INTRODUCING WATER-EFFICIENT TECHNOLOGIES INTO BANGLADESH

PROJECT SNAPSHOT

The *Introducing Water-Efficient Technologies in Barind Tract* (IWET) project was developed in 2018 as part of the 2030 Water Resources Group (2030 WRG) workstream on agricultural water.

The main objective of the project is to reduce the withdrawal of groundwater for agricultural use. The project introduces a technique for improving water efficiency for mango farmers through **intensive mango cultivation (UHDP) combined with drip irrigation**. This case study is a good example of bundling multiple techniques to ensure the productivity and profitability gains that will drive farmer adoption of climate-smart practices.

***Ultra High Density Plantation** : Nearly 700 plants are planted in an acre compared to 50 for a traditional orchard.*

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CONTEXT AND PROJECT DESIGN

Traditional mango orchards contribute to declining groundwater levels, through excessive flood irrigation.

This reduces long term resilience and productivity of farming systems, while low irrigation efficiency negatively impacts farmers' profitability and competitiveness. In 2018, The Coca Cola Foundation approached SFSA to help smallholder mango farmers increase their yields, whilst decreasing their water usage for irrigation. SFSA's USP: experience in irrigation and fruit cultivation.

The project's problem statement, objectives and activities are summarized below.

PROJECT AT A GLANCE

Project Period 2018 - 2020

Outreach 6,000 mango farmers

Funding Sponsor

The Coca Cola Foundation

Other Partners

2030 WRG, BWP, DASCOH, SFSA Bangladesh and various irrigation partners and government agencies

Technology

Ultra High Density Plantation

Drip Irrigation technology

PROBLEM DEFINITION

- Current mango cultivation is unsustainable due to continuous **groundwater extraction**
- **Low profitability** due to lower yielding variety, lower quality fruits and high costs of irrigation and pesticides

OBJECTIVES

- **Reduce groundwater extraction,** rationalise groundwater decline
- Improve profitability of 6,000 mango farmers by increasing yields, improving product quality and lowering orchard management costs

ACTIVITIES

1. **Ultra High Density (UHD) Mango Plantation,**

   using

2. **High yielding variety**

   and

3. **Drip irrigation technology**

CLIMATE CHANGE CHALLENGE IN IWET PROJECT

While Bangladeshi farmers experience heavy rainfall during the monsoon season in June and July, there is very little rainfall in the remaining 10 months. Farmers thus heavily rely on traditional unsustainable irrigation practices, such as flood irrigation, to grow crops outside of the monsoon season. This structural groundwater extraction has resulted in declining groundwater levels, which negatively impacts farmers' long term productivity and resilience. This is further aggravated by an increased frequency of dry spells over the past few years.

HOW THE PROJECT IS **CURRENTLY** CLIMATE-SMART

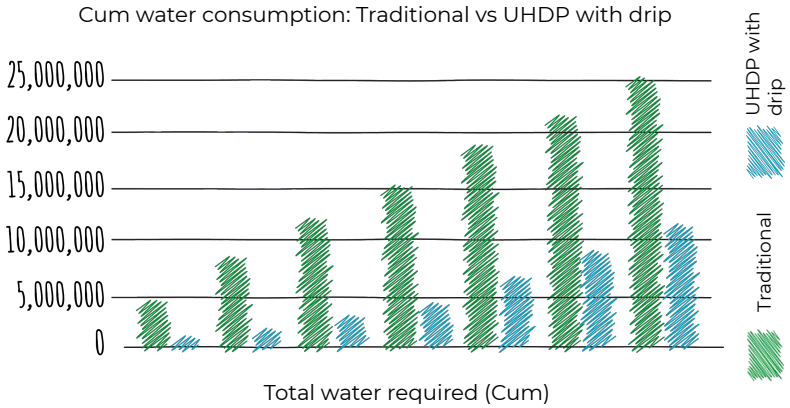
The project's 'climate smartness' can be assessed according to the 3 pillars of profitability, resilience and mitigation. The CSRA benefits are highlighted in the table below and are described in greater detail on the next pages.

	RESILIENCE	MITIGATION	PROFITABILITY
Ultra High Density Plantation	+ Reduced harvest loss Due to hand-picking	+ More efficient pesticide use	+ Higher yield & selling price + Reduced harvest loss + Reduced pesticide loss
High yielding variety	+ More constant revenues	+ Increased overall input use efficiency	+ Higher yields (+200-300%) + Improved labour use efficiency
Drip Irrigation	+ Reduced water usage	+ More efficient fertiliser use + Improved water efficiency	+ Higher yields + Improved input use efficiency - High up-front investment

PILLAR 1: RESILIENCE

The various techniques enhance farmers' resilience in 3 ways:

- **Reduced (post)-harvest loss:** In a **UHD plantation** there is neither harvest- nor post-harvest loss. In contrast, in a traditional orchard, losses of about 25% are common. The main reason is the difference in tree height: While trees in a traditional orchard are 10-12 metres high, the trees in a UHD plantation are regularly pruned to maintain a maximum height of 2 metres. Not only does this enable more effective pesticide application through hand- spraying, but mangos can also be handpicked.
- **More constant revenues:** The **high yielding variety** provides more constant revenues, as the trees can be harvested each season in comparison to the traditional mango variety that only provides fruits every other season.
- **Reduced water usage:** The **drip irrigation** system contributes to an improved water efficiency : over a period of 7 yrs, a drip irrigation system leads to 55% less water consumption, saving 13.000.000L of water per acre of land.



PILLAR 2: MITIGATION

The project offers the following mitigation benefits:

- **More efficient pesticide use:** In a **UHD - plantation**, the lower tree height, obtained through regular pruning, allows for more efficient and effective pesticide application, compared to a traditional mango orchard where over-application of pesticides, through use of high pressure sprayers, is common.
- **Increased overall input use efficiency :** The new mango variety requires less pesticide and fertilizer application per kg of output.
- **More efficient fertilizer use:** Using **drip irrigation** leads to 60% less fertilizer use, by using a liquid rather than granular fertilizer, and by placing the fertilizer immediately at the plants' roots. To date, the efficiency hasn't manifested yet, as the liquid fertilizer is not available in Bangladesh. As an intermediate solutions, farmers dissolve Urea and MoP in water, while applying TSP through ring irrigation.
- **Improved water efficiency:** The project encourages farmers to substitute the unsustainable practice of flood irrigation by **drip irrigation**, reducing the excessive pressure on groundwater levels.

PILLAR 3: PROFITABILITY

For reasons of overview and accuracy, we'll discuss separately:

1. The profitability of the UHD - plantation **without** drip irrigation
2. The profitability of the UHD - plantation **with** drip irrigation

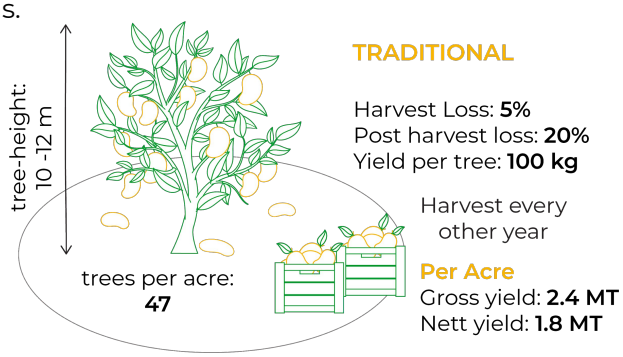
As the project targets existing mango farmers, the business case calculations compare a newly planted UHD-plantation to a mature traditional orchard. To help farmers manage the financial implications of transitioning a traditional orchard to a new UHD - plantation, the project proposes a **transitional system**. More details on page 8.

Project subsidies: The calculations below assume no subsidies, to evaluate the financial sustainability of the model. In reality, farmers received a full or partial subsidy for the drip irrigation; no subsidies were provided for the UHDP.

1 UHD - PLANTATION WITHOUT DRIP - IRRIGATION

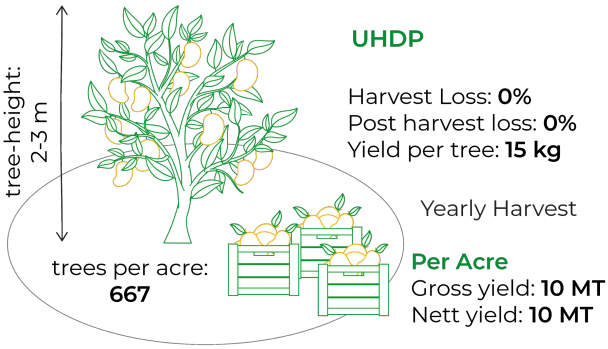
A UHD - plantation itself (so without drip irrigation) improves profitability via:

- **Higher yield** The yield of a mature UHDP is 4 times higher than a traditional plantation. A **UHDP** provides higher yields through a higher number of trees per acre that outweighs the lower yield for each individual tree. Also, the **high yielding variety** can be harvested every year, whereas the traditional variety only can be harvested every other year. A new UHD-plantation provides its first harvest after 18 months.



- **Reduced harvest and post-harvest loss** As explained, a UHD- plantation with lower trees minimises losses. In contrast, in a traditional orchard, harvest and post - harvest losses are about 25% due to mangos that drop during the picking process and less efficient pesticide application due to the higher tree height.

- **Higher selling price** Farmers are able to sell mangos from a **UHD - plantation** at a 20% price premium, because:
  - More effective pesticide application of leads to better quality mangos
  - Odd-sized fruits are removed via regular pruning, so mangoes are homogeneous in size and quality



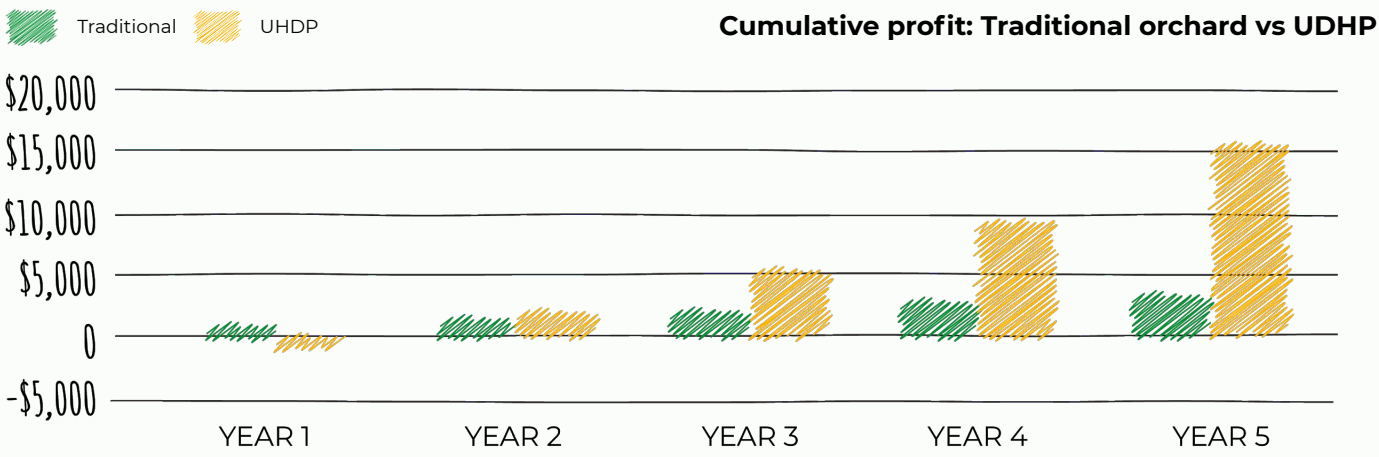
- **Higher input efficiency**
  - **Labour cost efficiency** : The labour costs per MT of yield are 70-80% lower for a UHDP compared to a traditional orchard. Note: In a traditional mango orchard, many farmers practice intercropping, meaning that their labour costs relate to various crops.
  - **Fertilizer cost efficiency** : For a UHDP, the fertilizer cost efficiency decreases as a fixed amount of fertilizer is applied per plant during sapling transplantation. With drip - irrigation, the efficiency increases, as the dosage for a water-soluble fertilizer is ~ 50% lower compared to a granular fertilizer
  - **Pesticide cost efficiency** : Within a UHDP, the pesticide cost per MT of yield are 60%-70% lower compared to a traditional orchard. With drip-irrigation, the pesticide efficiency increases further as part of the pesticides are applied in the water.

PROFIT & LOSS ANALYSES

UHDP WITHOUT DRIP IRRIGATION

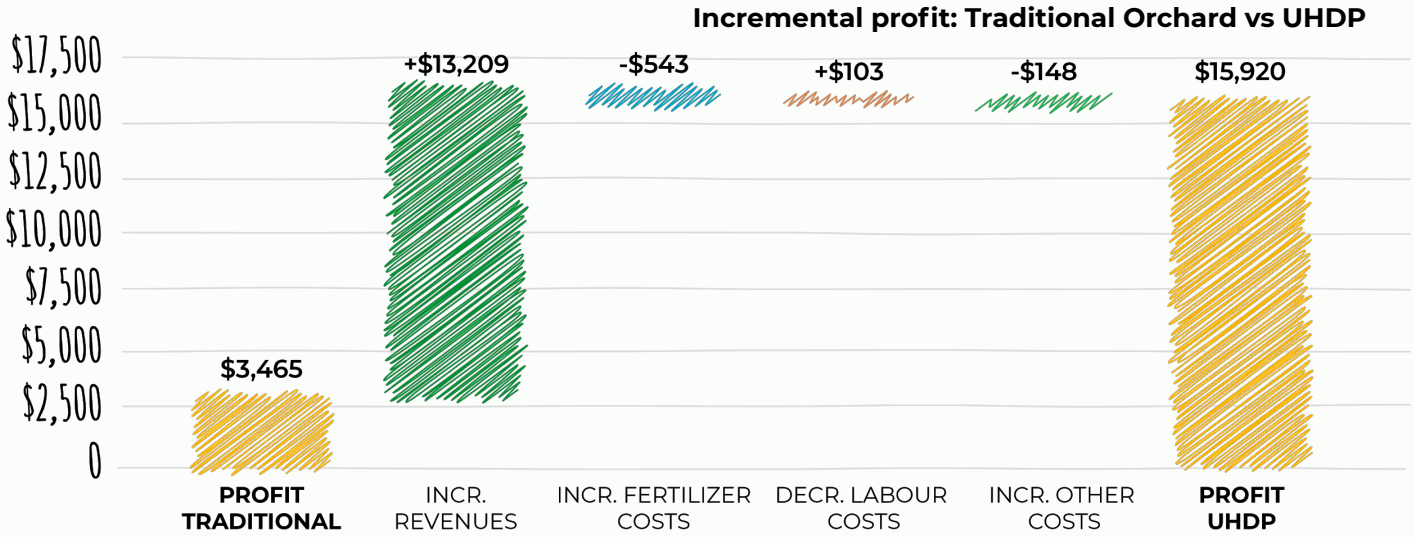
PROFITABLE FROM FIRST HARVEST IN YEAR 2

A UHD - plantation generates a profit from its first harvest in year 2. In year 1 the farmer makes a loss, because he/she makes investments, e.g. in the saplings of the high yielding mango variety and orchard management costs (fertilizer, pesticide, and labour costs). At the same time, he/she doesn't make any revenues yet, as the high yielding variety can first be harvested after 18 months.
As shown in the image, a UHD - plantation is also more profitable than a traditional orchard from its first harvest in year 2.



5 x MORE PROFITABLE OVER A 5 - YEAR PERIOD

A UHD - plantation is 5 times more profitable compared to a traditional orchard over a 5 - year period. As shown in the chart, the increase in profit nearly fully results from the higher revenues (higher yield and higher selling price). Although some of the costs are higher, the absolute cost increase is negligible in comparison to the higher revenues.



2 UHD - PLANTATION WITH DRIP - IRRIGATION

A drip - irrigation system improves profitability via:

- **Higher yield:** Drip irrigation technology boosts yields with 30% through a higher input efficiency (of water and fertilizers) and reduces expenses through lower fuel costs for irrigation. The lower fertilizer use does not translate into a cost advantage (yet), as the price of liquid fertilizers - that need to be imported - is significantly higher than granular fertilizers.

PROFIT & LOSS ANALYSES

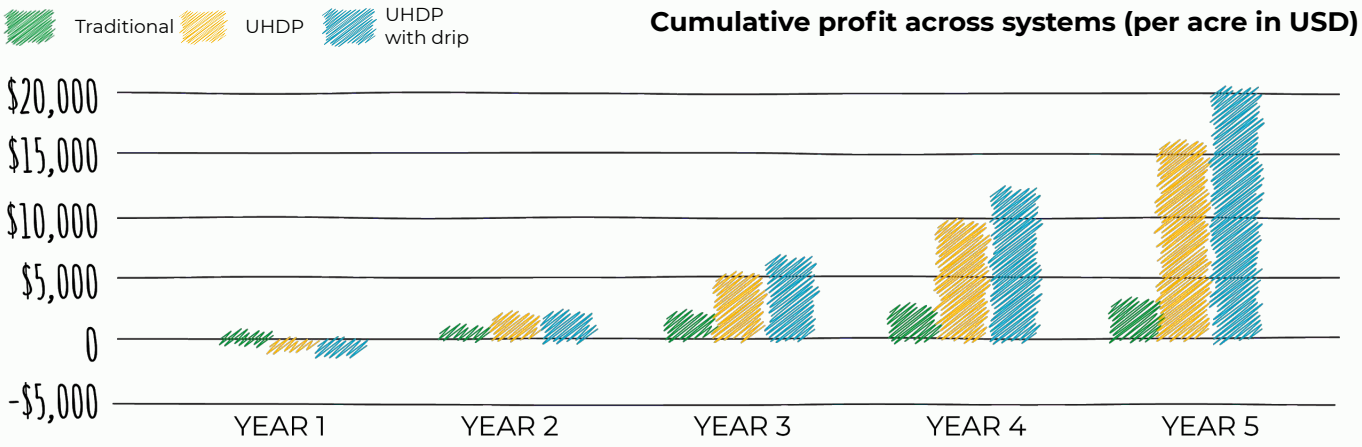
UHDP WITH DRIP IRRIGATION

INCREMENTAL INVESTMENT OF $650 IN YEAR 1

In this scenario, the total investment costs in year 1, add up to $1,329 due to the incremental investment of $650 in the drip - irrigation system alongside the seedlings for the high yielding variety, and the orchard management costs. As there are no revenues yet in year 1 - the ultra high density variety can be harvested after 18 months-, this means the farmers face a significant loss in year 1.

MORE PROFITABLE COMPARED TO OTHER SYSTEMS FROM YEAR 2

As shown in the visual below, a UHDP with drip irrigation is profitable in year 2, meaning that the investment costs of year 1 are fully recovered with the first harvest in year 2. Also, the cumulative profit of a UHDP with drip - irrigation is already higher than a UHDP without drip - irrigation (12%), and the traditional orchard (53%).



30% MORE PROFITABLE OVER A 5 YEAR TIMEFRAME COMPARED TO UHDP ONLY

A UHD - plantation with drip - irrigation results in a 30% higher profit in comparison to a UHD - plantation without drip irrigation, yielding an incremental profit of $4,360 per acre over 5 years.

Transitional System to avoid lack of revenues in year 1:

To avoid farmers having no revenues in year 1, the project proposes a **transitional system**.

What this means: Instead of replacing the traditional orchard with the high yielding variety at once, the two systems are temporarily combined. Under the proposed system, the mango farmers maintain their traditional orchard as it is, but start planting the high yielding variety in between. This allows for about 335 new seedlings/acre (50% of a full UHD -plantation) alongside +/- 47 traditional trees.

As the new plants must share their resources (sunlight, nutrients, water) with the larger trees, they will only bear fruits after 36 months (instead of 18 months) and the initial yield is about 30% lower compared to a full UHDP. However, the advantage is that farmers maintain revenues and profit during the entire transition period.

After 3 years, when the high yielding variety can be harvested, the traditional trees are gradually replaced by new seedlings, leading to a full UHD - plantation in year 5/6.

RESULTS TO DATE

- **Adoption rate of 8.5% for UHDP:** After three years, 504 mango farmers have adopted the UHD - Plantation with a growing adoption rate each year. None of these farmers received a project subsidy.

- **110 farmers adopted drip irrigation:** Among these 504 farmers, 110 have adopted drip irrigation, benefiting from a full or substantial project subsidy for the drip irrigation equipment (of $1,100)

- **Lower adoption barriers for UHDP:** Farmers are inclined to first adopt UHDP without the drip-irrigation, as the adoption barriers are lower : the investment costs are lower and the productivity gains more visible.

# Farmers	2018	2019	2020	Total
Outreach	1,200	2,400	2,400	6,000
Adoption (rate) - UHDP	71 (6%)	143 (7.1%)	290 (12%)	504
Adoption - Drip irrigation	30	40	40	110
% subsidized	**100%**	**70%**	**62%**	

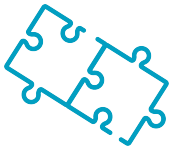
To encourage the adoption of the drip irrigation equipment, the project has taken the following actions:

- Over the project period the investment costs of the drip irrigation equipment have been reduced from $1,100 to $650 through local sourcing
- Through its 110 demonstration sites, the project aims to provide evidence for the productivity gains that result from the use of drip irrigation. Therefore, adoption rates are expected to go up further after the second harvest in June/July 2021.

CSRA IN A NUTSHELL

Climate-smart resilient agriculture (CSRA) is an important strategic pillar of SFSA's work.

SFSA's objective: To help smallholders grow profits (**profitability**) while increasing their capacity to deal with shocks (**resilience**) and reducing their negative impact on the environment (**mitigation**).

5 CSRA DESIGN PRINCIPLES	DESCRIPTION
 **A**dapt CSRA as starting point	Identify most important climate challenge Formulate objectives across the 3 CSRA pillars
 **B**ecome expert on target audience	Define and prioritise various target audiences Identify drivers and barriers to adoption of promoted behaviour Integrate behavioural change lens into project design
 **C**larify SFSAs role	Clearly define SFSA's role: - R&D - Testing to drive initial adoption, demonstrate to partners - Scaling / hand-over to partners
 **D**esign for farmer profitability & accessibility	Conduct P&L analysis to understand impact on short- and long term profits Understand cash flow implications and potential financing need Ensure financial sustainability after project subsidies end
 **E**nsure coherent project design	Demonstrate how activities contribute to achievement of objectives Ensure that activities are adapted to target audience Set indicators in alignment with the objectives and SFSA's role Make conscious trade-offs to ensure farmer adoption

REFLECTIONS

DESIGN PRINCIPLES	PROJECT REVIEW	LEARNING
Adapt CSRA as starting point	+ Excessive groundwater extraction key climate challenge in Barind Tract + Objectives defined across 3 CSRA pillars	- Often interlinkages between all 3 pillars, e.g. reduced water usage delivers mitigation, resilience & profitability
Become expert on target audience	+ Baseline study conducted on mango farming	- Farmer adoption may benefit from more detailed customer segmentation and behavioral change lens
Clarify SFSAs role	+ SFSA's role in this project is clearly to test and drive initial adoption + Objectives and indicators set accordingly	
Design for farmer profitability & accessibility	+ Detailed data collection on yield, revenues and expenses of systems + Project appears financially sustainable - Initial investment in drip irrigation reduced from $1,100 to $650 - Combined with UHDP, investment in drip-irrigation recovered in 2 yrs	- Business case should be built in correspondence to reality in field, e.g. incorporating transitional system - Revenues and profits from intercropping in traditional orchard not taken into account - Business case to be challenged by external "panel"
Ensure coherent project design	+ Activities clearly contribute to achievement of objectives by bundling of drip irrigation with UHDP + Activities adapted to target audience: - Investment in drip-irrigation reduced from $1,100 to $650 through local sourcing - In combination with UHDP, investment of $650 recovered at first harvest in year 2 - Transitional system guarantees revenues for farmers during adoption of UHDP + Indicators well aligned with objectives and SFSA's role + Trade off made in favour of high yielding variety over drought resistant variety to drive adoption of UHDP, as a stepping stone to introduction of drip irrigation.	- Liquid fertilizer that is required for drip - irrigation system not available locally, or at very high costs - inhibiting large scale adoption - Farmers are likely to adopt new techniques with clear short-term profitability gains first. Hence UHDP serves as stepping stone to drip irrigation, rather than via 'bundled approach' - Project Team on lookout for a variety that is both drought-resistant and high yielding