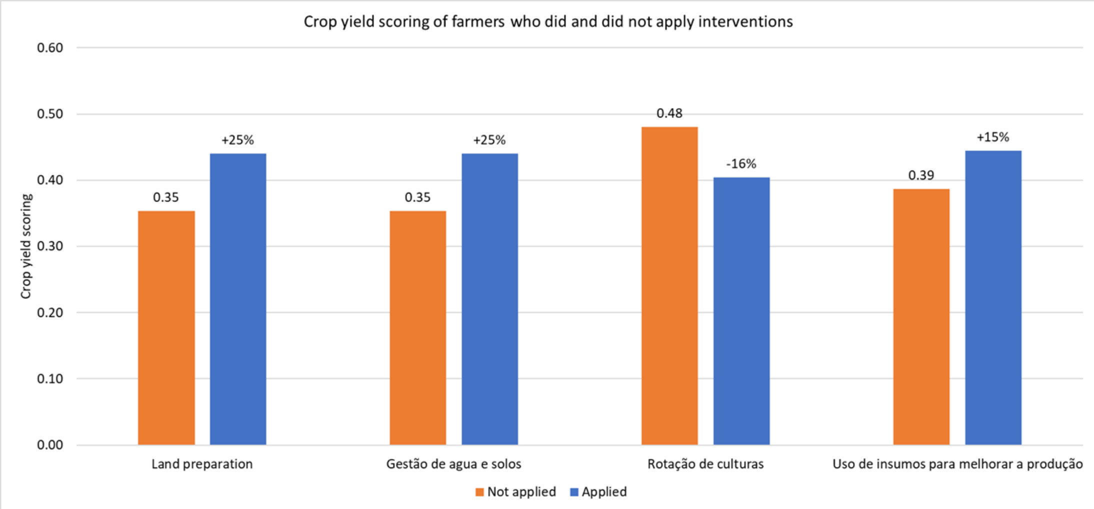

Figure 26 Impact of four key interventions (land preparation, soil and water management, crop rotation, and additional inputs) indicating the difference in crop yield score between applied and not applied

5.5 Overall results

In conclusion, the analysis of observed impact demonstrates the relevance of using this approach for determining the effect of various interventions. The land preparation practice (consisting of runoff management) gave the highest percentage of adoption by selected farmers, followed by providing additional inputs such as fertilizers and seed variety selection. The other practices of plant rests, crop rotation, and pest management, were all adopted by more than half of the selected farmers and 70% or more from the farmers in general. Since the PPCs adopted various of the practices, the effect of individual interventions was less pronounced. Secondly, results show significantly higher soil moisture contents when mulching is applied. Fields with mulch are far better in preserving soil moisture than fields without mulch, even after a week without rain.

Scoring of the crop yield and water productivity shows that the highest crop yield also resulted in higher values for water productivity. They also coincide with high adoption of practices. However, high adoption of practices is also perceived for farmers with a lower crop yield score. By comparing farmers that adopted the interventions with those that did not adopt the intervention, for four selected interventions, an increase in crop yield score was observed for three interventions: land preparation, soil and water management, and additional inputs. The intervention crop rotation had a slight negative impact. However, crop rotation is an intervention that encompasses multiple seasons therefore the impact will likely be observed at a later stage.

Overall, the interventions had a positive impact on the crop yield scores and water productivity scores. In addition, high crop yield scores also generally aligned with the water productivity values. Continuation of the analysis and recommendations are elaborated in the following chapter.

6 Discussion and concluding remarks

The approach for determining the theoretical and observed impact of field interventions, is demonstrated as being relevant and suitable for the APSAN-Vale project and will be used and refined in the continuation of the project. The scoring system provides the relevant insight to compare the crop yield and water productivity results between districts and determine the interventions with higher impact or more successful implementation.

The analyses performed as reported in chapters 4 and 5 gave a few relevant points of recommendation for follow-up activities. These are as follows:

- Future activities can focus more on the harmonization of farmers being monitored by the flying sensors (thus having a water productivity analysis) and the farmers included in the monitoring survey.
- In this analysis, the applied practices were categorized based on the log-frame indicators. For the next impact analyses the practices will be analyzed in more detail, such as fertilizer and improved seeds instead of 'use of inputs.' This also includes market indicators to analyze the practices in relation to income.
- The observed impact data shows limited variability in values of crop yield and water productivity because the farmers are all PPCs (small commercial farmers). Future analysis can include adjacent field of PPE's (smallholder farmers) to achieve a greater range of crop yield and water productivity.
- The expectation is also that the irrigation season will show greater differences because farmers make diverse decisions regarding their on-field water management.
- There is a need to integrate the theoretical impact and observed impact to evaluate if the theoretical achievements are plausible in the field or if other significant factors play a role in the success of the interventions.
- Lastly, it is relevant to bring the results from the theoretical impact and observed impact to the field for quality control and understanding the full story.

Annex 1: The adoption interview (March 2020)

Entrevista : Avaliação da Adoção dos Tópicos de Treinamento APSAN VALE

1. INTRODUÇÃO

Nós somos da ○ **HUB** ○ **Resiliência** ○ **FW** e estamos realizando uma pesquisa a nível dos agregados familiares constituídos por pequenos agricultores os quais são assistidos no quadro do **Projecto APSAN-Vale**. Eu gostaria de falar com você sobre como tem aplicado os conhecimentos adquiridos nos treinamentos que participou sobre a promoção de Boas Praticas Agrícolas e técnicas melhoradas de Irrigação.

Atenção: Não deixe perguntas em aberto, use os códigos gerais **997** "Nenhuma ideia" ou **999** "Nenhum / Não Aplicável".

2. Dados da Entrevista

1. Nome do técnico:____ Data da entrevista:____/____/202___

2. Tipo de entrevistado: ○ PPE ○ PPC ○ Novo produtor ○ Outro (especifique)___________________

3. Código do produtor: (*Preencher antes da Entrevista Começar*)

1. Distrito: O BA (Báruè) O MO (Moatize) O NH (Nhamatanda)

2. Nome: ____________________ Segundo nome:_________________ Apelido:____________________Idade:______Contacto:____________________

O código deve ser criado usando as primeiras 2 letras do distrito + Primeiras letras dos nomes e apelidos do produtor (usar apenas 3 letras)

4: Demografia e estrutura familiar

Q1: Género: ○ Feminino ○ Masculino

Q2: Numero de membros do agregado familiar? ________	**0 a 5 anos**	**5 a 35 anos**	**+ de 36 anos**
Q3: Faixa etária dos membros da família »»»»»			
Q4: Numero de crianças na escola________			

5. Trabalho e Renda

Q5: Quantos membros da família trabalham na machamba familiar?______

Q6: Esses membros são pagos? ○ Sim ○ Não

Q7: Quantos dias de trabalho laboral você precisa anualmente para cultivar/irrigação? ________

Q8: Tem alguma atividade comercial ou fonte de renda fora de agricultura? ○Sim ○Não

Q9: Quanto você ganha por ano com outras actividades fora da agricultura? _________MZN

Q10: Quanto você ganha por ano com machamba? __________MZN

6. Acesso à terra

Q11: Tem DUAT? ○Sim ○ Não

Q12:Área total cultivada: ___________ha

Q13: Área total de sequeiro: _______ha

Q14: Área total irrigada: ___________ha

Q15 Número de machambas(se for possível):_______

7. Localização das Áreas

Q16: Em que distrito se encontra localizada a (s) sua (s) machamba (s) irrigada (s) (indique o distrito e a localidade)

Nhamatanda (Sede)
- ○ Metuchira
- ○ Siluvo
- ○ Chirassicua
- ○ Macorococho
- ○ Bebedo

Nhamatanda (Tica)
- ○ Tica Sede
- ○ Nhampoca
- ○ Chiadeia

Báruè (Nhampassa)
- ○ N'Fudze
- ○ Nhassacara
- ○ Chimondzo

Báruè (Catandica Sede)
- ○ Catandica Sede
- ○ Chuala
- ○ Inhazónia

Báruè (Serra Chôa)
- ○ Chôa Sede
- ○ Nhauroa

Moatize
- ○ Moatize sede
- ○ Benga
- ○ N'panzu
- ○ Msungo

Moatize(Kambulatsitsi)
- ○ Kambulatsitsi – sede
- ○ Necungas
- ○ Mameme 2

Moatize (Zobue)
- ○ Zobue – sede
- ○ Capiridzanje
- ○ Ncondedzi
- ○ Samôa

Q16.1: Tem tendência em aumentar a área irrigada? ○Sim ○Não

Q16.2: Se a resposta for sim, quanto quer aumentar? ______ha

Q17: A (s) machamba (s) de sequeiro encontra-se na mesma localidade com a (s) irrigada (s)? ○Sim ○Não.

Q17.1: Se a resposta for **Não** Em que distrito se encontra a machamba de **sequeiro**? (indique o distrito e a localidade)

Nhamatanda (Sede)
- ○ Metuchira
- ○ Siluvo
- ○ Chirassicua
- ○ Macorococho
- ○ Bebedo

Nhamatanda (Tica)
- ○ Tica Sede
- ○ Nhampoca
- ○ Chiadeia

Báruè (Nhampassa)
- ○ N'Fudze
- ○ Nhassacara
- ○ Chimondzo

Báruè (Catandica Sede)
- ○ Catandica Sede
- ○ Chuala
- ○ Inhazónia

Báruè (Serra Chôa)
- ○ Chôa Sede
- ○ Nhauroa

Moatize
- ○ Moatize sede
- ○ Benga
- ○ N'panzu
- ○ Msungo

Moatize(Kambulatsitsi)
- ○ Kambulatsitsi – sede
- ○ Necungas
- ○ Mameme 2

Moatize (Zobue)
- ○ Zobue – sede
- ○ Capiridzanje
- ○ Ncondedzi
- ○ Samôa

Q17.3: Tem tendência de aumentar a área de sequeiro? ○ Sim ○ Não

Q17.4: Se a resposta for sim, quanto quer aumentar? ______ha

8. Mercados de entrada / saída

Q18: Você tem acesso a insumos agropecuários, como fertilizantes, inseticidas, herbicidas ou sementes? ○ Sim ○ Não

Q19: O acesso ao mercado de entrada (insumos) e de saída de produtos (venda) melhorou no ano de 2019 com ao APSAN Vale? ○ Sim ○ Não

Q20: A sua produtividade aumentou? ○ Sim ○ Não

Q21: A sua renda aumentou? ○ Sim ○ Não

9. Avaliação do conhecimento sobre BPA e Gestão da Água

Q22: O seu conhecimento com praticas de irrigação melhorou com o APSAN-Vale? ○ Sim ○ Não

Q23: Você tem acesso informações de mercado? ○ Sim ○ Não

Q24: Você tem acesso a insumos melhorados? ○ Sim ○ Não

Q25: Você e sua família tem acesso a alimentos diversificados? ○ Sim ○ Não

Q26: Você tem acesso melhorado e apropriado dos alimentos? ○ Sim ○ Não

10. Avaliação da Implementação dos tópicos dos treinamentos (Perguntas exclusivas para PPC e PPE)

Q27: Tem recebido algum treinamento do APSAN-Vale nos últimos 6 meses? ○ Sim ○ Não

Q28: Depois de receber os treinamentos e as recomendações técnicas quais novas praticas você implementou? ***(Múltiplas respostas)***

Tópicos Agrícolas			**Tópicos de Nutrição e Higiene**	**Tópicos de Higiene**
Agricultura	**Irrigação**	**Mercados**		
○ Visitas e Troca de experiência com outros PPCs	○ **Mulching**	○ Elaboração de plano de negócios	○ Treinamento em produção de lages	○ Latrina melhorada c Tip Tap
○ Boas Praticas Sequeiro	○ Rega por sulcos	○ Diversificação de culturas	○ Lavar as mãos antes de preparar refeições	○ Treinamentos em promoção de higiene
○ **Preparação** de alfobres	○ Rega por bacias	○ Uso de insumos para melhorar a produção	○ **Diversificação** dos alimentos/ introdução de novos alimentos (exemplo uso de soja, moringa, beterraba, ovos, etc.)	○ Treinamentos em boas praticas de higiene
○ **Arrumação** do terreno	○ **Quando regar**		○ Preparar papas enriquecidas para crianças	
○ Amanhos culturais	○ Cumprimento dos estândares de mercado para produtos agrícolas		○ Boas praticas de higiene e saneamento	
○ Diversificação de culturas			○ Troca de experiencia entre voluntários	
○ Controle integrado de pragas e doenças			○ **Demonstrações**	
○ Adubações e fertilizações			○ **Feira**	
○ Fertilização química			○ Visitas domiciliarias	
○ Fertilização integrada			○ Visitas domiciliarias	
○ Rotação de culturas			○ Entrega de ramas de BDPA	

○ Escalonamento da produção			○ Entrega de poedeiras	
○ Espaçamento/compassos e Sementeira			○ Entrega de uniformes	
○ Gestão de agua e solos			○ Treinamento em pacotes de nutrição	
○ Gestão e manuseio de pesticidas			○ Treinamentos em promoção de higiene	
○ Diversificação de culturas			○ Treinamentos em boas praticas de higiene	
○ Técnicas de irrigação			○ Treinamento em conservação pós colheita	
○ Treinamento em Agronegócio			○ Treinamento em processamento de alimentos	
○ Acesso a insumos melhorados				
○ Acesso a informações de mercado				
○Conformidade com o padrão do produto				
○ Uso de compasso adequado				
○ Uso de fertilizantes				
○ Ajuste de densidade de sementes por covachos				
○ Produção escalonada				
○ Adubação com esterco				
Total de treinamentos:	**Total de treinamentos:**	**Total de treinamentos:**	**Total de treinamentos:**	

Q29: O sistema agrícola do produtor tornou-se mais resiliente com o APSAN-Vale? **(*se o numero de tópicos de treinamentos em agricultura + irrigação + mercado for >10 a situação agrícola é resiliente e se for < 10 a situação nutricional não é resiliente*).** ○ Sim ○ Não.

Q30: A situação nutricional do produtor tornou-se mais resiliente com o APSAN-Vale? **(*se o número de tópicos de treinamentos em Nutrição e Higiene for >6 a situação nutricional é resiliente e se for < 6 a situação nutricional não é resiliente*).** ○ Sim ○ Não.

Annex 2: Table of regional average crop yield

Table 7 Crop yield forecast for the 2019/2020 campaign (Source: SDAEs districts, PES 2020)

Crop types	Crop yield (ton/ha)		
	Nhamatanda	Moatize	Báruè
Corn	2.5	2.2	3
Mapira	1.1	1.1	1.2
Rice	1.1	0	0
Peanut	0.9	0.9	1.2
Bean *Nhemba*	0.9	0.9	1
Bean *Vulgar*	1	1	1.2
Bean *Boer*	0.9	1.2	1.6
Sesame	1	0.8	1
Horticulures	12	10	12
Soy		0	1.5

Annex 3: Results of maize yield from field cut method

Table 8 Yield per hectares from APSAN Vale interventions 2019 - 2020

Rain season 2019/20	Number of producers growing crop	Number of Producers who have already harvested	Area (ha)	Yield (ton/ha)	Represen-tation (%) *
Maize	768	768	1.9	2.9	98.3%
Báruè	208	208	2.2	3.2	26.6%
Moatize	187	187	1.7	2.9	23.9%
Nhamatanda	373	373	1.8	2.6	47.8%
Beans *Vulgar* (Moatize)	7	1	0.6	0.2	0.1%
Sesame	320	34	1.1		
Báruè	165	0	1.0		
Moatize	121	0	1.4		
Nhamatanda	34	34	0.7	1.8	4.4%
Peanuts	66	66	0.6	0.9	8.5%
Báruè	62	62	0.5	0.9	7.9%
Moatize	4	4	0.9	0.8	0.5%
Beans *Nhemba*	112	112	0.6	1.3	14.3%
Moatize	30	30	0.8	1.3	3.8%
Nhamatanda	82	82	0.5	1.3	10.5%
Mapira (Moatize)	3	3	0.4	0.9	0.4%
Beans Boer (Moatize)	23	0	1.9		
Sweet potato (Moatize)	2	2	0.3	20.0	0.3%
Beans *Catarina* (Báruè)	144	130	0.7	0.9	16.6%
Soy (Báruè)	66	66	0.9	0.9	8.5%
Rice (Nhamatanda)	25	25	0.6	2.0	3.2%
Cotton (Báruè)	6	6	1.9	1.6	0.8%