2nd cocoa dialogue: Co-designing sustainable and inclusive irrigation to leverage the climate-resilience cocoa initiatives

Airport View Hotel,

Airport, Ghana

March 16, 2023

Objectives

- Identify the effects of climate change on cocoa production and the resilience strategies available.
- Assess the irrigation potential for cocoa production
- Co-identify gaps for designing best-fit irrigation for the different cocoa production systems

Agenda

Time	Activity	Remarks
08.30 – 09.00	Registration	IWMI
09.00 – 09.15	Welcome by IWMI, IITA, COCOBOD	IWMI/ IITA/ COCOBOD
	Sharing and learning about the Cocoa sector in Ghana and other countries	
09.15 – 10.15	Cocoa sector in Ghana: a state-of-art - Cocoa production regions - Cocoa production systems (land size, land tenure, management) - Water resource availability and suitability (quantity and quality)	 Rev. Edwin Afari, COCOBOD Leonard Rusinamhordzi, IITA Komlavi Akpoti, IWMI
10.15 – 11.00	Farmer spotlight: What should be done differently to enable cocoa farmers' resilience to climate change and socioeconomic impacts?	All participants (spotlighting cocoa farmers)
11.00 – 11.30	Coffee Break	
11.30 – 12.30	**Cocoa Irrigation initiatives**	
	- Cocoa irrigation in Ivory Coast - Cocoa irrigation pilots - Solar-based water-lifting technology for cocoa - Water application options for cocoa	Romain Aka, Barry Callebaut Alex Agyepong, Aireli Moses Tampoe, Pumptech Fares Al-Ayadi, Interplast
12.30 – 13.45	Lunch break and networking	
13.45 – 14.00	2. Cocoa farmers' willingness and ability to invest in (solar-based) irrigation	Kekeli Gbodji and William Quarmine, IWMI
14.00 – 15.00	Breakout discussion	
	1. What are elements that need to be considered when designing best-fit irrigation systems for cocoa 2. What and how can different stakeholders support irrigation in cocoa? 3. How can cocoa farmers' investment in irrigation be accelerated?	All participants
15.00 – 15.45	Reporting back	All participants
15.45 – 15.50	Reflection: What key messages have come out from today's section?	All participants
15.00 – 16.00	Follow-up and meeting closure	All participants

CO-DESIGNING RESILIENT AND SUSTAINABLE CLIMATE – SMART COCOA THROUGH AFFORDABLE IRRIGATION AND FINANCING MECHANISMS

COCOA HEALTH AND EXTENSION DIVISION(CHED)

GHANA COCOA BOARD.

Introduction

- Irrigation is defined as the science of artificially providing water in accordance with the "**crop requirement**" throughout the "**crop period**" for the complete nourishment of the plant.
- Irrigation is the most important water use sector accounting for about **70%** of the global freshwater withdrawals and **90%** of consumptive water uses.

Do we need irrigation at all?

- Seasonal nature of the rainfall pattern
- Uneven distribution of rainfall within the year
- Crop water requirement deficit. CWR deficit of about **50%.**
- The high average **annual rainfall** ranges from **780mm – 2160mm** in Ghana.
- Crop Water Requirement (CWR) for cocoa varies between **130 mm/month and 235 mm/month**.

Importance of Irrigation to cocoa

- Increase productivity
- Bring most of the fallow land under cultivation
- Revegetate disturbed soils in dry areas and during times of below-average rainfall
- Prevent soil consolidation
- Stabilizes output and yield levels
- Helps to make up for the crop water requirement deficit
- Help to curb the situation of plant stress during dry spells

Irrigation System COCOBOD has done (Pilot)

Solar powered Drip irrigation system

Challenges experienced with Solar Powered Irrigation System

- Lack of maintenance
- Inadequate under ground water
- Insufficient power generated by solar panels
- Lack of training for beneficiaries
- Late receipt of irrigation materials
- Lack of proper handing over

Our Main Objective and Focus

- Seeking to collaborate with Private and Public sector to bring affordable and cost effective irrigation systems to farms in the 3 categories

  1) Small holder Systems

  2) Medium Scale Systems

  3) Large scale Systems

Productive cocoa area categorization

- Number of Farms Mapped – Over 1.239 million
- Total Size of Farms – 1.380 million ha
- Total Number of Farmers – about 762 K

  Male - almost 488K

  Female – about 274K

Source: CMS data, 2023

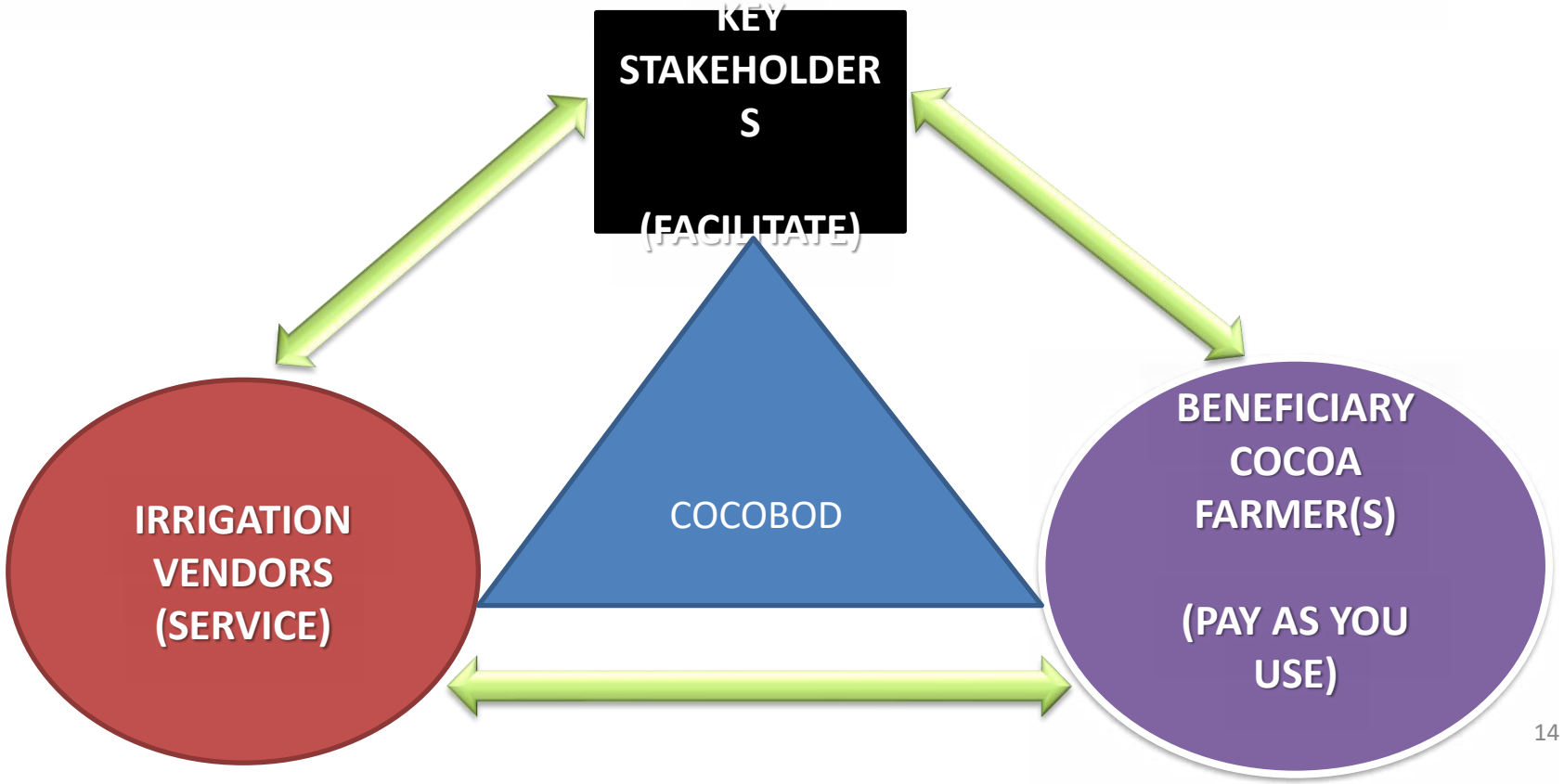
SWOT Analysis for Irrigation systems in cocoa farming

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
• CMS data • Productive cocoa farms. • Cluster Farms • Credibility with Cocoa Farmers and Stakeholders • Dedicated staff	• High cost • Size of farm • Gender • Absentee farmers • Aged farmers • Diseased farms	• Availability of both underground and surface water • Cocoa farms along some major river belts • Topography • Willingness of farmers • Cooperatives (8,642)	• Tenancy Issues • Climate Issues • Drop in the water table • Galamsey

THE BIG QUESTION

How do we make irrigation affordable to our farmers and what Type is appropriate?

IRRIGATION & FINANCING MECHANISM



Way forward

- Wider coverage Irrigation systems
- Cost sharing repayment strategies
- Business case models for farmers and stakeholders to consider – cost is an issue
- Quality of surface and underground water

THANK YOU

Cocoa production systems: challenges and opportunities




Leonard Rusinamhodzi (PhD)
Senior Scientist - Systems Agronomist for West Africa

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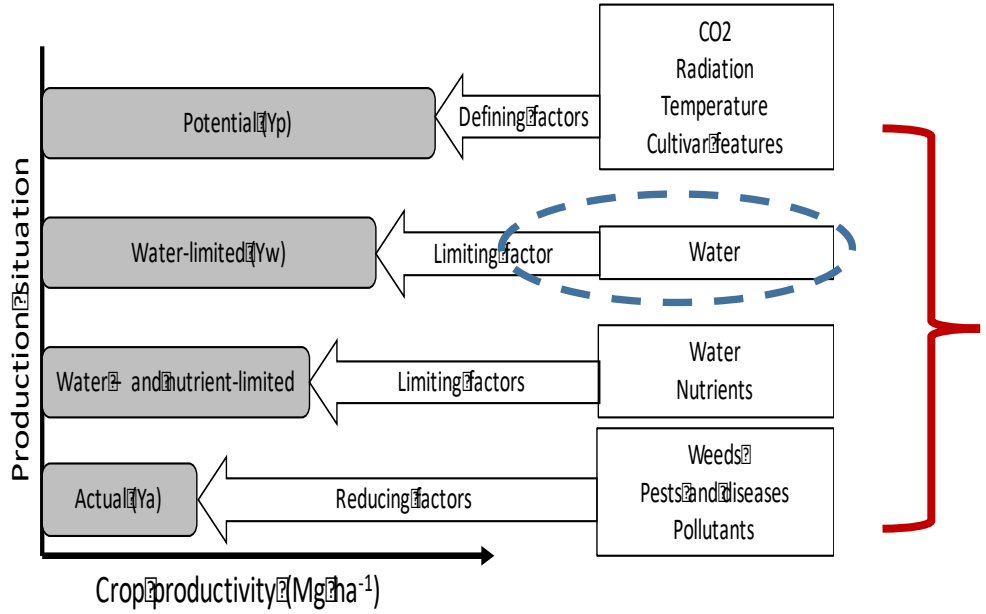
The challenge – yield gap



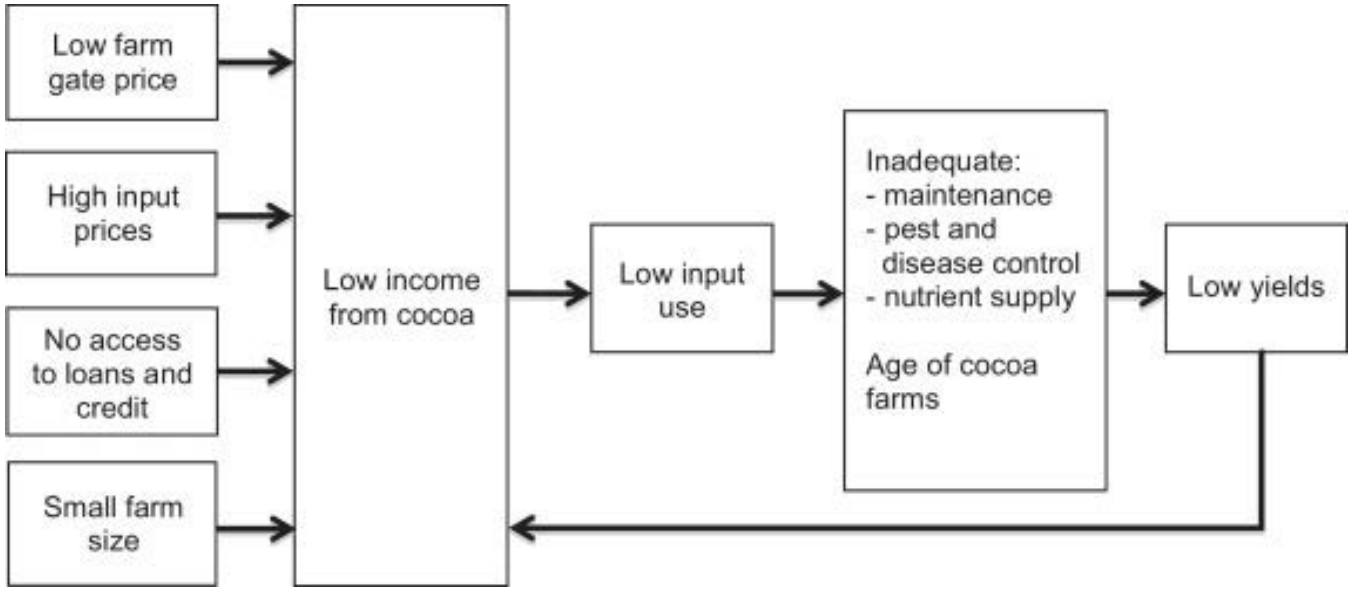
van Ittersum *et al*. (2013)

- Farmers get a fraction of the yield possible in their locations
- Gap > 500kg/ha
- Suboptimal management depletes soil fertility
- Long-term effect is a wider gap

In Ghana, average yield of ≤ 500 kg/ha

Causes of low cocoa yield in West Africa

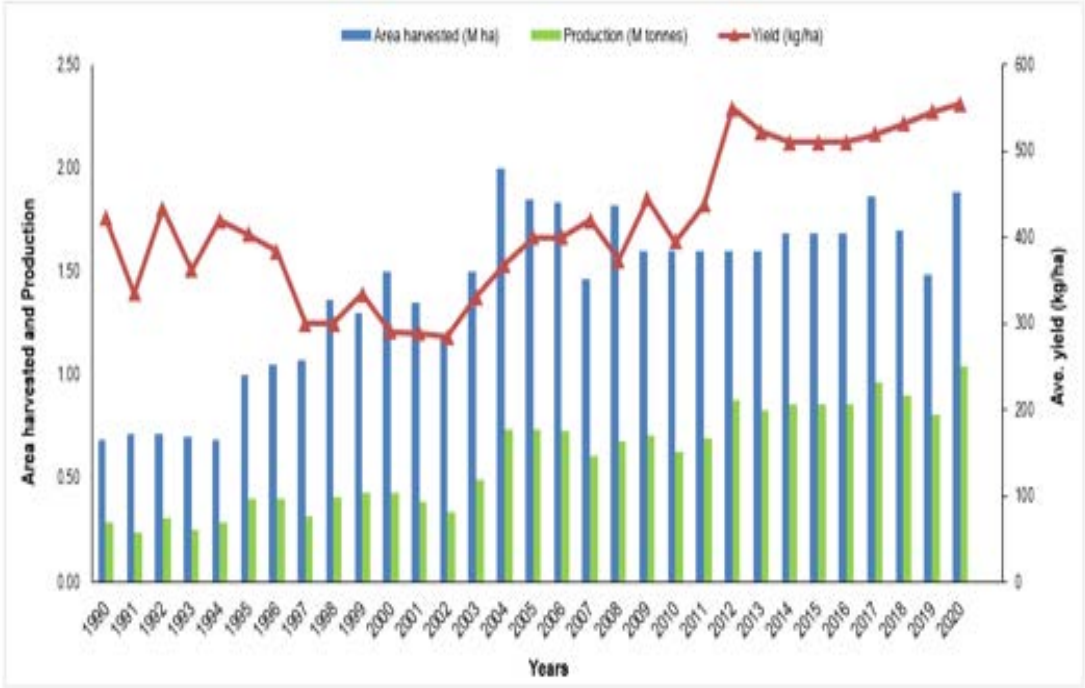
- Yields remain low because of extensive cultivation practices and old age of cocoa.



Wessel, M., Quist-Wessel, P.M.F., 2015. Cocoa production in West Africa, a review and analysis of recent developments. NJAS - Wageningen J. Life Sci. 74–75, 1–7. https://doi.org/10.1016/J.NJAS.2015.09.001

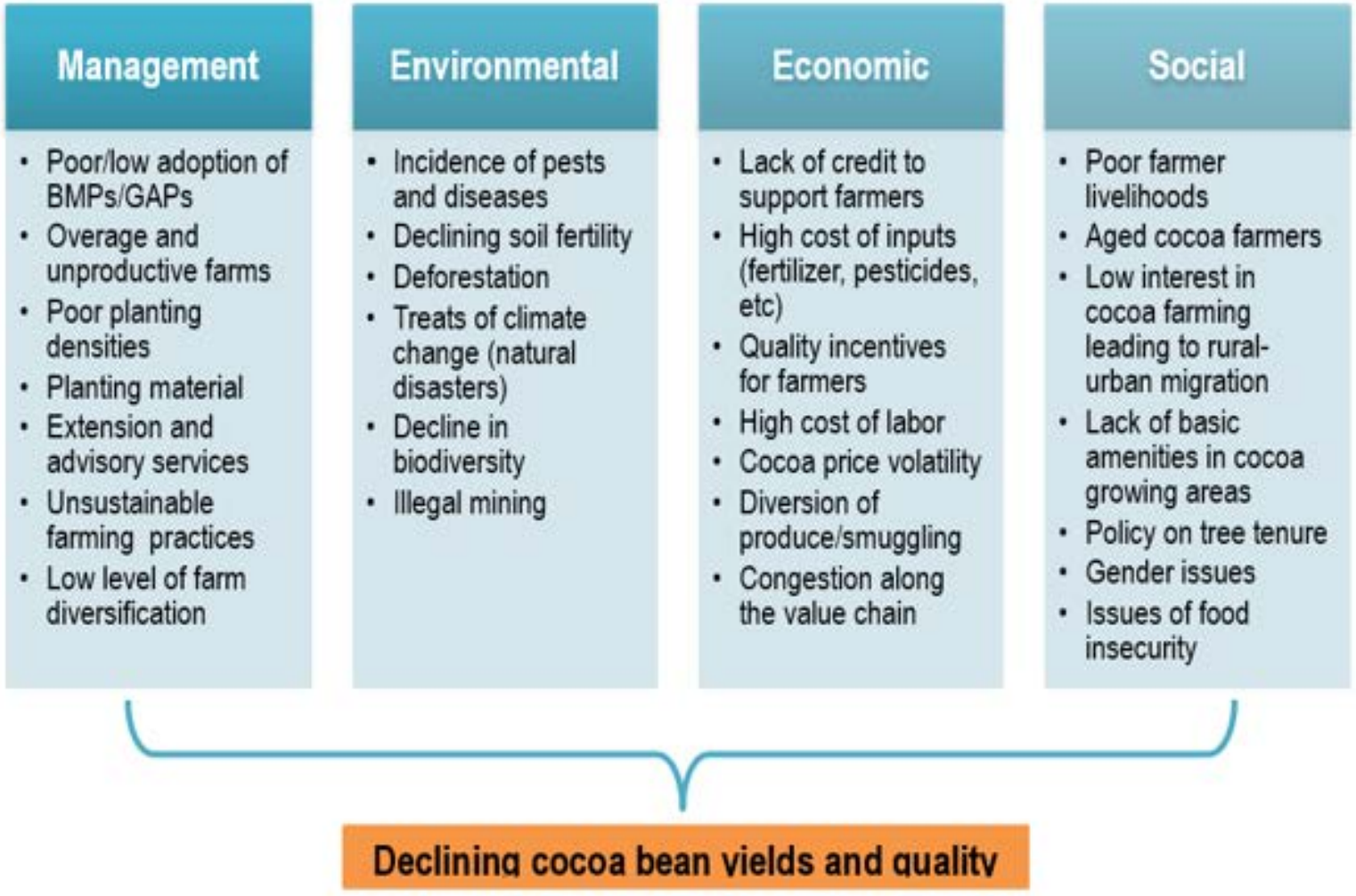
Importance of Cocoa in Ghana

- ✓ Cultivated in about 8 regions in Ghana since 100+ years (avg. 1 – 4 ha)
- ✓ major driving force of the economy



Source: Lartey (2013)

Main challenges



Share cropping

Land access - outright purchase, gift, license, inheritance, lease, **sharecropping**

- **Sharecropping is the most efficient means to access land (migrant farmers and landless poor)**
- **Abusa system** – allows tenant to retain a third of the land established by his/her effort into cocoa plantation (less secure)
- **Abunu system** (50:50 basis) ensures equal share between the landlord and the tenant (response to land scarcity)

➢ In some cases, physical division of the farmland does not confer proprietary rights to the tenant in respect of the portion of land received

➢ **lack of clarity surrounding land/tree tenure is a major constraint to general farm management practices and cocoa productivity**

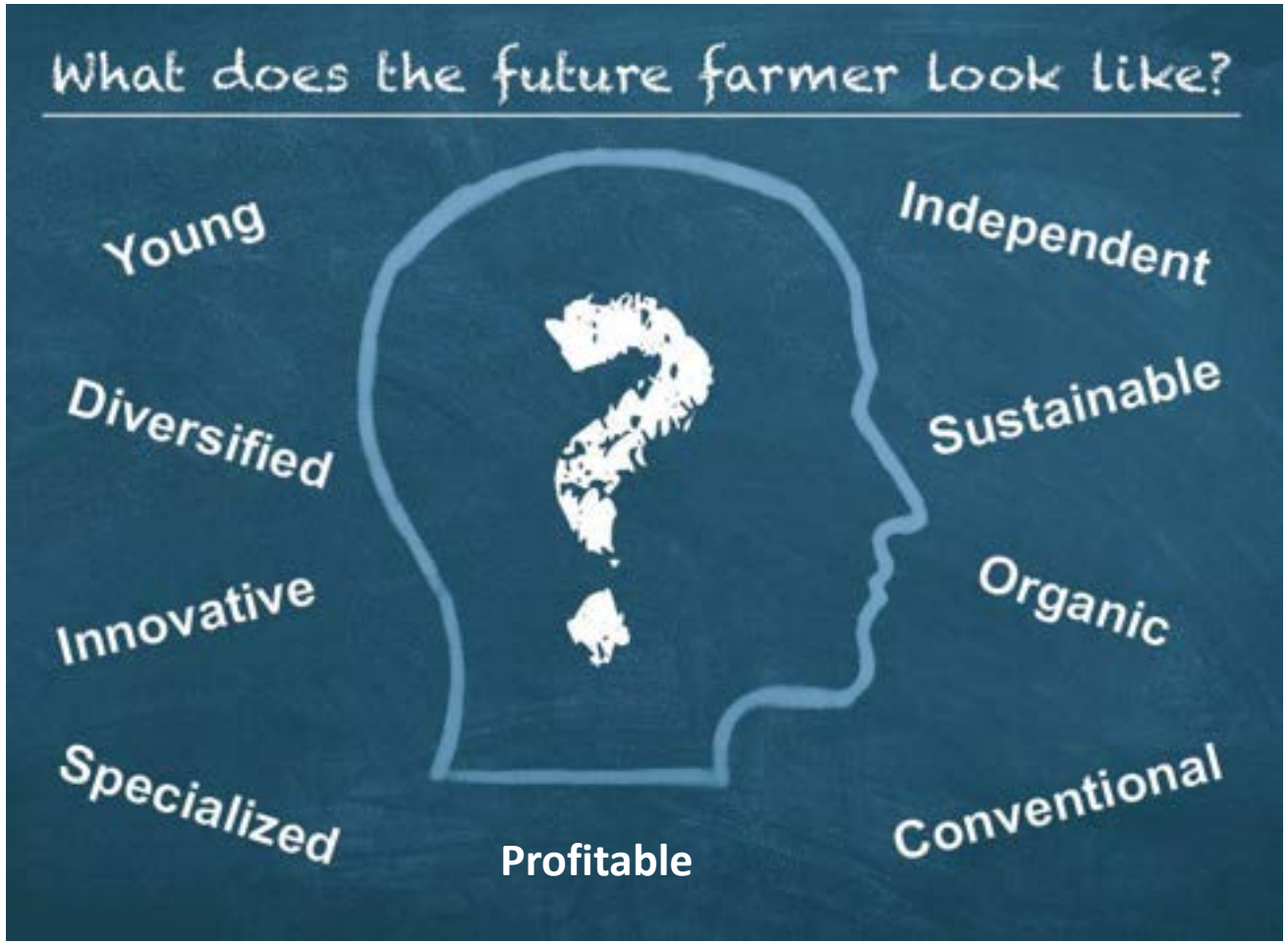
  ➢ Need consent of owner to replant when trees are old, or rehabilitating diseased trees

Baah K, Kidido JK (2020) Sharecropping arrangement in the contemporary agricultural economy of Ghana: A study of Techiman North District and Sefwi Wiawso Municipality, Ghana. Journal of Planning and Land Management 1 (2):50-62. doi:10.36005/jplm.v1i2.22

Climate variability and change

- Start and end of rainfall season becoming more and more unpredictable
- Harmattan season becoming longer and more severe
- Pest and disease incidence become more uncertain
- Natural enemies (including endophytes) affected
- Significant reduction in groundwater recharge

Improving Cocoa Productivity



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Opportunity - nutrient management in cocoa

- New cocoa plantings will not benefit from old forest soil fertility (zero deforestation).

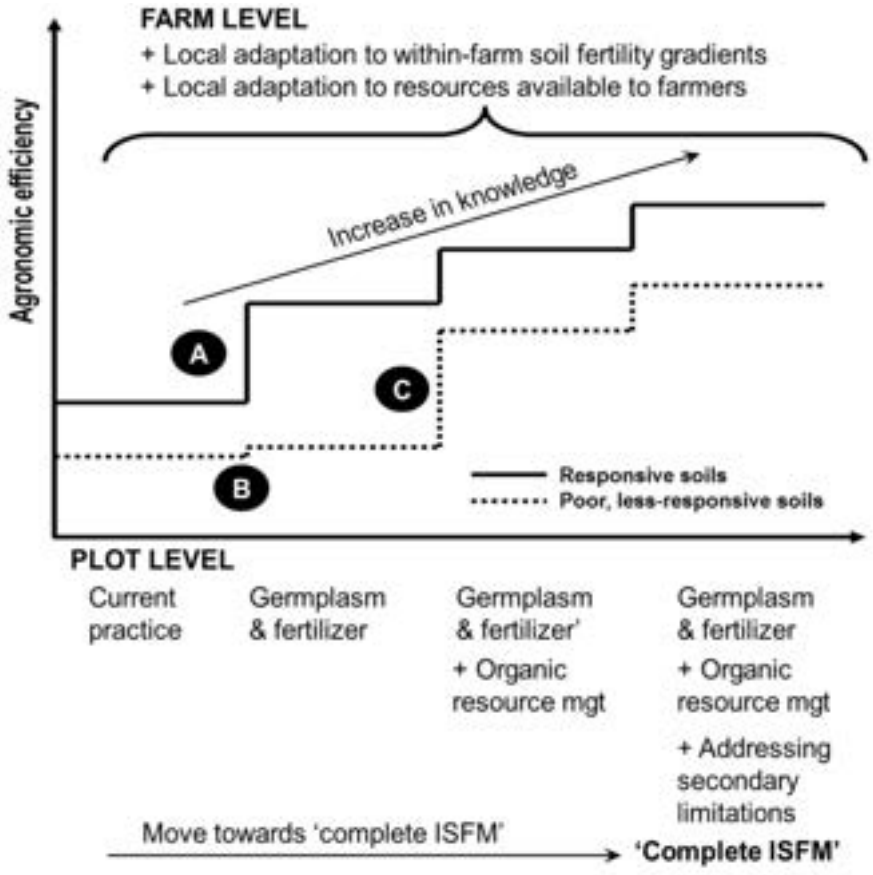
- New cocoa varieties grow faster, start producing earlier, thus export nutrients earlier.
- Nutrient demands of new varieties for maximum bean yields are unknown.

- Fertilizer recommendations are old and many were never verified.

- No recommendation today considers the actual nutrient demand and export with beans, i.e., current recommendations are independent of the bean yield.

CocoaSoils Program

- Sustainable intensification of cocoa production through the development and dissemination of integrated soil fertility management (ISFM)



Vanlauwe *et al* 2015

- The major knowledge gap is **what nutrients** at **what rates** are needed at **what stage of cocoa growth** – and how do we best maintain soil fertility in the long term.

Two set of field trials

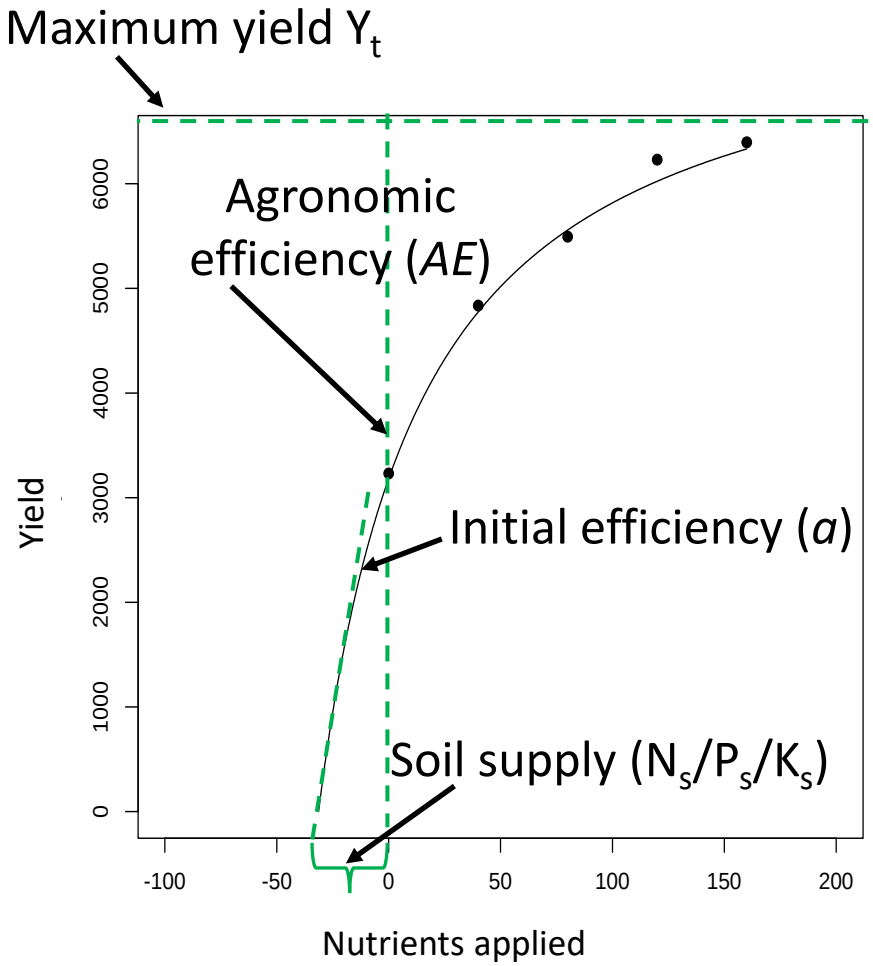
- Multi-nutrient, multi-locational reponse trials generally referred internally as CORE trials

- Simple 4-plot trials in established plantations plantations, generally referred to as Satellite trials

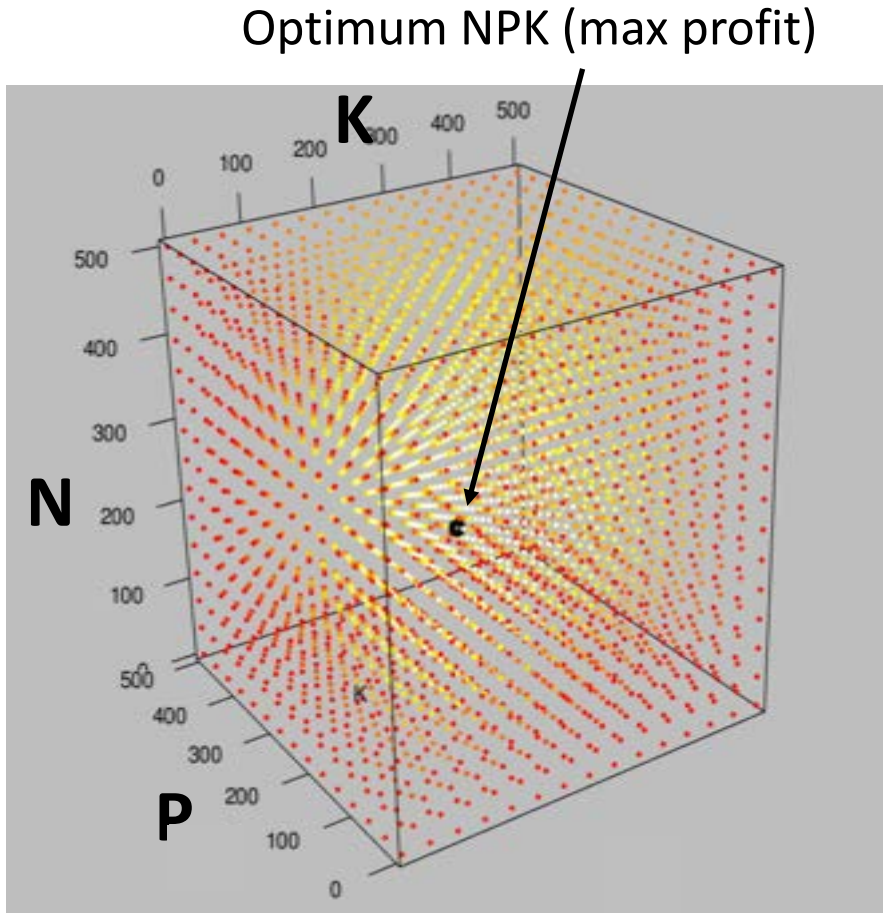
Core Trials

- long term, researcher-managed, and multilocational trials of at least two hectares with a factorial design looking at optimal nutrient compositions and rates for cocoa.

What needs to be estimated?



Greenwood et al. 1971

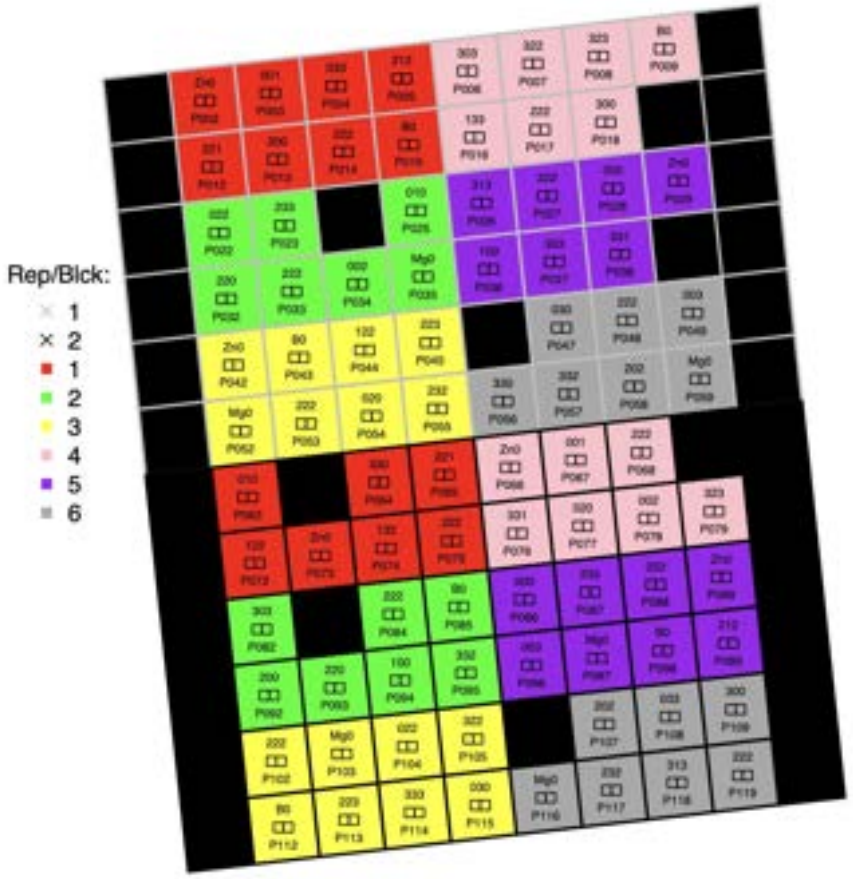


Core Trial Design

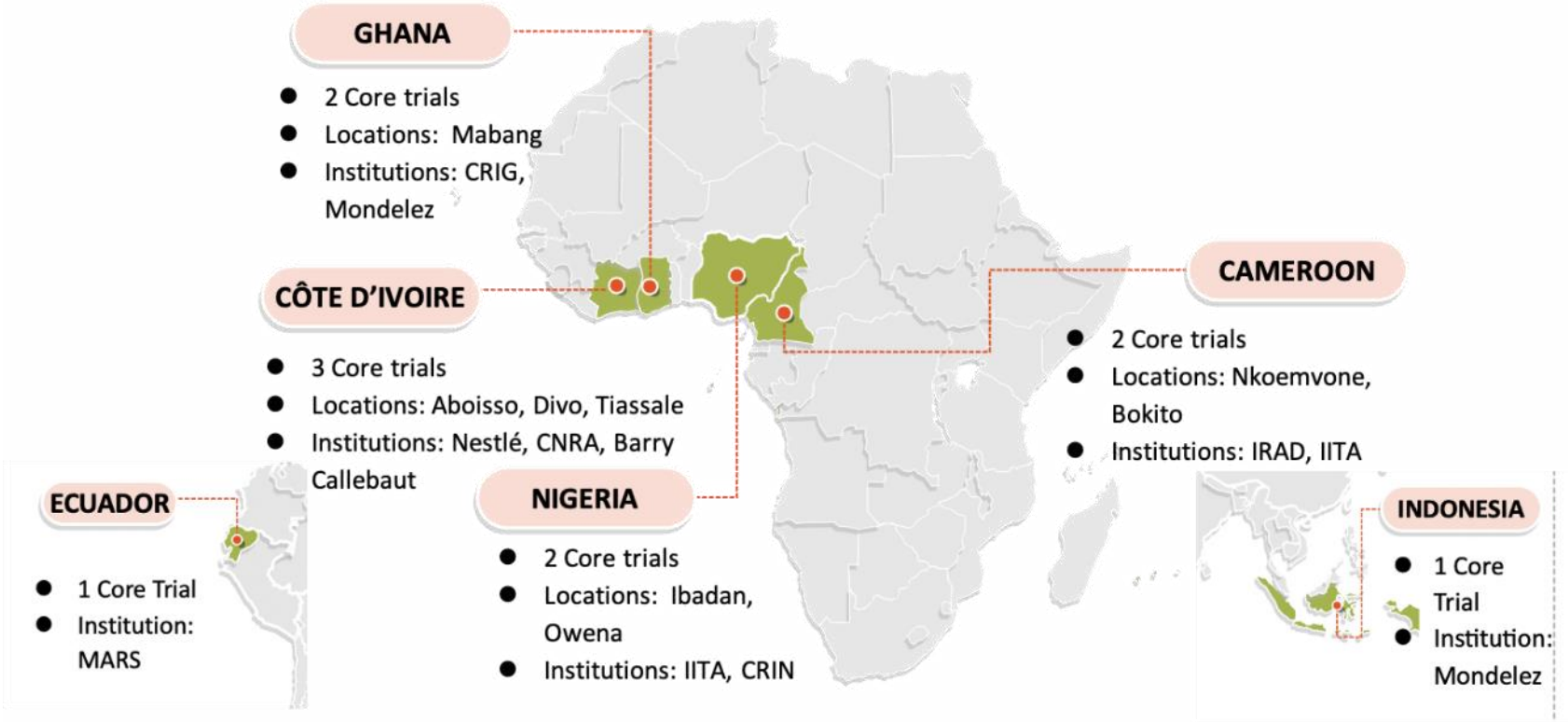
Allocation of 44 treatments of different combinations of N, P, K and a set of Mg, Zn and B omission plots

Treat	N	P	K
122	50%	100%	100%
133	50%	**150%**	**150%**
100	50%	NIL	NIL
212	100%	50%	100%
221	100%	100%	50%
222	100%	100%	100%
222	100%	100%	100%
222	100%	100%	100%
222	100%	100%	100%
222	100%	100%	100%
222	100%	100%	100%
223	100%	100%	**150%**
220	100%	100%	NIL
232	100%	**150%**	100%
233	100%	**150%**	**150%**
202	100%	NIL	100%
200	100%	NIL	NIL
313	**150%**	50%	**150%**
322	**150%**	100%	100%
323	**150%**	100%	**150%**
331	**150%**	**150%**	50%
332	**150%**	**150%**	100%
333	**150%**	**150%**	**150%**
330	**150%**	**150%**	NIL
303	**150%**	NIL	**150%**
300	**150%**	NIL	NIL
010	NIL	50%	NIL
022	NIL	100%	100%
020	NIL	100%	NIL
033	NIL	**150%**	**150%**
030	NIL	**150%**	NIL
001	NIL	NIL	50%
002	NIL	NIL	100%
003	NIL	NIL	**150%**
000	NIL	NIL	NIL

C0NI002_Y2020

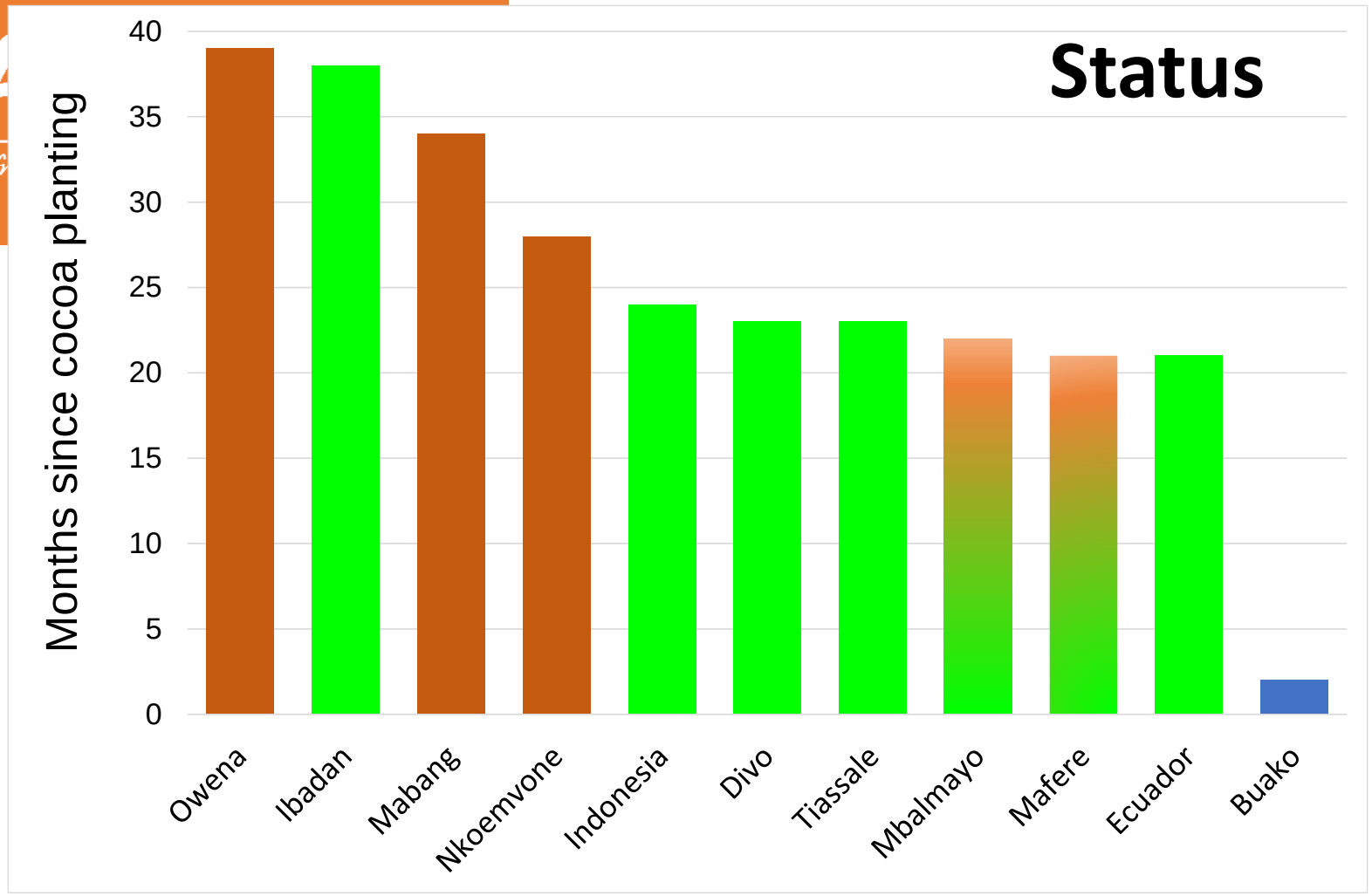


Core Trial locations



These trials provide a unique opportunity to collect data for future assessments including graduate students

- **Collaborations are open**



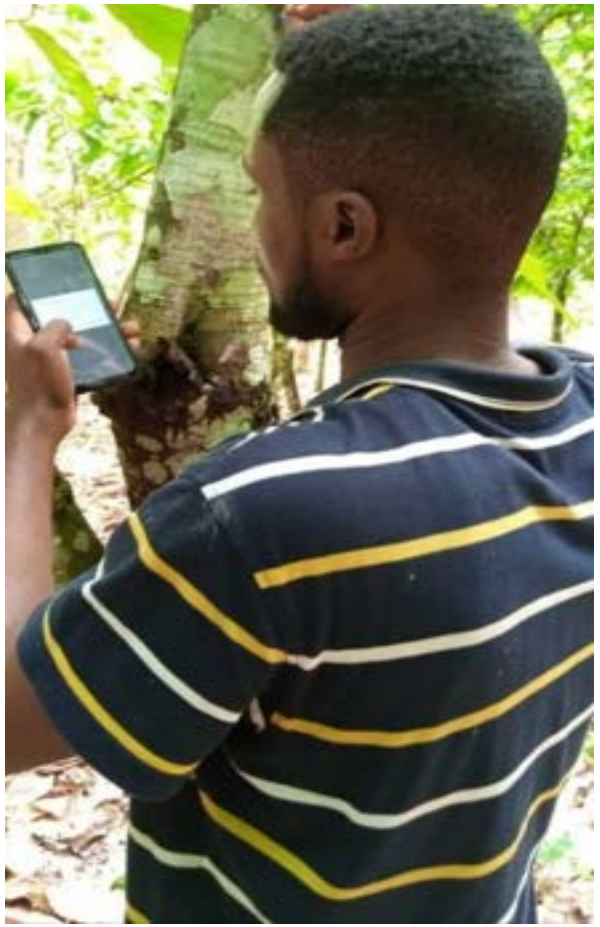
Cocoa tree age since field transplanting in the core trials

No major replanting

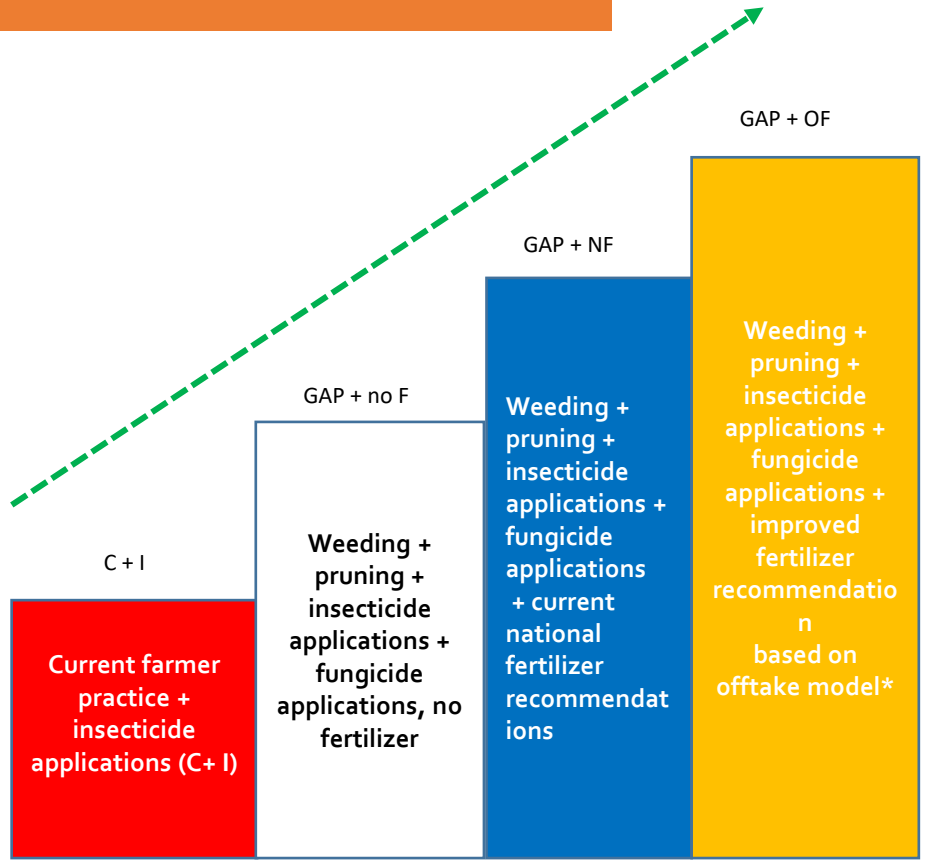
Several major re- plantings

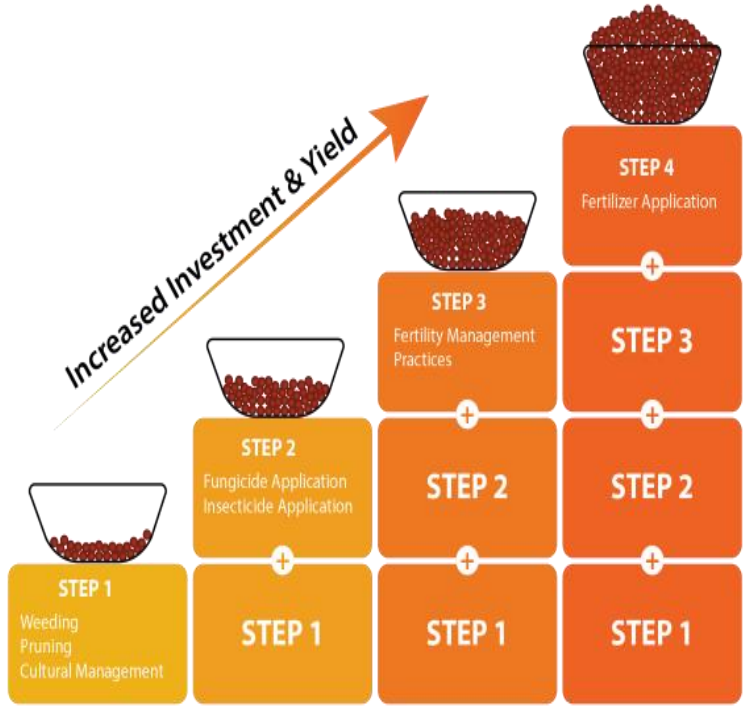
WATER

Satellite trials - established in existing cocoa plantations and managed by **company technicians** and farmers to test different fertiliser combinations and shade interactions to examine the effects on yield under field conditions.



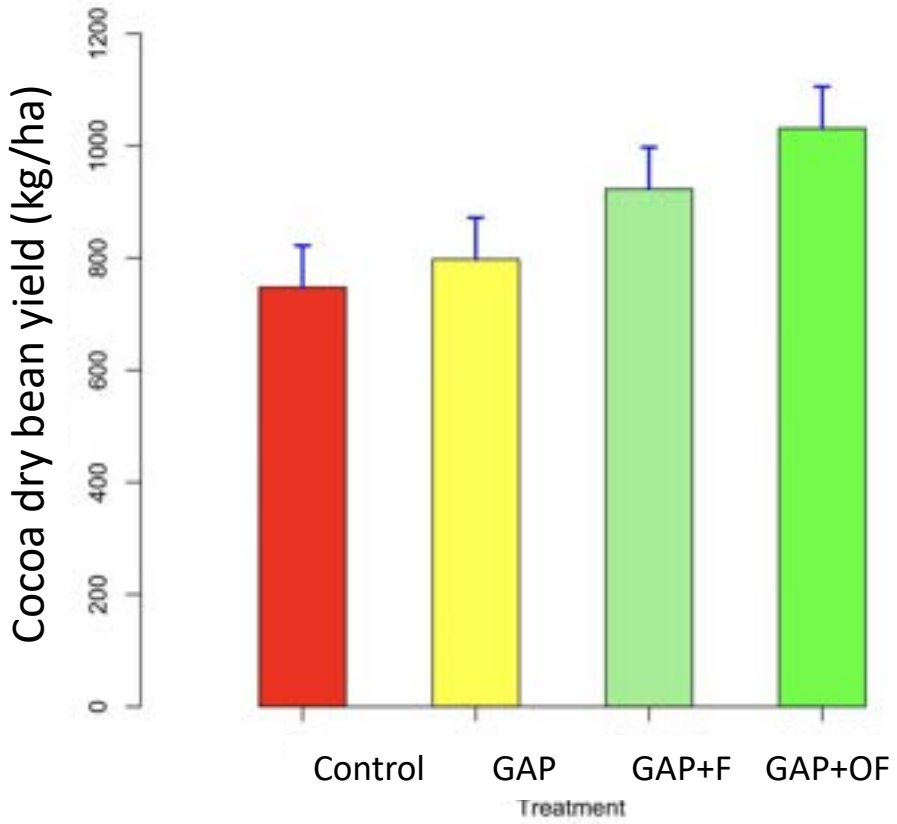
A stepwise approach – satellite trials





On-farm ‘Satellite’ Trials

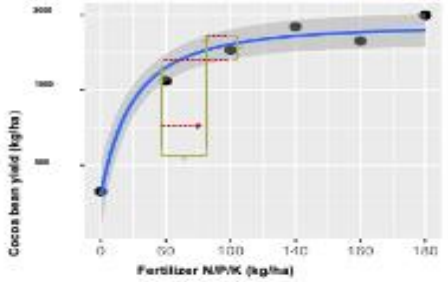
- Preliminary results
- Step-wise intensification
  - Control (+insecticide)
  - Good Agricultural practice (pruning, full pest control)
  - GAP + local fertilizer recommendation
  - GAP + ‘Offtake model’ recommendation



Preliminary results prove the ”stepwise” concept but work in progress

Summary of CocoaSoils approach

G x E x M



Weather/climate data

Soil data

Farmer management

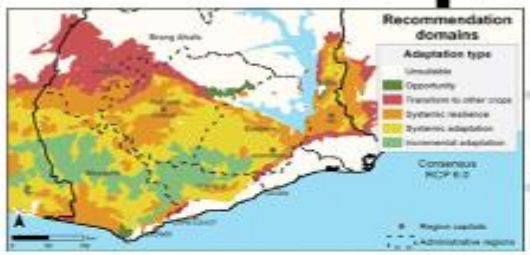
Input/ouput price data

CASE2
Cocoa
Water Limited Yield

CASE3
Cocoa
Nutrient Limited Yield (N, P, K)

Economic Model
Revenue implications of N, P, K rate

Yield and money prediction/ each step



Bunn et al, 2019

Abu *et al*, 2021

Spatial modeling of recommendations in the cocoa belt

How will the results be scaled?

Project Lead/Donor	IITA Transforming African Agriculture; the sustainable trade initiative; WAGENINGEN UNIVERSITY & RESEARCH; Norad
National Research Institutes	IRAD; CNRA; Cocoa Research Institute of Ghana; Cocoa Research Institute of Nigeria
Intl Research Centres	UN environment WCMC; IITA Transforming African Agriculture; CIAT; WAGENINGEN UNIVERSITY & RESEARCH; World Agroforestry Centre
Private partners	Nestlé; Cargill; World Cocoa Foundation; BARRY CALLEBAUT; BAYER; ICL; Mondelēz International; S&D SUCDEN; Kuapa Kokoo; Olam; Tulip Cocoa; MARS Incorporated; OLATUNDE INT'L LTD.; YARA; Rockwinds

Major lessons

- The multi-stakeholder and multiple-country approaches are important (provide a convening platform) in addressing the various challenges in the cocoa industry concurrently.
- The stepwise investment approach is promising to be inclusive even for farmers with limited resources
  - initial financial and technical challenges associated with the adoption of improved technologies
  - incrementally invest in best agronomic management practices (BMPs) of crops/
- Presence and visibility at the local level is important to get the message through
  - achieved via a network of 389 partner managed field trials

- How to keep the interest and commitment in a ‘slow-moving’ environment such as perennial systems

- How to balance Short term needs/gains vs long term investments

Thank you for listening

I need some water!!

IWMI International Water Management Institute

CGIAR

Water resource availability and suitability for Cocoa Irrigation in Ghana

Komlavi Akpoti
Post Doctoral Fellow, Spatial Hydrology, IWMI

16th March 2023

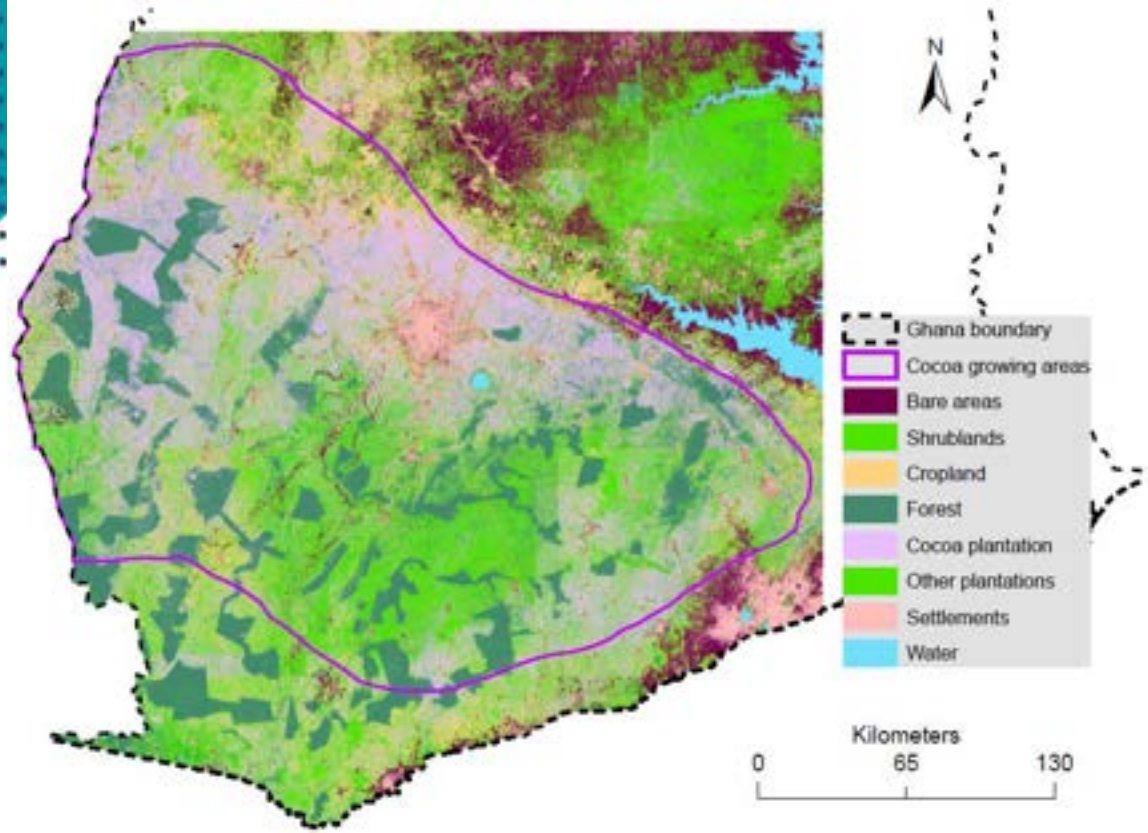
Innovative water solutions for sustainable development

Food · Climate · Growth

Outline

- Cocoa area classification
- Surface water availability
- Challenges with surface water availability
- Groundwater potential
- Climate change impact on water availability
- Conclusions

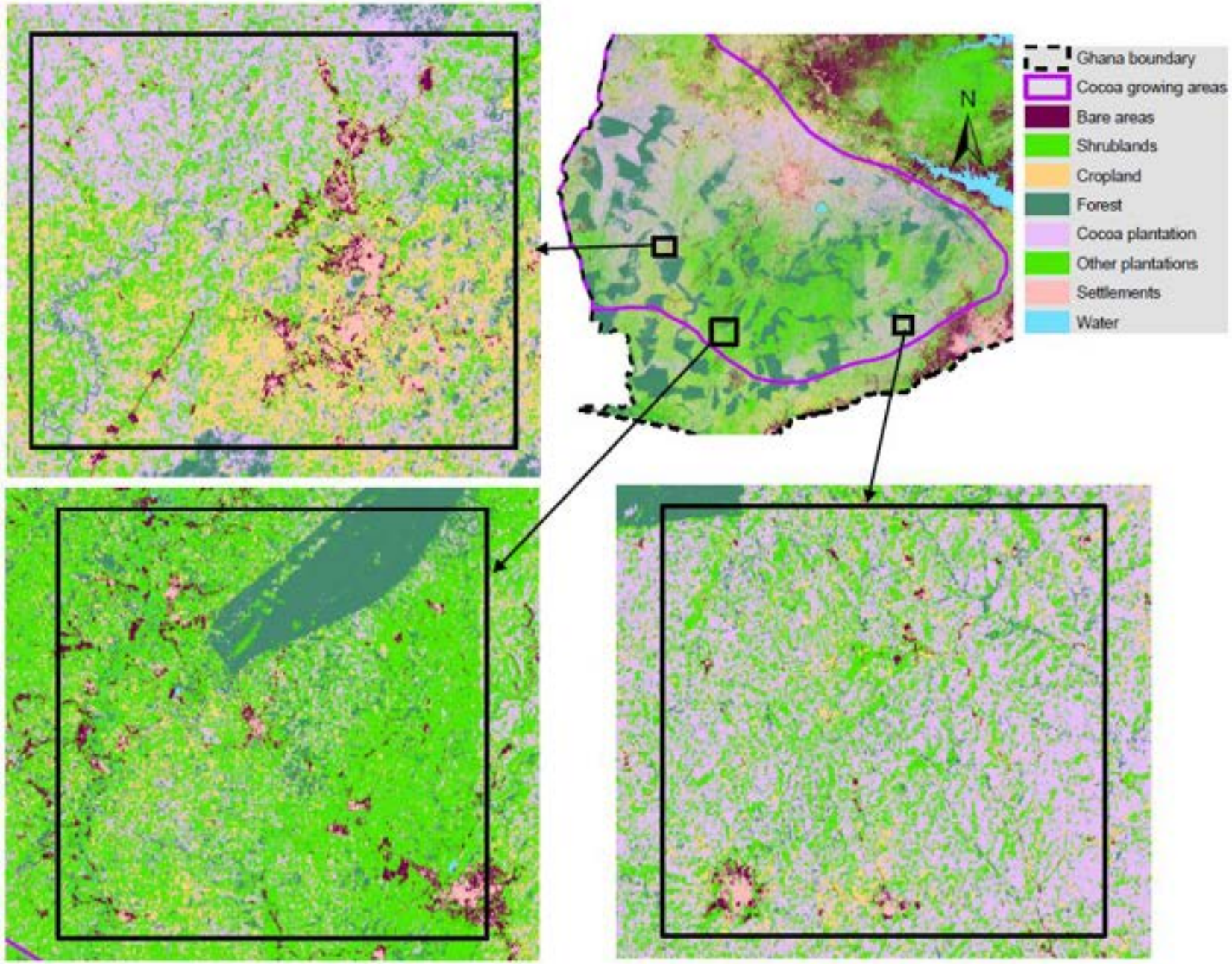
Area coverage of the land use/ land cover classes



- Good classification accuracies were obtained for all classes (97% Overall Accuracy)
- The cocoa class is dominant, with an area coverage of about 37% (22,126 km²).

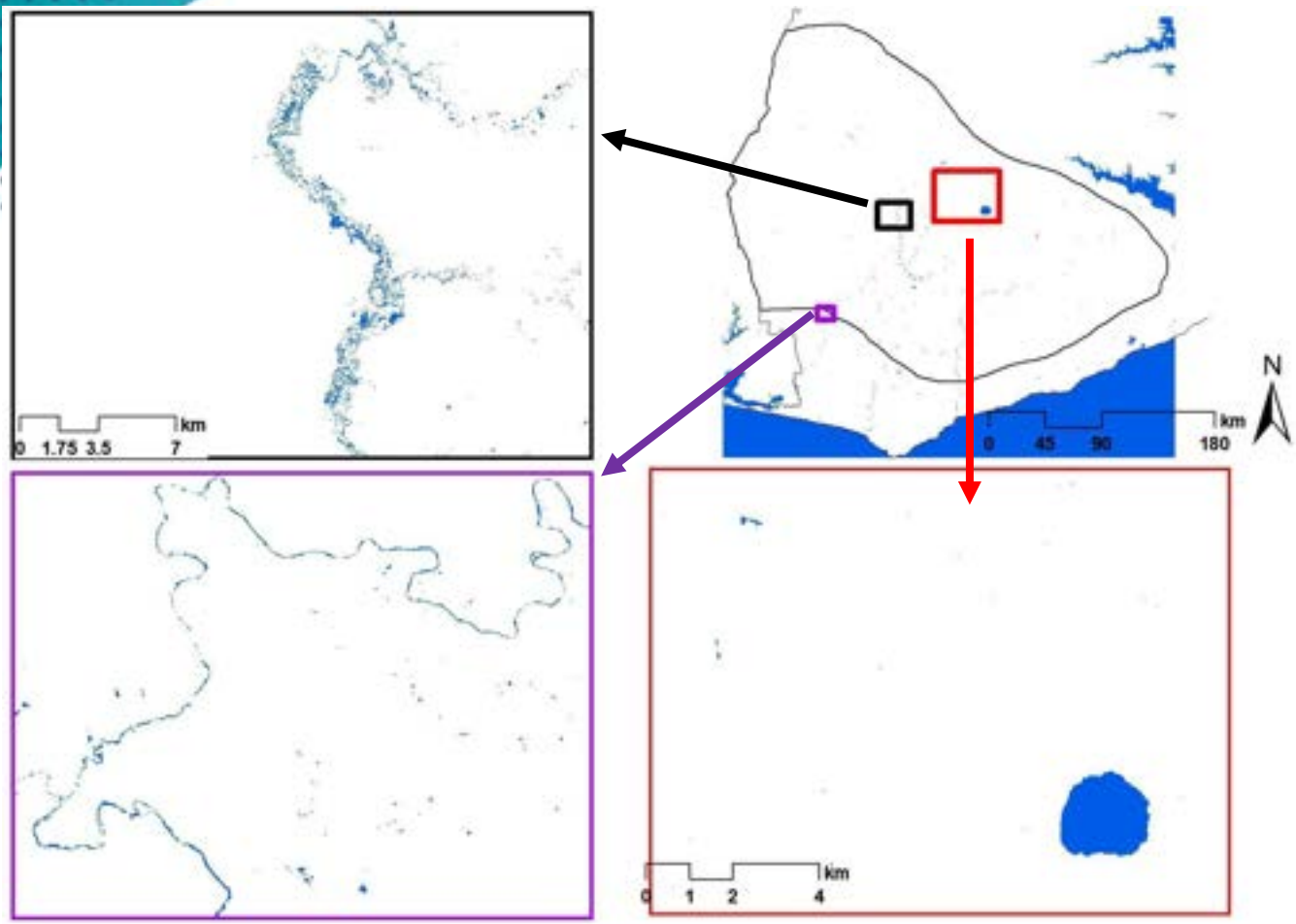
LULC class	Bare	Shrubland	Cropland	Forest	Cocoa	Plantation	Settlement	Water
Area (km²)	4316	6443	7331	8085	22126	9771	879	125
% Area	7.31	10.91	12.41	13.69	37.45	16.54	1.49	0.21

Zoom over selected areas of land use/ land cover classes



- Cocoa plantations are not uniformly distributed.

Water bodies in the cocoa-growing areas



- About 125 km² of surface water resources (rivers, lakes, dams, etc.).
- This includes Lake Bosomtwe, which has an area of 49 km², and the Barekese dam, which supplies water to most of Kumasi.
- It includes water bodies and ponds along rivers, small reservoirs, lakes, and lagoons.
- It should, however, be noted that this could differ depending on seasonality.

LULC class	Bare	Shrubland	Cropland	Forest	Cocoa	Plantation	Settlement	Water
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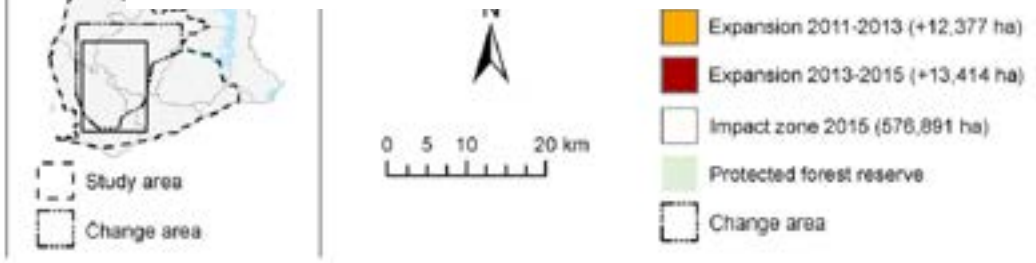
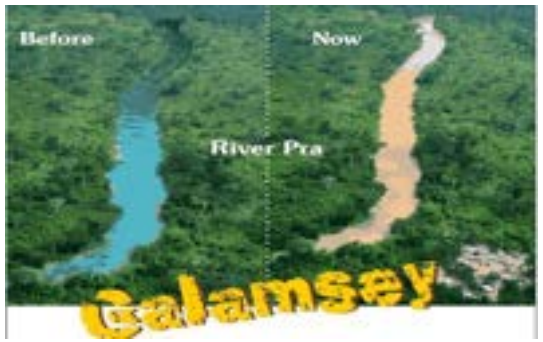
Potential challenges of using surface water for cocoa irrigation

Expansion of galamsey in 2011, 2013, and 2015 (Snapir et al., 2015)

- The estimated total area of galamsey in 2015 is at 43,879 ha with an impact zone of 551,496 ha.
- Galamsey has more than tripled between 2011 and 2015.
- Galamsey is developing along most of the **river network (Offin, Ankobra, Birim, Anum, Tano),** with downstream **pollution affecting both land and water**.





- Heavy pollution of rivers that may not be useful for cocoa irrigation
- Important sediment load

- Creating water ponds that are heavily polluted and can not be used for irrigation

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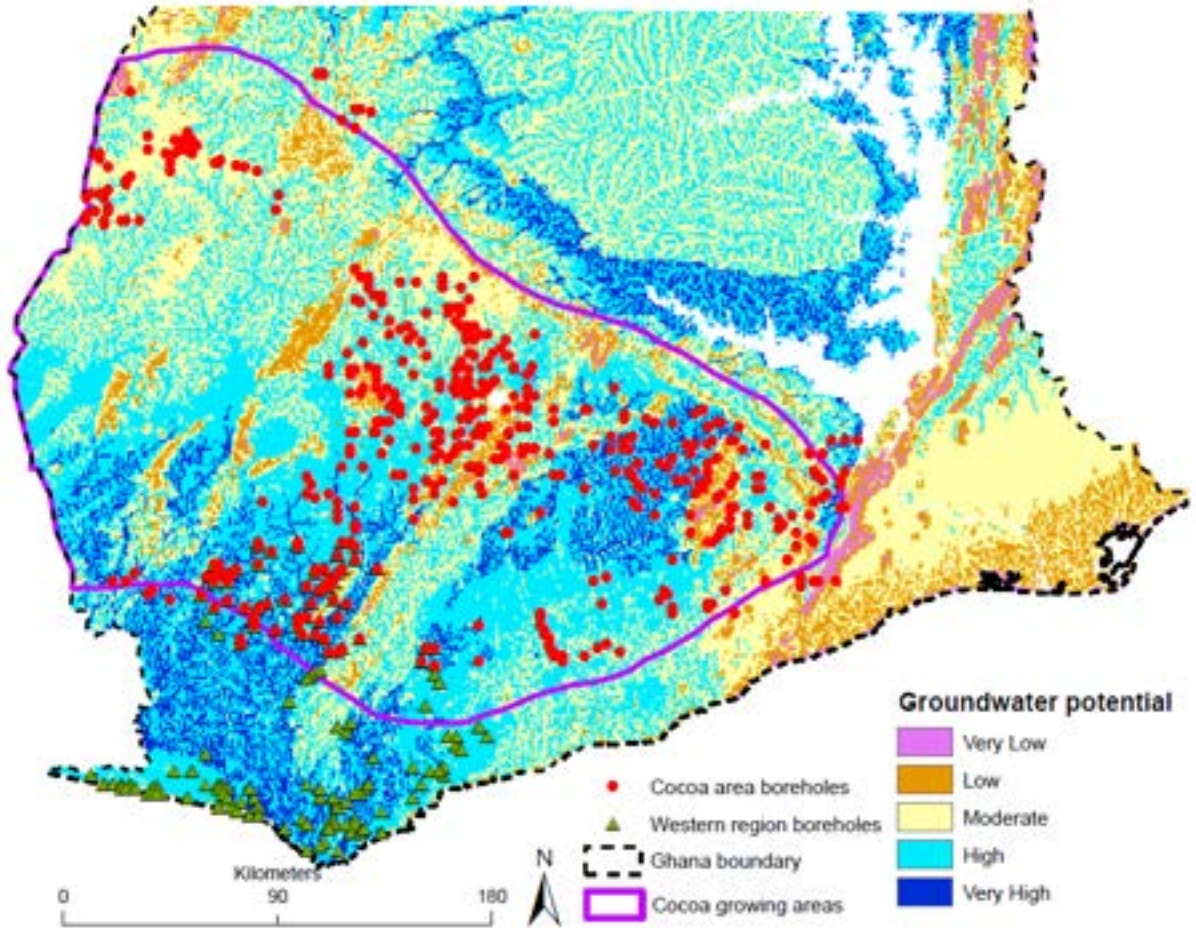
Groundwater potential for Cocoa irrigation

- A significant portion of the study area (~80%) has moderate to very high groundwater availability potential

GW Availability Potential Classes	MCA Results (% Area)
Very low	5.3
Low	16.5
Moderate	29.7
High	31.7
Very high	16.8



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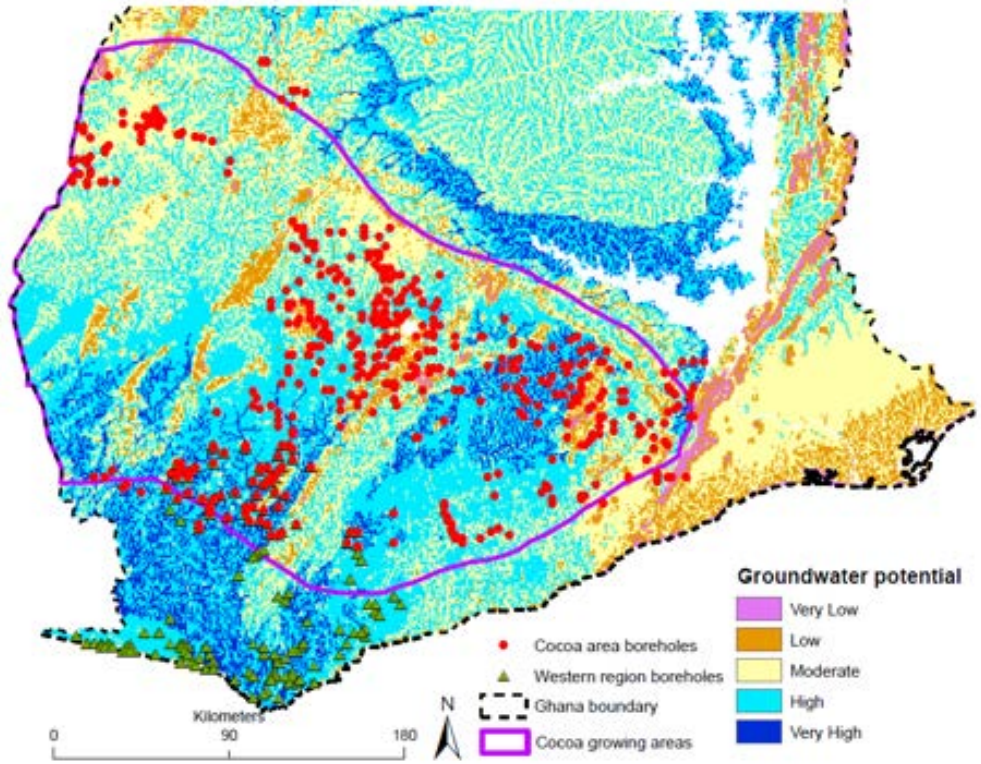
Borehole yield correlate with GW potential

- The reasonable correlation between existing borehole locations and high GW potential areas.
- Western Region boreholes not included in the analysis fall in areas with high or very high groundwater availability potential. This means there is a high potential for obtaining groundwater in areas modelled as having high or very high potential.



Potential class	Number of boreholes	Min. Yield (l/min)	Max Yield (l/min)	Mean Yield (l/min)	Standard Deviation (l/min)
Very low	17	12.6	120	66.3	33.2
Low	69	10	138	58.2	33.6
Moderate	135	5	750	65.5	92.3
High	150	3	650	64.0	70.7
Very high	55	11.3	1200	90.7	157.6

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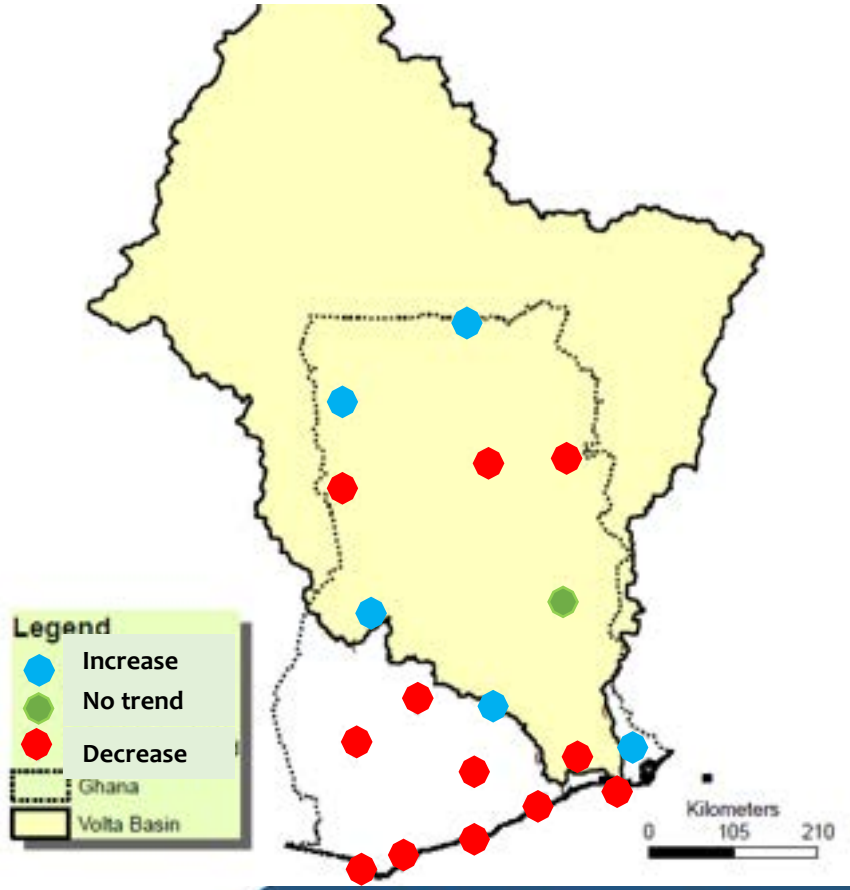
Climate change impact on water availability: Trends in the past

- Spatial distribution of annual precipitation from 1960 to 2011.

- High precipitation areas coincides with **cocoa growing areas and High GW potential zones.**

- **Annual Rainfall change over the last 50 years has shown a decreasing trend in the Cocoa growing areas.**

- Annual Rainfall change over the last 50 years



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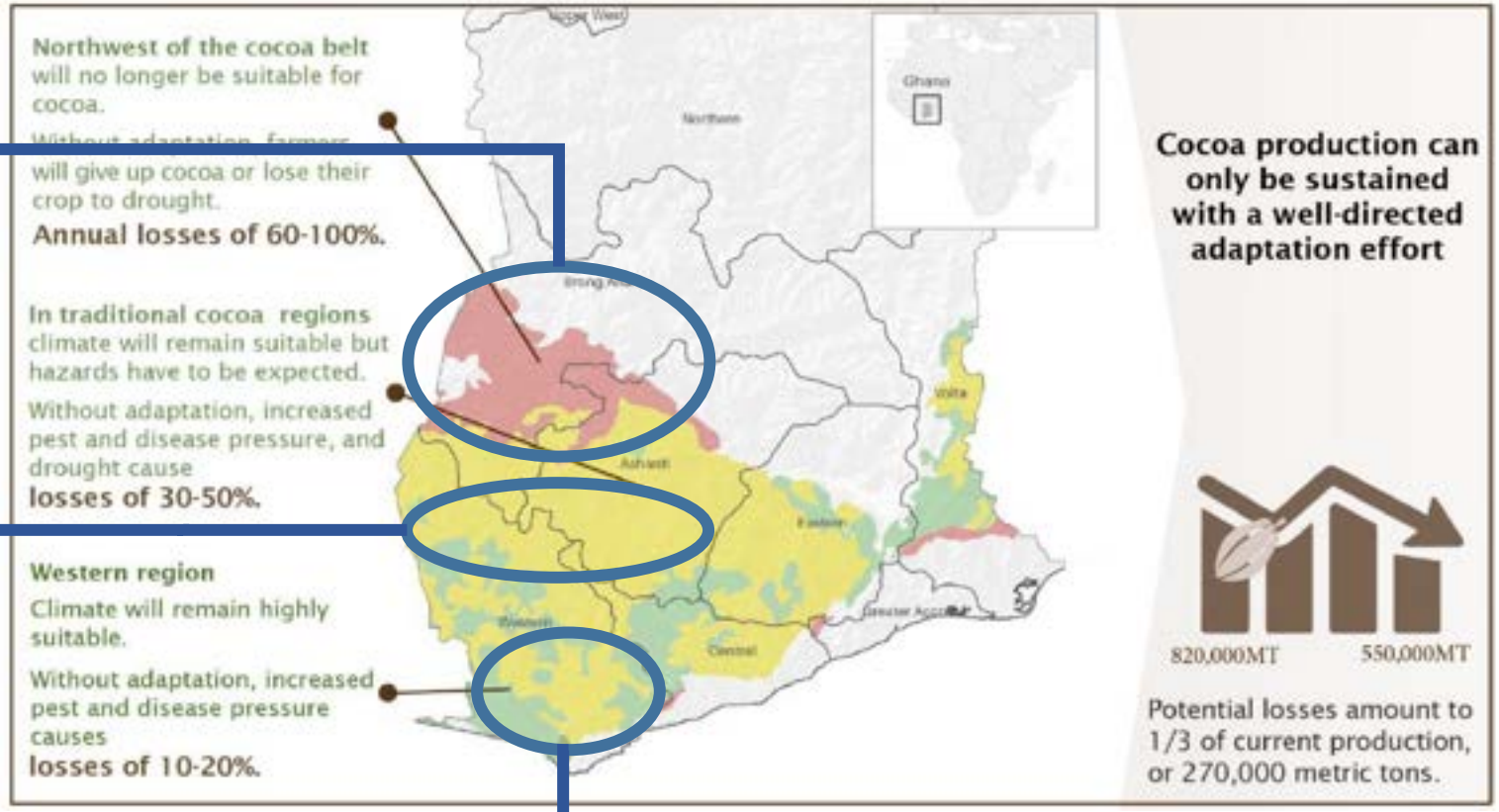
Climate change impacts on Water Availability and the Need for Adaptation

- Cocoa yield is more highly impacted by precipitation than any climate variable, making the **crop vulnerable to the scarcity of soil water** (Kosoe and Ahmed, 2022).
- High evaporation rate implies more soil water stress and drought.
- Decline in rainfall may induced reduction in GW recharge with potential negative impact on irrigation.
- Cocoa-producing regions are anticipated to become increasingly vulnerable to adverse weather conditions as the changing climate advances.

Climate change impacts on Water Availability and the Need for Adaptation

- Northwest of the cocoa belt will no longer be suitable for cocoa **(Annual loss of 60-100%) without adaptation**
- Traditional Cocoa growing area will remain suitable but with pest and disease incidence and **drought (Losses of 30-50%) without adaptation**
- Western Region will remain highly suitable but with pest and disease incidence **(Losses of 10-20%) without adaptation**

Cost of inaction



Climate Smart Cocoa in Ghana (Bunn et al. 2019)

IWMI International Water Management Institute

Conclusion

- Within the cocoa growing areas, the analysis revealed a total area of 22,126 km^2 and 125.2 km^2 for cocoa plantations and surface water bodies, respectively.
- The multi-criteria analysis (MCA) showed that ~80% of the study area has moderate to very high groundwater availability potential.
- The overlay between the MCA output and existing borehole locations revealed a reasonable correlation between the two, with ~80% of existing boreholes located in moderate to very high potential areas.
- Boreholes in very high potential areas had the highest mean yield of 90.7 l/min, while the lowest mean of 58.2 l/min represented boreholes in low groundwater availability potential areas.
- There is potential to expand the area under irrigation in cocoa production by implementing sustainable cocoa irrigation practices.

IWMI International Water Management Institute

Thank you!!

(email: k.akpoti@cgiar.org)

Innovative water solutions for sustainable development

Food·Climate·Growth

CGIAR


BARRY CALLEBAUT
IRRIGATION MANAGEMENT
Euromacchine
New Holland

Context

- This presentation highlights how irrigation (manual and drip) is being held on the trial during the second phase of the Cacao-Intercropping project from **December 2021** to **February 2022**.
- It is structured in three major parts:

Part 1 : Drip irrigation

1. **Presentation of the different equipment**
2. **Principles of irrigation operation**
3. Watering and pump program
4. data collected

Part 2 : Manuel irrigation

1. **Principles of irrigation operation**
2. Watering program and quantity of water applied

Part 3 : Overview of manually and drip irrigated cocoa trees and Key learnings

Part 1 : Drip irrigation

1. Presentation of the different equipment

Dripper

- Spacing between drippers: 50cm
- Actual flow rate: 1,5L/H
- Diamètre: 16 mm

Head control

- The solenoid valves receive instructions from the demeter according to the program.
- Demeter system works with an internet chip (3G network)
- The volumeter gives information on the volume of water supplied to the plot.

Diesel motor pump

- Manual ignition
- Turn off of the motor pump can be automated
- Diesel : 2L/H
- Water: 850L/H

Demeter system

- Demeter system consists of a solar panel and a demeter box.
- Battery of the box is powered by the solar panel.
- Demeter system works with an internet chip.
- Demeter box receives the information from the supplier's server

2. Principles of irrigation operation

How does the drip irrigation system work?

1

2

4

3

Drip irrigation video

3. Watering and pump program

Periode	Pump start time	Pump stop time
Morning	08:02 am	11:55 am
Afternoon	1:02 pm	16:55 pm

Pump operating program

OPENING TIME (h)	CLOSING TIME (H)	PLOT
08:00 am	10:00 am	**S3P1**
10:00 am	12:00 am	**S2P1**
1:00 pm	3:00 pm	**S1P2** and a part of **S4**
3:00 pm	5:00 pm	and a part of **S4**

Watering program

Which quantity of water supplied to cocoa trees?

- Each cocoa tree receives **18L/day** in **block 1** and in **S4** each cocoa tree receives **12L/day**
- They are watered **6 days a week**

4. Data collected

Which data are collected ?

Data collected at the pumping station :

- The number of times the motor pump operates;
- The number of midnight revolutions of the motor pump
- Fuel consumption
- Water pumping pressure.

Data collected at the plot :

- The volume of water supplied to each plot;
- The flow rate of the drippers;

Date	Month	Plot	volume of water start (m3)	volume of water End (m3)	volume of water daily (m3)	Comment
19/01/2022	Janvier	S1P1	325	343	18	
19/01/2022	Janvier	S2P2	335	355	20	
19/01/2022	Janvier	S3P1	368	390	22	
20/01/2022	Janvier	S1P1	343	361	18	
20/01/2022	Janvier	S2P2	355	375	20	
20/01/2022	Janvier	S3P1	390	413	23	
21/01/2022	Janvier	S1P1	361	378	17	
21/01/2022	Janvier	S2P2	375	394	19	
21/01/2022	Janvier	S3P1	413	432	19	
22/01/2022	Janvier	S1P1	378	398	20	
22/01/2022	Janvier	S2P2	394	413	19	
22/01/2022	Janvier	S3P1	437	454	17	
24/01/2022	Janvier	S1P1	398	417	19	
24/01/2022	Janvier	S2P2	413	434	21	
24/01/2022	Janvier	S3P1	454	473	19	
25/01/2022	Janvier	S1P1	417	435	18	

Example of collected data

Part 2: Manuel irrigation

1. Principles of irrigation operation

- Water is supplied to the plants through hoses connected to tanks mounted on the tractor. This system is used for Block 2,3,4 Schemes 1, 2 and part of Block 2,3,4 Scheme 3.
- The other inaccessible part of Block 2,3,4 Scheme 3 (SSP3) is covered by hand using watering cans.
- According to the watering programme, the workers (hand watering with watering cans) and the tractor water schemes 1 and 2 of blocks 2,3 and 4 in synergy.

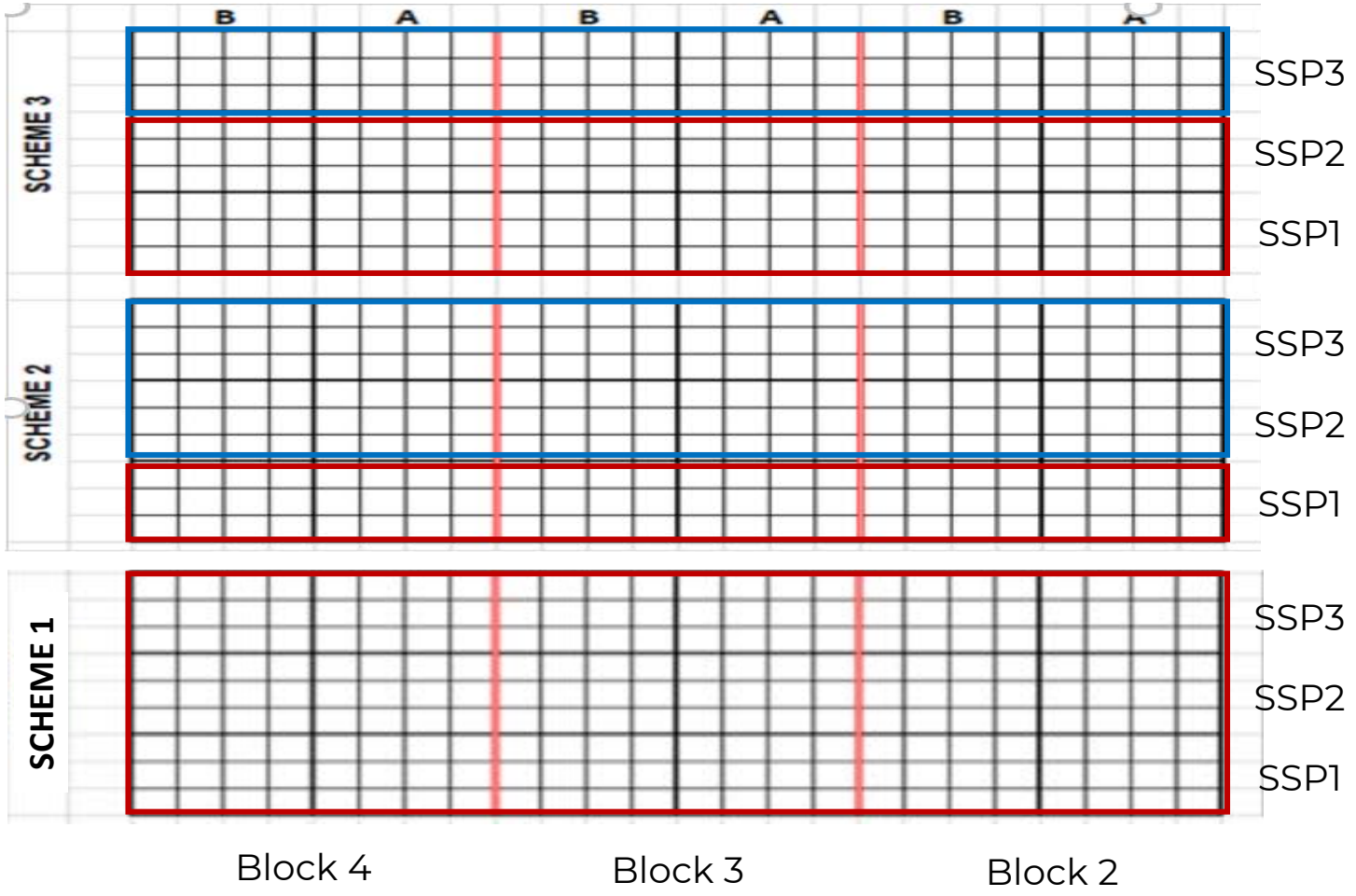
watering with tractor

Manual watering with watering cans

1. Principles of irrigation operation

: **SSP** watered by the **tractor**

: **SSP** watered **manually by workers**



Manual irrigation program design

2.Watering program and quantity of water applied

Day	Blocks	Schemes	Frequency	L/tree/day	L/tree/week
Monday	2, 3 and 4	S1 and S2	4	8	32
Tuesday	2, 3 and 4	S1 and S2			
Thursday	2, 3 and 4	S1 and S2			
Friday	2, 3 and 4	S1 and S2			
Wednesday	2, 3 and 4	S3	2	8	16
Saturday	2, 3 and 4	S3			

The quantities of water applied to the cocoa trees are recorded on an XLS file.

Part 3: Overview of manually and drip irrigated cocoa trees

Overview of manually and drip irrigated cocoa trees

S1P1 irrigated by drip

S1P2 manually irrigated

Key learnings

- Water stress is higher in the double cocoa lines closer to the teak lines
- Soil quality requires irrigation (manual or drip) in the dry season
- Drip-irrigated plants did not suffer from water stress
- The shading generated at the level of scheme 3 makes it possible to mitigate the effect of water stress on the cocoa trees
- Teak leaf litter prevents weeds from growing
- The blooming of glyricidia flowers in the dry season attracts pollinating insects (bees...)

BARRY CALLEBAUT

THANKS YOU FOR YOUR ATTENTION

ARIELI

GG

Your partner in development

Solar pumping station for potable water and Agriculture (COCOA IRRIGATION)

Arieli-AG Ltd Introduction

- Arieli-AG Ltd is involved in Water Treatment & Agriculture Project Development.

- Our vision is to introduce and develop sustainable economic & Ecological methods and practices suitable for the designated location environment.

- Our offering includes the design and build of turnkey projects. We bring the technical knowledge and experience of our team alongside the knowledge of our network of suppliers and research institute's experience to the benefit of the end-users.

- We introduce Modern and Precise water treatment & agriculture methods by maximizing the benefits and mitigating the threats . We design sustainable systems that minimize Carbon emission and water footprint .

- In any given project we consider ourselves as partners in development and committed to the successful execution .

Cocoa
Impact on Community & Social Responsibility

TODAY:

- The cocoa sector is endangered by severe and worsening environmental pressures brought about by a warming and drying climate and devastating plant diseases caused by viral and fungal pathogens. These pressures lead to vast areas of weakened or dead cocoa trees and highly distressed rural communities.
- In Ghana, for example, cocoa provides the livelihood of over 850,000 families directly and additional millions whose livelihoods are generated along the supply and services chain.
- Most cocoa farms in Africa are small (1-5 ha) and run/maintained by small-holder farmers or community cooperatives. Farming, harvesting and processing techniques are primitive due to lack of funds for needed inputs and improvements.
- Yields are low (average 500 kg/ha) and farmers and their families are impoverished. Making farming unattractive to the young folks.
- Mortality rate of young planted cocoa trees is about 30% per year during the dry season and in most cases mature cocoa trees are also affected and die during long drought making it very difficult for farmers handle.
- Scientific research proves that young cocoa trees needs 10 litres of water a day and mature cocoa trees needs 30 litres of water a day.
- If this water requirement is achieved the cocoa will yield throughout the year.
- This water requirement can only be achieved through **IRRIGATION**

System Components

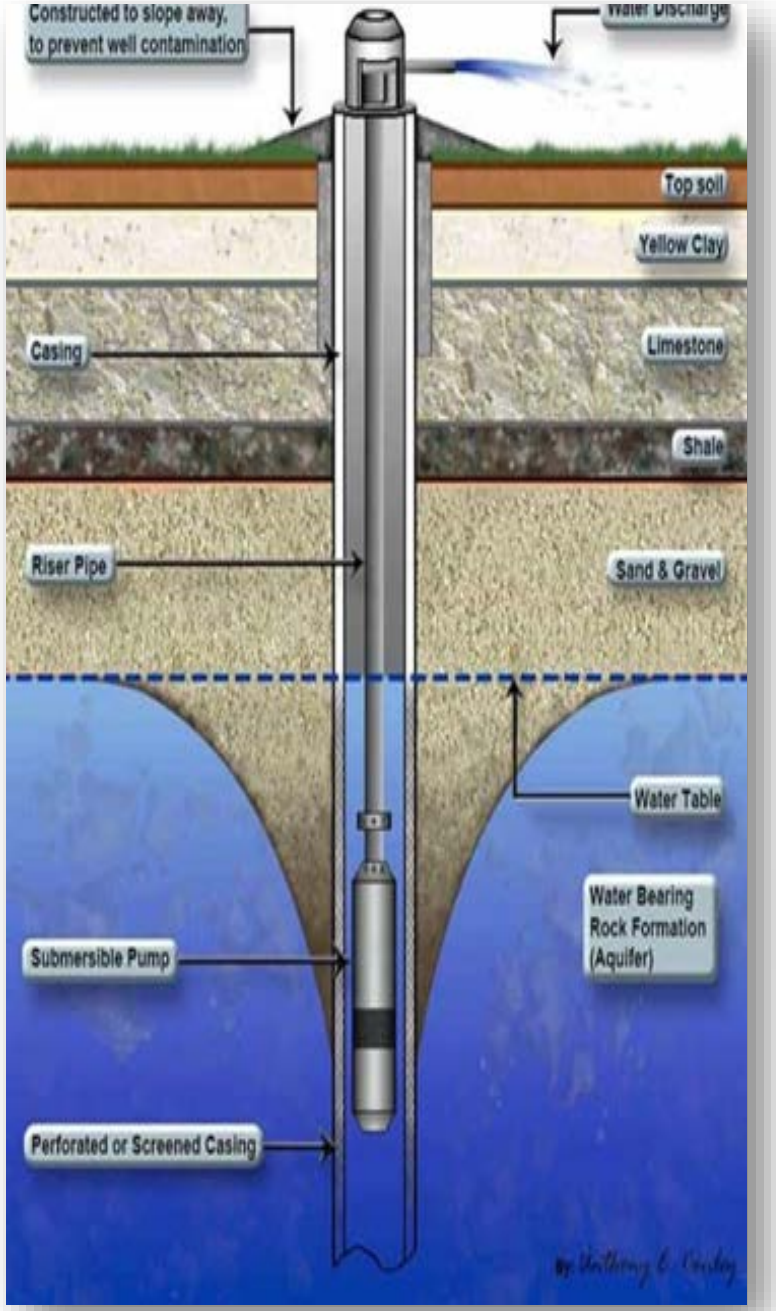
- **Borehole or any other water source for irrigation water source**.
- Solar powered electrical pump.
- Support structure for the solar panels.
- **PV solar panels.**
- Inverter charger DC to AC & controller.
- AC filter box for PV panels.
- Water storage tanks .
- Water filtration system.
- Irrigation system head and control.
- Dowsing nutrition system.
- Flexible water piping system.
- **Drip piping system.**

Borehole drilling

- Identifying a good underground water source is paramount. We use detecting device that indicate water QTY and depth of the underground water in order to save unsuccessful borehole drilling .

- The depth of borehole and its yield are two key parameters to enable effective use of the borehole.

- Testing of water quality should be done on all our project sites for Irrigation and other purposes.




1. Inverter charger


AC filter unit


Head control


Dosing tank
Filter unit

Detecting the underground water

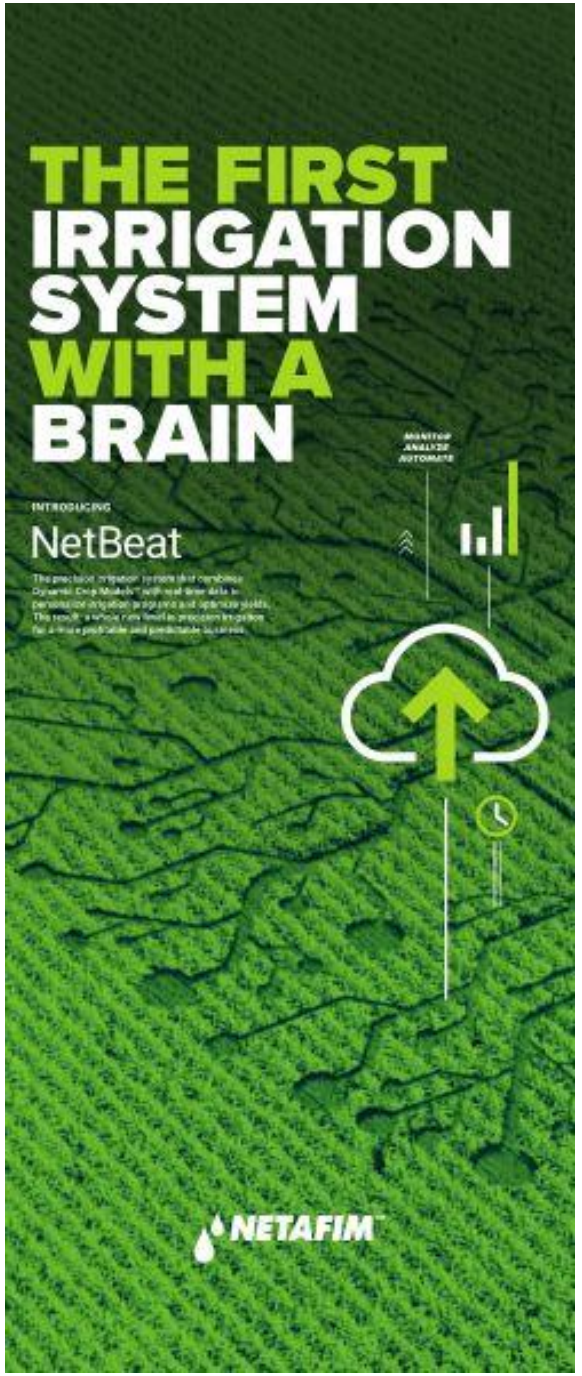
We have acquired a River G Water Detector, totally new device works by three exploration systems of groundwater and artesian wells in the ground

1. 3D imaging system that enables you to see the presence of water in the ground.
2. Geophysical search system to determine the quantity, depth, type of water and the percentage of its salinity in the ground.
3. Long range system to search for water within vast areas to a depth of 1500 meters underground and up to 3000 square meter in front range.

This is because about 50% of the boreholes drilled during the pilot project were unsuccessful.

So far success rate with this device is 100%

Drip Irrigation Piping System



65 Solar Drip Irrigation System has been Handed Over


Kwame Tatra - Assin Foso, Central Region
5°44'52", -1°20'25", 176.0m
6 Apr 2022 11:28:09


Kwame Tatra - Assin Foso, Central Region
6 Apr 2022 11:29:31


Kwame Tatra - Assin Foso, Central Region
5°44'52", -1°20'26", 178.1m
6 Apr 2022 09:45:29


Kwame Tatra - Assin Foso, Central Region


Asuboi - Suhum District Eastern Region
Unnamed Road, Ghana
5°55'36", -0°25'50", 139.7m
30 Apr 2022 15:07:43


Anyinasu -Ajumaku District Central Region
5°32'23", -1°6'11", 131.3m
7 Apr 2022 15:11:29


Anyinasu -Ajumaku District Central Region
5°32'22", -1°6'10", 128.8m
8 Apr 2022 12:09:20

The objective of this study is to determine the impact, if any that solar powered drip irrigation has on the yield of the Cocoa farms where they were installed on a pilot basis in the Central and Western Regions of Ghana.

- **The data used comes from Cocobod purchase records (Cocoa Passbook), not farm production records.**
- **The data is from 2 (two) farms in the Central Region of Ghana, specifically Kwame Tatra in the Assin Central District and Nuanua in the Assin South District.**
- **This analysis assumes that the purchase records of the farms can reasonably serve as proxy data of total farm production.**
- **It must be noted also that only 1 hectare of total farm size was put under irrigation on a pilot basis.**

Irrigated site 12th March 2022 after long harmattan
The farmer is harvesting and cocoa is flowering throughout the year.

Data from the two Farms

1. (**K. AGYEI - NUANUA (FARM SIZE - 4.1 Ha)** Right after the pilot drip irrigation was completed in May 2019 for 1 hectare out of the 4 hectares, total sales to Cocobod per season increased by an annual average of 66%. Before irrigation, that is 2013 to 2018 yield per hectare averaged **1.13 Ton .** Right after irrigation was completed in May 2019, this has increased significantly to an average of **5.08 Ton per hectare**. That is an increase by a factor of 4.50.

2. Kwame Tatra Before irrigation, that is 2013 to 2018 yield per hectare averaged 1.13 Ton . Right after irrigation was completed in May 2019, this has increased significantly to an average of 5.08 Ton per hectare. That is an increase by a factor of 4.50.

- The summarized data presented above have been graphically illustrated in the pages that follow to allow an observer to appreciate the huge improvement that solar powered drip irrigation can bring to the Cocoa industry in a sustainable manner.

Irrigated site 12th March 2022 after long harmattan
The farmer is harvesting and the cocoa is flowering through out the year

EVALUATION OF RETURNS FROM COCOA IRRAGATION

the successful pilot project

Cost benefit of proposed irrigation system on 1 Hectare of cocoa plantation

	Total expected Benefit per 1 Ha	Ghc	%
1	**No Irrigation**	1300	100%
2	**With irrigation Average Yelled**	25,660	1974%

	Description	Unit	QTY	Unit price	No Irrigation	With Irrigation
						Average yelled
				GHC	GHC	GHC
1	**Income from cocoa production 1Ha**					
1.1	No Irrigation	Kg	500	10.56	5,280	
1.2	With irrigation average yelled	kg	3,000	10.56		31,680
	Total for income				**5,280**	**31,680**
2	**Running Cost**					
2.1	fertilizer	Bag	6 & 9 respectivly	80	480	720
2.2	Crop protection (insecticides , fungicide)	lot	1	600	600	600
2.3	Spraying & fertilizer application	lot	1	1,000	1,000	1,500
2.4	Other farm maintenance cost	lot	1	1,500	1,500	2,200
2.5	Other unforeseen expenses	Lot	1	500	500	1,000
	Total for cost (expenditure)				**4,080**	**6,020**
3	**Operating profit**				**1,200**	**25,660**

Collaborated Partners:

The Cocoa Cure Center (CCC), Israel brings scientists specializing in various agricultural disciplines together to help develop synergetic and creative practical solutions to problems associated with growing cocoa.

Arieli-ag and the CCC are working in collaboration Submitting proposals for Development of cocoa projects for private , public and EU programs .

Our Partners in development

	Entity	Role & Responsibility	
Partner	Netafim Ltd	Design , manufacturer and supply of drip irrigation system	
Partner	FOB Engineering Gh Ltd	Local partners for installation and Maintenance works	
Partner	ICL Fertilizer	Manufacturer and supply of Fertilizer for sustainable crop nutrition	
Research partner	Volcani / Cocoa Cure Center (CCC)	Provide best practices methods, agronomical support, introduction of new technologies, collaborate with CRIG	
Research partner	CRIG Ghana	Localize research, follow Ghana Cocobod protocol of growing, collaborate with CCC	

Why Partner with us

- The skillset and experienced engineers we have has successfully executed several solar pumping projects in Africa
- Our sense of identification with our client's project means we are constantly striving to provide solutions for individuals and communities.
- We deliver our projects on time using modern technology tools.
- We give you value for your money

Contact us :

+233(0)557663957

+233 (0) 244321943

E-mail: moshe.h@fob-engineering.com

Physical address: No. 12 UNA Home, Airport city , **Accra , Ghana**

Website : http://fob-engineering.com/

FOB ENGINEERING GHANA LIMITED

ARIELI

GG

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GHANA LIMITED

THANK YOU

PUMPTECH




Water lifting technologies for cocoa irrigation.

Moses Tampoe:
0257965277

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PUMPTECH
The Trusted Solar Water Pumping Company

ABOUT PUMPTECH

PUMPTECH

A Ghanaian water infrastructure development company founded in 2007

Market leader in the solar water pumping market in Ghana.

Available across Ghana at the following locations:

Spintex Accra, Tamale, Wa and Bolga

Upcoming outlets: Takoradi, Kumasi, Sunyani.

Focus on solar water pumping

- Community Water Supply
- Irrigation
- Industrial applications

Distributor of Lorentz and Grundfos Pumps

Sun. Water. Life.

The Complete Solution

Pumps and Accessories

- Wide range of pumps
- Wide range of accessories
- All integrated into COMPASS
- Single supplier and tested together for lowest project risk

Sun. Water. Life.

Service delivery

- Free training training-operation and trouble shooting
- In-house capacity for repairs and maintenance.
- 2 years warranty-manufacturer’s defect
- Dedicated technical team.

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The Trusted Solar Water Pumping Company

PUMPTECH

Dynamics of ground water sources for solar powered irrigation in cocoa farm

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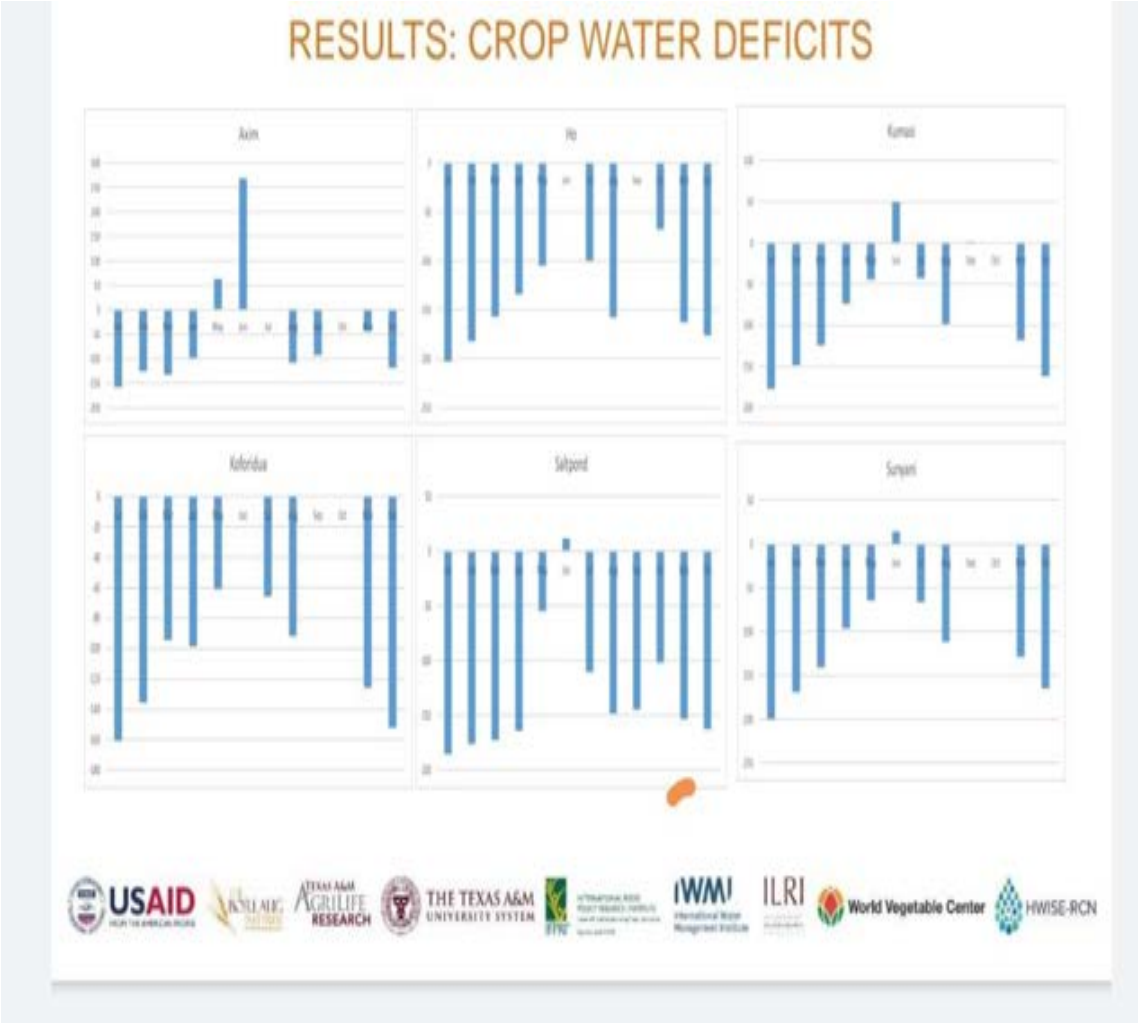
Some conditions required for cocoa growth

- High temperature
- High Humidity
- High precipitation 130-235mm/month

Water Deficits: cocoa



RESULTS: CROP WATER DEFICIT GRAPH

- The crop water deficit graphs (mm/month) have been calculated by subtracting the monthly water need from the effective monthly rainfall (Pe) for 10 years (2006 – 2016).

Aziz Fati & Abeyou W. Worqlul

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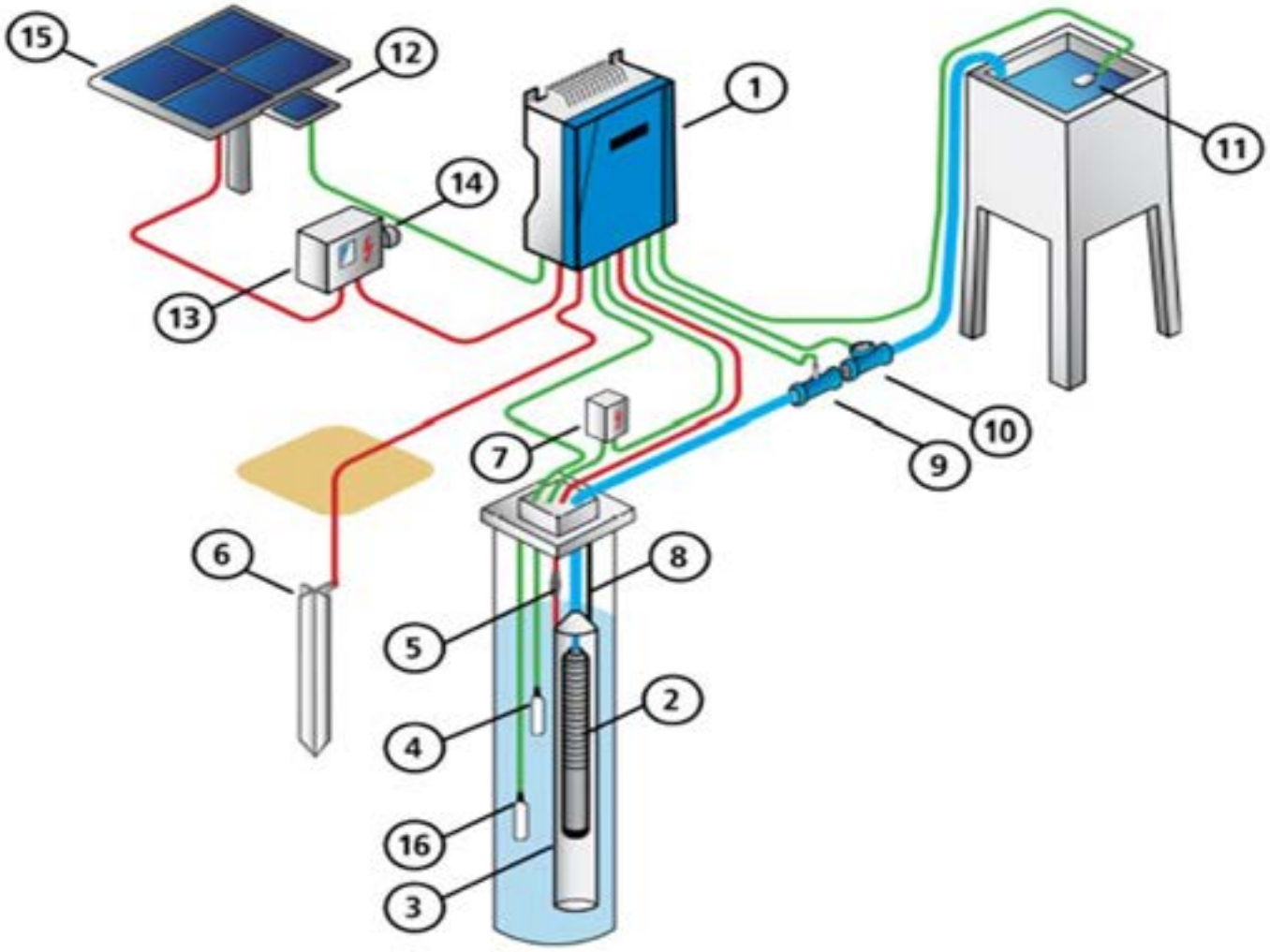
Medium-to-large-scale solar irrigation systems



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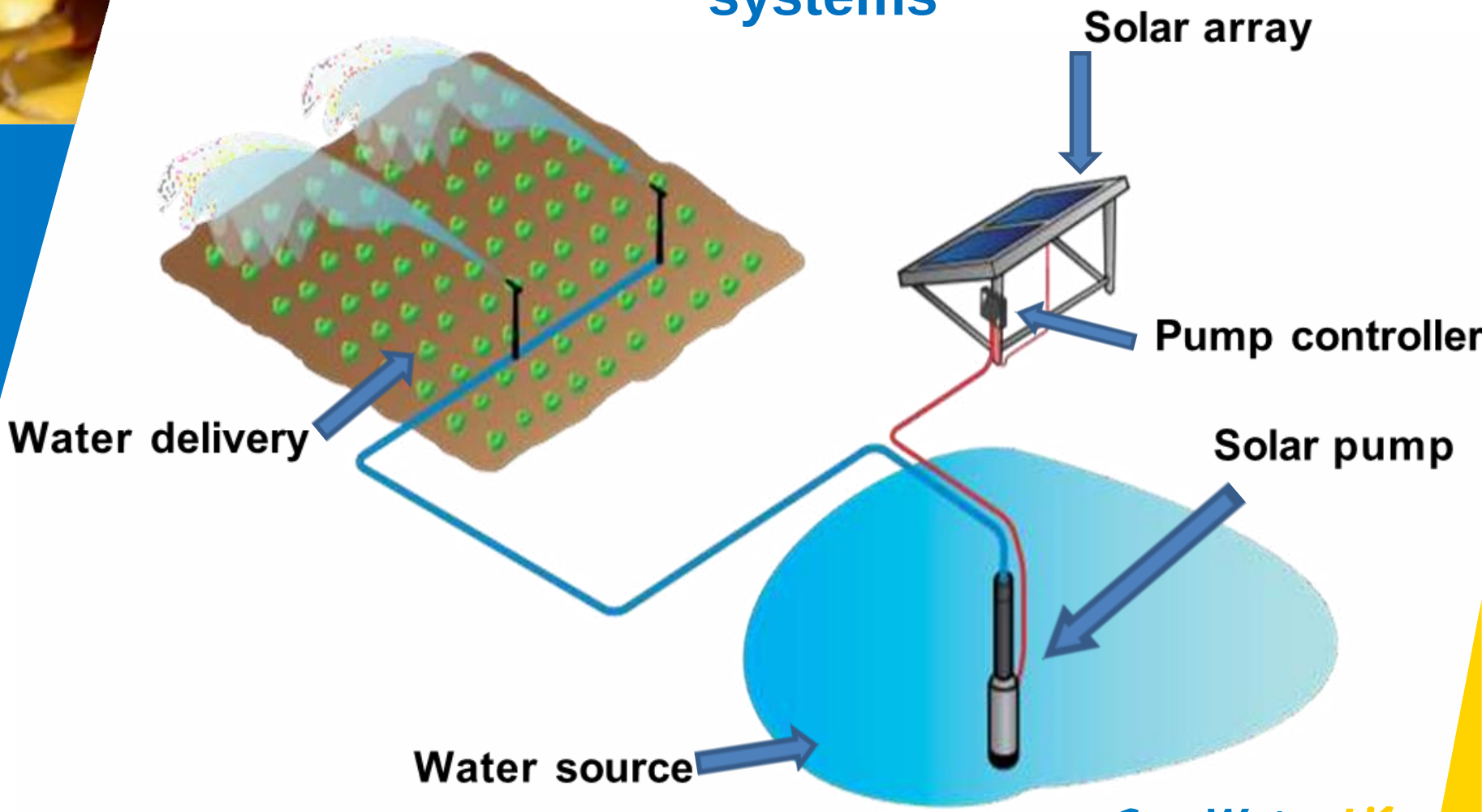
Smallholder solar irrigation systems



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Submersible pumps can pump from deeper depths

LORENTZ

PS2-1800 C-SJ12-4

Solar Submersible Pump System for 4" wells

System Overview

Head	max. 18 m
Flow rate	max. 20 m³/h

Technical Data

Controller PS2-1800

- Controlling and monitoring
- Control inputs for dry running protection, remote control etc.
- Protected against reverse polarity, overload and overtemperature
- Integrated MPPT (Maximum Power Point Tracking)
- Battery operation: Integrated low voltage disconnect
- Integrated Sun Sensor

Power	max. 1.8 kW
Input voltage	max. 200 V
Optimum V_{mp}**	> 102 V
Motor current	max. 14 A
Efficiency	max. 98 %
Ambient temp.	-40...50 °C
Enclosure class	IP68

Motor ECDRIVE 1200-C / ECDRIVE 1800-C

- Maintenance-free brushless DC motor
- Water filled
- Premium materials, stainless steel: AISI 304/316
- No electronics in the motor

Rated power	1.7 kW
Efficiency	max. 82 %
Motor speed	900...3 300 rpm
Insulation class	F
Enclosure class	IP68
Submersion	max. 150 m

Pump End PE C-SJ12-4

- Non-return valve
- Premium materials, stainless steel: AISI 304
- Centrifugal pump

Efficiency	max. 58 %

Pump Unit PU1800 C-SJ12-4 (Motor, Pump End)

Borehole diameter	min. 4.0 in
Water temperature	max. 50 °C

Standards

CE 2006/42/EC, 2004/108/EC, 2006/95/EC

IEC/EN 61702:1995

The logos shown reflect the approvals that have been granted for this product family. Products are ordered and supplied with the approvals specific to the market requirements.

**V_{mp}: MPP-voltage under Standard Test Conditions (STC): 1000 W/m² solar irradiance, 25 °C cell temperature

LORENTZ

PS2-1800 C-SJ1-25

Solar Submersible Pump System for 4" wells

System Overview

Head	max. 140 m
Flow rate	max. 3.0 m³/h

Technical Data

Controller PS2-1800

- Controlling and monitoring
- Control inputs for dry running protection, remote control etc.
- Protected against reverse polarity, overload and overtemperature
- Integrated MPPT (Maximum Power Point Tracking)
- Battery operation: Integrated low voltage disconnect
- Integrated Sun Sensor

Power	max. 1.8 kW
Input voltage	max. 200 V
Optimum V_{mp}**	> 102 V
Motor current	max. 14 A
Efficiency	max. 98 %
Ambient temp.	-40...50 °C
Enclosure class	IP68

Motor ECDRIVE 1200-C / ECDRIVE 1800-C

- Maintenance-free brushless DC motor
- Water filled
- Premium materials, stainless steel: AISI 304/316
- No electronics in the motor

Rated power	1.7 kW
Efficiency	max. 82 %
Motor speed	900...3 300 rpm
Insulation class	F
Enclosure class	IP68
Submersion	max. 150 m

Pump End PE C-SJ1-25

- Non-return valve
- Premium materials, stainless steel: AISI 304
- Centrifugal pump

Efficiency	max. 49 %

Pump Unit PU1800 C-SJ1-25 (Motor, Pump End)

Borehole diameter	min. 4.0 in
Water temperature	max. 50 °C

Standards

CE 2006/42/EC, 2004/108/EC, 2006/95/EC

IEC/EN 61702:1995, IEC/EN 62253 Ed.1

The logos shown reflect the approvals that have been granted for this product family. Products are ordered and supplied with the approvals specific to the market requirements.

**V_{mp}: MPP-voltage under Standard Test Conditions (STC): 1000 W/m² solar irradiance, 25 °C cell temperature

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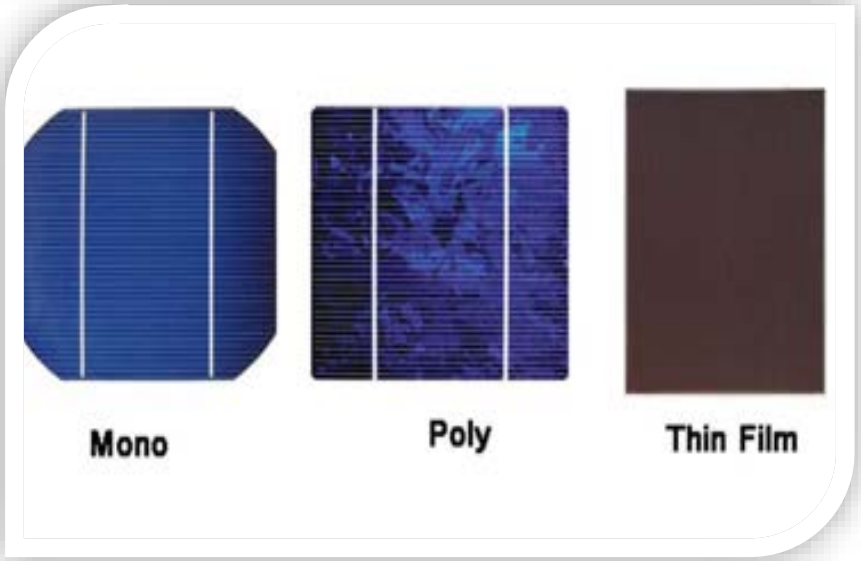
Propensity to generate more power with little space



80 Wp  =  1 person

The Solar Water Pumping Company

Prospects of SPIS for Cocoa production

3960watt array at a farm

- Solar power is in abundance
- Less Dust
- Less heating of modules thus better performance
- Drip irrigation can minimize the incidence of diseases.
- Drip irrigation also reduces run-off and thus erosion and leaching

Sun. Water. Life.

Thank you!

PUMPTECH

Interplast Irrigation Solutions for Cocoa Trees

March 2023

Interplast®
PRODUCERS OF HIGH QUALITY PIPES & PROFILES

Content

- Introduction
- Why Irrigate Cocoa ?
- Why Interplast?
- Why INGREEN Irrigation Solution?
- INGREEN Irrigation Solution for Cocoa

Introduction

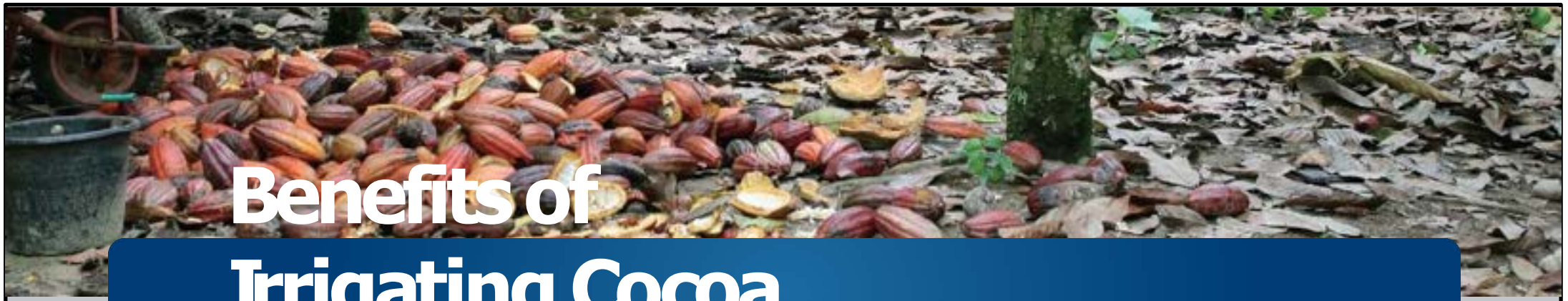
Cocoa in Ghana

- Cocoa production has been the backbone of Ghana's economy for more than six decades now.
- Cocoa sector employs over a million people throughout the country and remains the major source of livelihood for many people in the country.
- Ghana is the Second largest cocoa exporter in the world.

Cocoa Production challenges-related to irrigation

- Cocoa trees productivity is below international average due to inadequate fertilizers and water application.
- Cocoa production is highly affected by the fluctuating rainy season.
- Cocoa trees suffer from soil born diseases due to the use of non-adapted irrigation methods.

Why Irrigate Cocoa?



Benefits of Irrigating Cocoa

1

Reduce your risk of low and/or inconsistent rain affecting production in terms of quantity and quality.

2

Reduce the period needed to obtain commercial production of cocoa trees and extend the production period along the year.

3

Increase the productivity per hectare (up to 100%).

Benefits of cocoa irrigation with Drip Systems

1. **Gain top-quality yields:**
   Push cocoa production to the maximum quantity and quality with drip irrigation system.

2. **Save on fertilizers, crop protection and labor costs:**
   By distributing nutrients and crop protection directly to the root zone in the most efficient and uniform way.

3. **Drastically reduce soil born diseases due to minimal contact between water and tree stems**

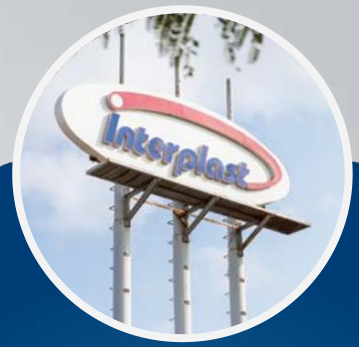
Why Interplast?

Why Interplast?

Interplast is 100% Ghanaian company.

Interplast stands as the biggest pipes manufacturer in West Africa since 1970.

Interplast products match and exceed the international standards (ISO/DIN)



Interplast has the financial capacity to supply large projects.

Why Interplast?

Interplast - The Biggest Irrigation Solutions Provider in Ghana

Interplast has a dedicated department for irrigation: INGREEN.

Ingreen has supplied and implemented irrigation materials for more than 10,000 hectares in Ghana and the region.

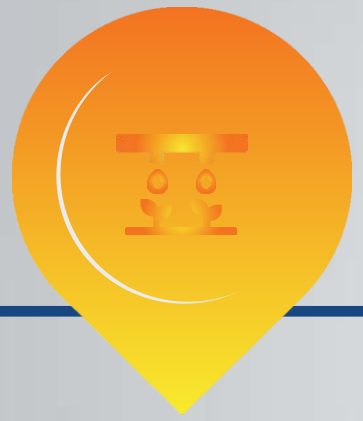
Why Ingreen Irrigation Solution?

Why Interplasts's INGREEN Irrigation Solution?

INGREEN offers complete solutions for cocoa irrigation, including but not limited to:

- Irrigation Drip Kit Design
- Materials supply
- Technical Assistance
- After sales : Supply of spare parts
- Training

Irrigation Drip Kit Designs



INGREEN irrigation solutions are adapted to the local context.

Materials Supply

- We are the only drip pipes' manufacturer in West Africa with a production capacity of 230m per minute (> 2,000,000m per week).
- Our fittings, accessories and filters are sourced from world-known suppliers in Spain, Italy and USA.
- We are the only company in Ghana that has the COMPLETE range of irrigation products available in our warehouses.
- INGREEN is a one-stop-shop for irrigation solutions.

Technical Assistance

Interplast's irrigation team are equipped with in-depth knowledge and skills in irrigation network installations with more than 20 years of experience worldwide.

We have the equipment and tools needed for irrigation networks installation.

After Sales : Supply of Spare Parts

- INGREEN provides maintenance support to the farmers whenever the need arises.
- INGREEN has in stock all the spare needed to sustain the supplied irrigation systems.
- INGREEN technical team is a phone call away from farmers.

Training

- INGREEN trained over 500 engineers, farmers and practitioners all over the country.
- INGREEN trained MOFA extension agents, GIDA extension agents and plumbers for Ghana Plumbers Association (GPA).
- We have ready training modules for: beginners, Intermediate level, Advanced training, Training of trainers

INGREEN Irrigation Solution for Cocoa

INGREEN Irrigation Solutions for Cocoa Trees

- INGREEN offers complete solutions for cocoa trees. Our solutions include: Head Unit: filters, fertilizers' injector.
- Main line, submains and manifolds: Interplast produces HDPE pipes from 16mm to 1200mm and uPVC pipes up to 400mm.
- Drip lines: our drip lines come in different thicknesses, with different flow rates and spacing of emitters.
- Fittings and accessories: our solutions include all the items needed to ensure smooth and easy operation of the system.

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IWMI International Water Management Institute

CGIAR

Effective demand for solar technologies for cocoa irrigation in Ghana

Kekeli Gbodji, William Quarmine, and Thai Thi Minh

Introduction

- Cocoa is essential to Ghana's economy
- Climate change = threat
- Solar irrigation = one solution
- Scaling technology!

- **Effective demand? Market prospect?**

- Cocoa farmers' **willingness and ability to invest** in Solar-powered irrigation pumps (SPIPs)

Study Design

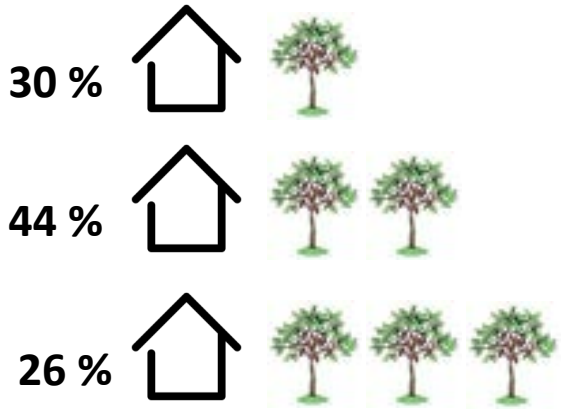
11 cocoa districts selected

523 Sampled households

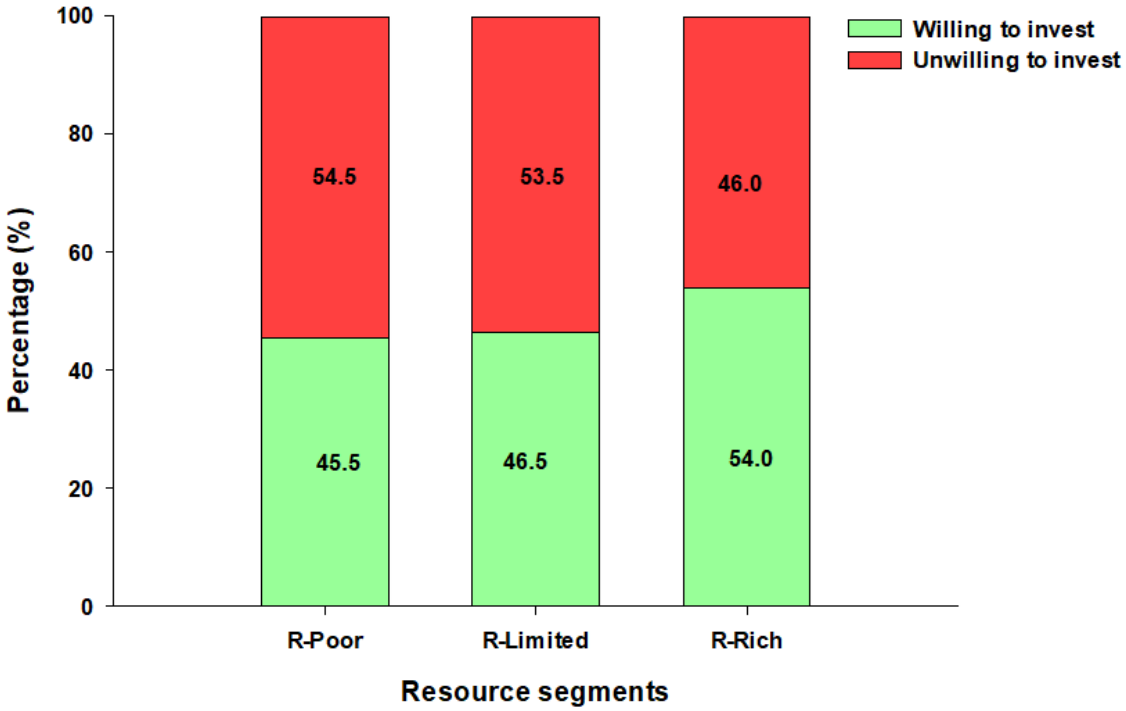
Data collection

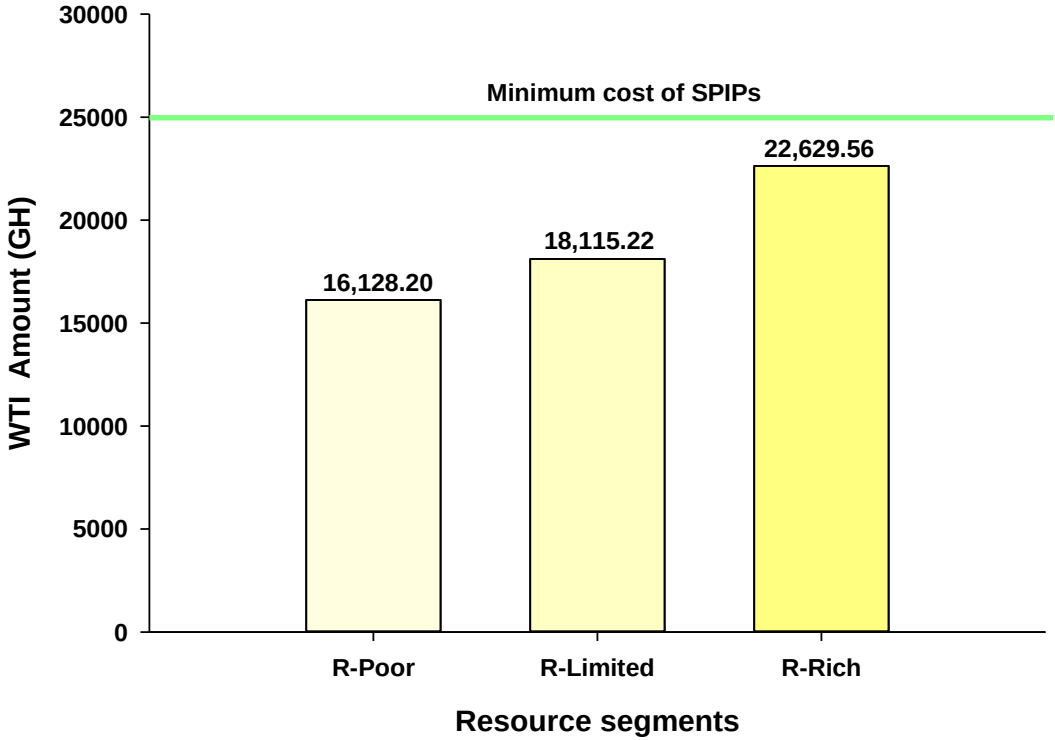
Data Analysis

3 segments



Willingness to Invest (WTI) in SPIPs by cocoa farmers





- Majority of the resource-poor and limited segments were not willing to invest in SPIPs.
- Although most of the resource-rich farmers were willing to invest, the amount they are willing to invest is below the minimum pre-determined market price of SPIPs.

Top 3 factors that influence WTI

Resource Poor

Cocoa land size

Education

Age of Cocoa tree

Resource Limited

+24%
Credit Access

High Income Category

Extension

Resource Rich

+ 34%
High Income Category

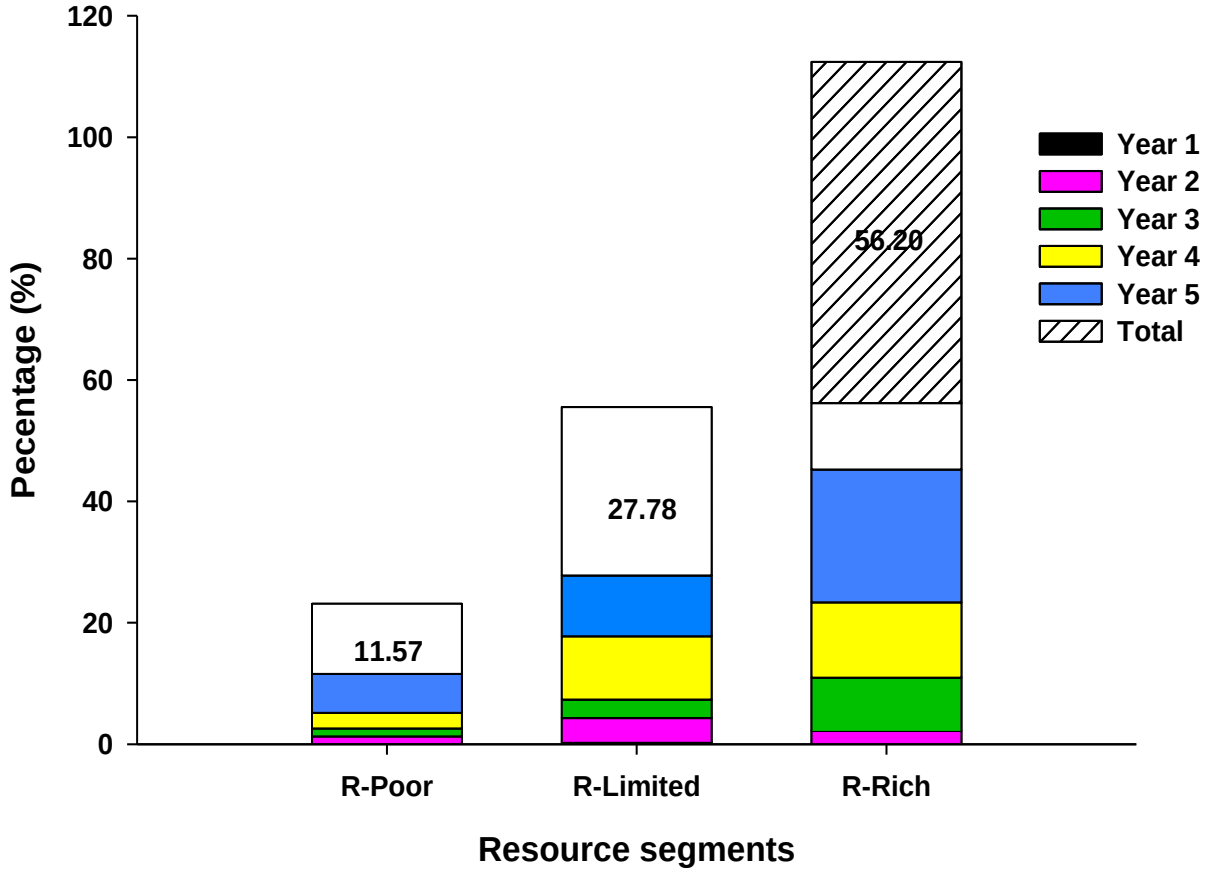
Education

Off-farm Activity

Real Ability to Invest (ATI)

Real Ability to Invest (ATI) in SPIPs

Resource segments	Real Ability to Invest per annum (GHc)
Resource-poor	2,220.39
Resource-limited	3,974.06
Resource-rich	6,918.14



- Resource-rich segment has the highest real ATI, due to their high resource endowments
- However, even among this group, the majority can only complete payment for the SPIPs after 5 years

Resource endowment of cocoa farmers

Resource Poor

Income sources	Amount (GH)
	4, 789
	758
	2, 156
	4, 726

Resource Limited

Income sources	Amount (GH)
	10, 075
	892
	3, 785
	7, 495

Resource Rich

Income sources	Amount (GH)
	23, 123
	1, 643
	5, 194
	8, 771

Summary

- SPIPs can address water stress in cocoa
- Effective demand increases across the resource segments with resource-endowed farmers more likely to demand SPIPs
- Resource-rich farmers are more likely to invest in SPIPs. But they can only pay for the cost of SPIPs after 5 years
- For all farmers, however, credit, income and off-farm economic activity will boost effective demand.

Key messages

Sustaining COCOBOD's PEPs initiative → to reduce aged and diseased cocoa trees

Segmentation → financing/business models

Promotion → initiatives for income diversification and microcredit services (resource-poor and limited)

Strengthen Extension → awareness among farmers

THANK YOU