UNIVERSITY OF CAMBRIDGE

The Challenge of an Evergreen Revolution

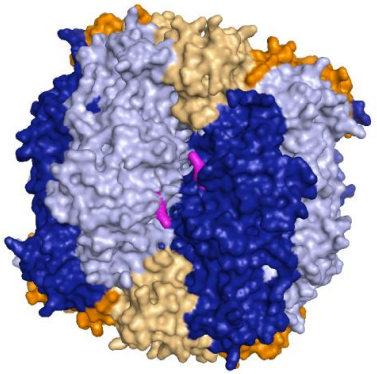
- Water, carbon, biomass and waste: the plant context for food, fuel and emissions
- Basic Research and Integration across Cambridge
- Opportunities arising from GCRF and Newton Fund
- Strategies for engagement used in GCRF TIGR2ESS programme

Howard Griffiths,
(Professor of Plant Ecology,
Co-Chair, Global Food Security Interdisciplinary Research Centre)
Department of Plant Sciences and
Fellow of Clare College

GLOBAL FOOD SECURITY

Department of Plant Sciences

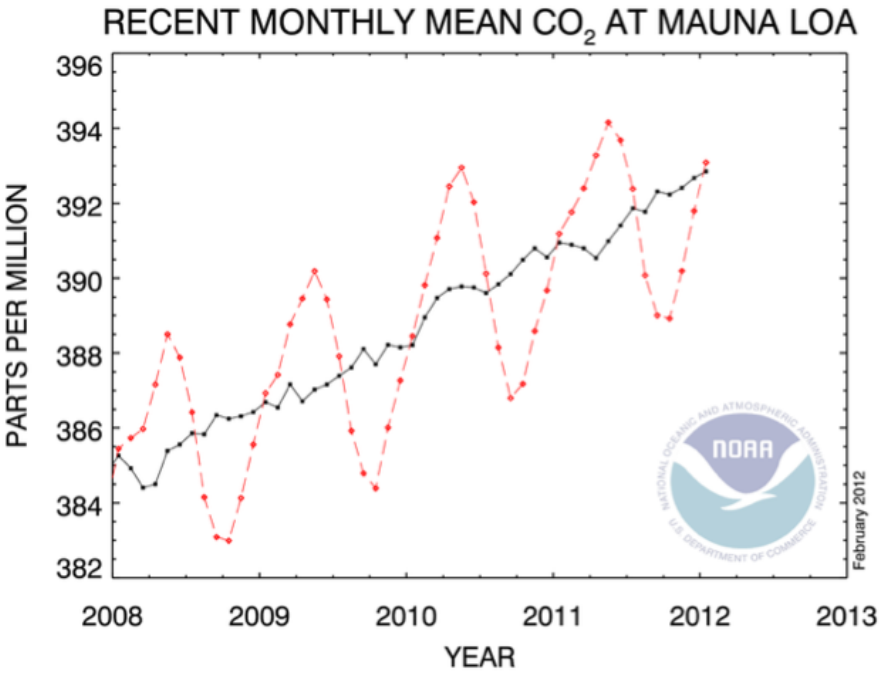
CARBON: Activate Rubisco and the planet draws breath…total carbon fixation by plants



- The atmosphere contains 750 Gigatonne Carbon (Petagram or 10^{15}g)

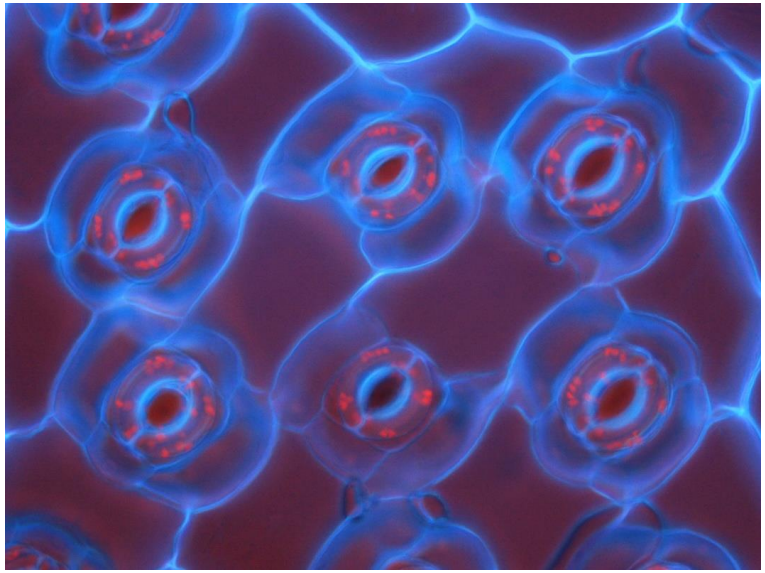
Terrestrial vegetation:

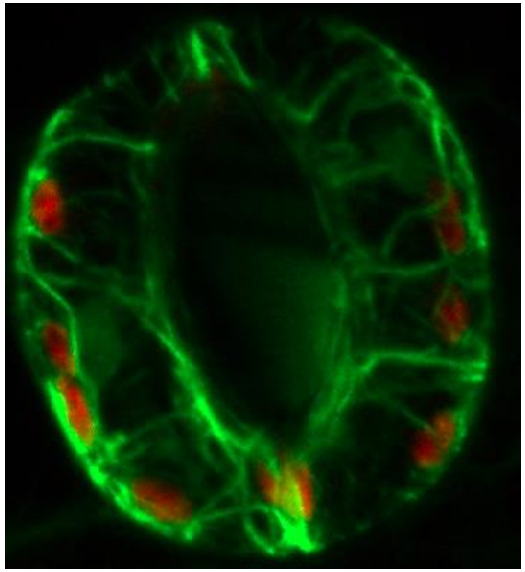
- absorbs 15% of the atmospheric CO_2 pool each year (120 Gtonne)
- sequesters 1-2 Gtonne anthropogenic CO_2 emissions



So terrestrial and marine plants are helping to limit that progressive increase in atmospheric CO_2

- WATER: Between 250 – 1000 water molecules are lost via transpiration through stomatal pores for every CO_2 molecule fixed.





- Global impact of CO_2 and H_2O gas exchange at leaf surfaces:
  - Carbon: 15% of global atmospheric CO_2 pool (120 x 10^{15} g or 120 Gt (gigatonnes) of carbon as CO_2
  - Water: 32,000 km^3 (= 1.5 times the volume of the Baltic Sea) or x2 atmospheric water vapour content .
  - For every kilo of carbon fixed, up to 1 tonne of water transpired by crops
  - Direct and indirect water use now a major consideration for cropping systems

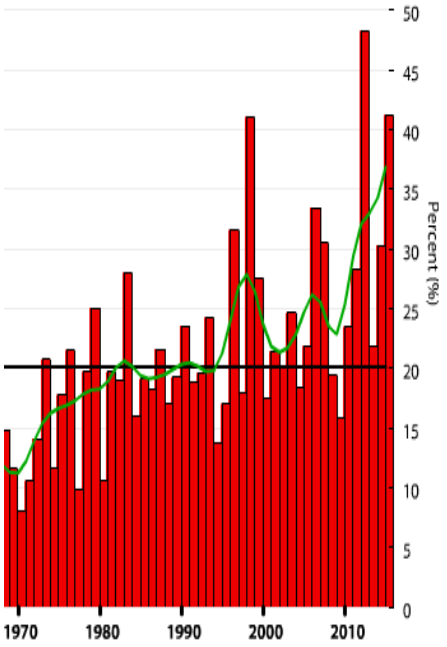
- Costing the earth: water use in food production

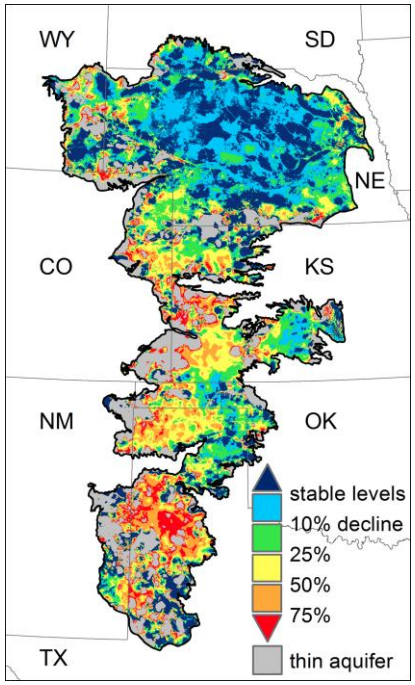
Foodstuff	Quantity	Water consumption, litres
Chocolate	1 kg	17,196
Beef	1 kg	15,415
Sheep Meat	1 kg	10,412
Pork	1 kg	5,988
Butter	1 kg	5,553
Chicken meat	1 kg	4,325
Cheese	1 kg	3,178
Olives	1 kg	3,025
Rice	1 kg	2,497
Cotton	1 @ 250g	2,495
Pasta (dry)	1 kg	1,849
Bread	1 kg	1,608

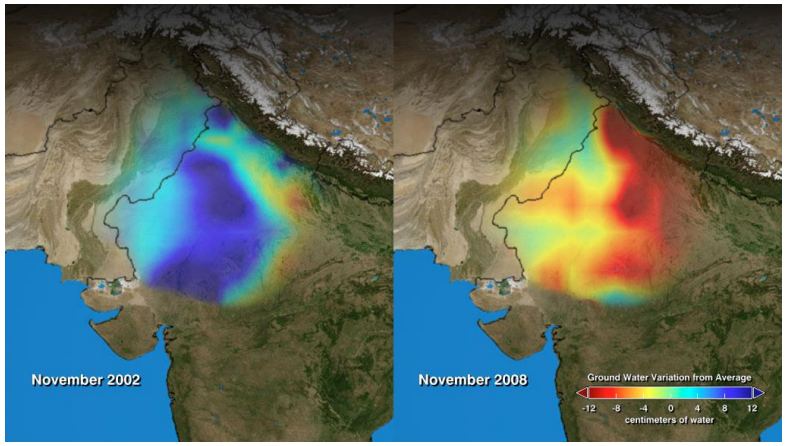
https://www.nature.com/scitable/blog/eyes-on-environment/water_world

Frequency of extreme droughts plus depletion of aquifers in US and the Punjab

Climate extremes index







Contiguous U.S. CEI (All Steps Combined)
Annual (January-December) 1910-2015

9-Point Binomial Filter — Mean — Actual Percent

- During the past decade, groundwater beneath the northern Indian states of Punjab, Haryana, and Rajasthan has decreased by more than 88 million acre-feet (nearly 110 billion cubic metres).
- Wells dug initially 1- 3 m now need to be 60- 70 m deep

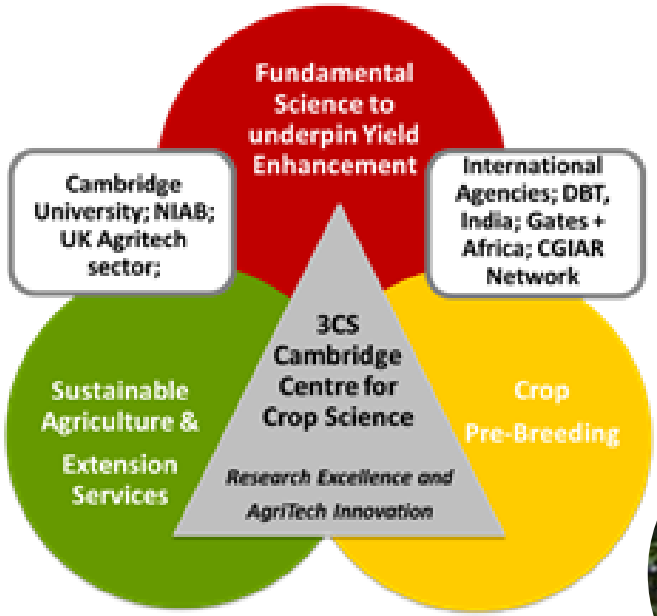
Not to mention the extent of food waste

- And that burgeoning global population and north-south differentials as food poverty = both obesity and starvation/nutritional imbalance
- And need to rebalance diets to reduce meat consumption

Basic Research and Integration across Cambridge

- Department of Plant Sciences, Sainsbury Laboratory at University of Cambridge
- Partnerships: Collaboration with local and regional crop science institutions: 3CS- Crop Science Centre
- Partnerships and networks: Global Food Security IRC, CambPlants network

Flagship project with NIAB-
3CS: Cambridge Centre for Crop Science



Prof. Sir David Baulcombe

Dr Tina Barsby

HEFCE RPIF award July 2017: £17M for 3CS;
University: £5M to endow Professor of Crop Science;
MOU with Nestlé; ongoing CUPGRA Potato research funded by Pepsico

The Challenges:

- Population Growth and Food Supply
- Malnutrition
- Food wastage
- Food security & climate change https://www.globalfood.cam.ac.uk/
- *Co-ordinator: Jaqueline Garget (jg533@cam.ac.uk)*

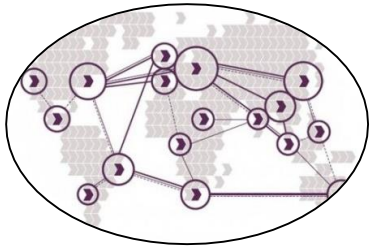
Cambridge Global Food Security: Interdisciplinary Research Themes

Infectious disease

Plant Biology

Food Landscapes

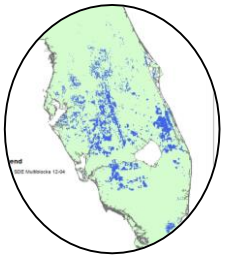
Supply chains



Political Economy

Global Governance

Modelling



Land resources and regulatory influences

Food & Health

Opportunities arising from GCRF and Newton Fund

- Newton Fund- joint UK and Key partner country- e.g. Brazil, India, China
- GCRF – £I.5 billion fund associated with DFID / ODA funding
- https://www.ukri.org/research/global-challenges-research-fund/
- But beware of the reporting challenges!!

Ongoing Collaborations with NIAB, ADAS, PAU, NIPGR and ICRISAT

CambPlants Hub

Plants for Food, Energy, Materials, Health and Eco-systems

Home | About us | Research | 3CS | Bioenergy | The Community | News and Events | Contact Us

Cambridge-India Network for Translational Research in Nitrogen (CINTRIN)

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last modified Nov 07, 2016 06:48 AM

Cambridge-India Network for Translational Research in Nitrogen (CINTRIN)

CambPlants is coordinating the centre which led by NIAB's Dr Tina Barsby and involves University of Cambridge Professor Howard Griffiths from the Department of Plant Sciences and Professor Ottoline Leyser from Sainsbury Laboratory , as well as colleagues from ADAS, ICRISAT, Punjab Agricultural University and NIPGR Delhi.

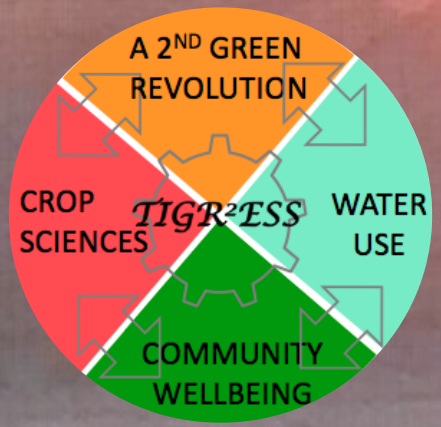
An investment with a total value of £3.3M co-funded by the DBT Bhabba will fund

Related Links

- NIAB
- Department of Plant Sciences
- Sainsbury Laboratory
- CambPlants
- ADAS
- ICRISAT
- Punjab Agricultural University

http://www.rcuk.ac.uk/funding/gcrf/growingcapability/

TIGR²ESS:
Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies



India and the UK are on the move:
TIGR²ESS combines capacity-building fundamental research with a development agenda to impact and empower rural populations

RESEARCH COUNCILS UK

BBSRC bioscience for the future

GCRF Global Challenges Research Fund

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology

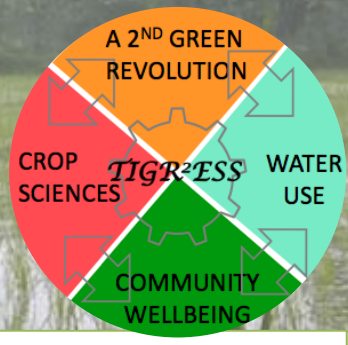
GLOBAL FOOD SECURITY

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

PUNJAB AGRICULTURAL UNIVERSITY

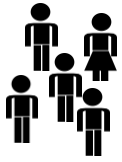
UNIVERSITY OF CAMBRIDGE

TIGR²ESS: Major Development Challenges associated with India



Challenges

Food production & post-harvest loss

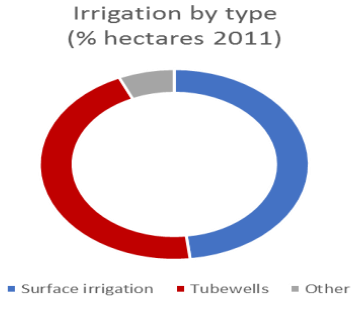


Food losses equate to per capita income of **20 million rural Indians**

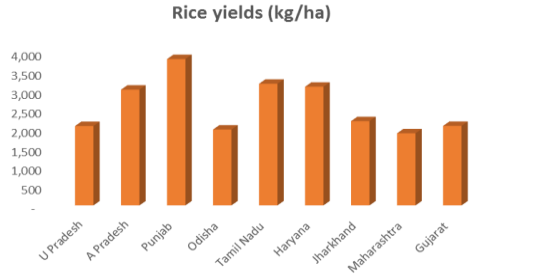
Human & Financial capital

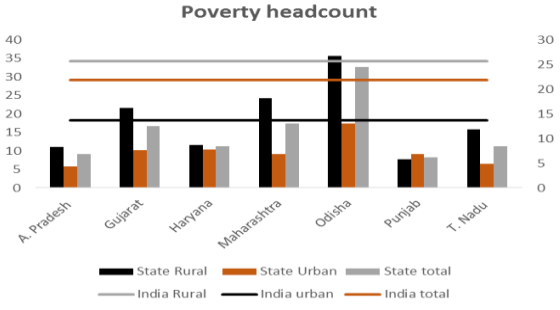
470 million households in debt. Over twice annual income in Tamil Nadu & Andhra Pradesh

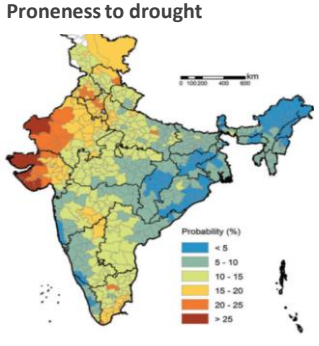
Natural & Physical capital



Regional dimension

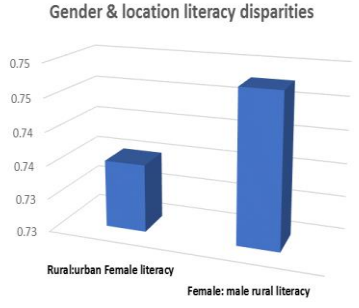






Social dimension

82,762,934	Male farmers
82,742,337	Male labourers
36,045,846	Female farmers
61,591,353	Female labourers



5 GENDER EQUALITY

10 REDUCED INEQUALITIES

4 QUALITY EDUCATION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

2 ZERO HUNGER

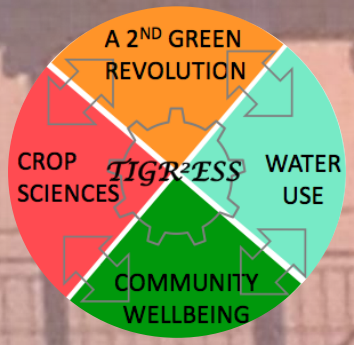
1 NO POVERTY

3 GOOD HEALTH AND WELL-BEING

15 LIFE ON LAND

Multiple Challenges,

Multiple dimensions



TIGR²ESS:

GCRF
Global Challenges Research Fund

PI: Prof Howard Griffiths (Dept Plant Sciences; £7.8M award)

Representing

- **UK-India Crop Science MOU** partners-
- UCAM (Plant Sciences, Archaeology, IfM, Land Economy/Centre for Development Studies, Geography/UCCRI, CSaP, Centre for Global Equality, Global Centre for Nutrition and Health (NNEdPro)
- Plus NIAB, JIC Norwich, Rothamsted Research, UEA), University of Essex, Hull,
- **19 Higher Education and Research Institutes across India**, (from Punjab via New Delhi to Hyderabad (ICRISAT), but also east to Varanasi and south to Odisha (Bhubaneswar) and Tamil Nadu (Chennai); and northwest to Mumbai, the Indus Valley, and Faisalabad in Pakistan.
- **7 NGOs in India**

TIGR²ESS Vision and Objectives:
Key Research Questions and Capacity Strengthening Research Activities

VISION framed by key research questions:

1. **What should a Second Green Revolution (GR) deliver?**
2. **Can crop productivity increase yet maintain yield stability?**
3. **Can water supplies be shared to match community demand?**
4. **How best to engage and educate for local community wellbeing?**

TIGR²ESS will provide Capacity Building and Strengthening:

- integrate the four thematic questions through 6 fully interlinked Flagship Projects;
- Research opportunities for over 8 PDRA in UK over 3 year research programmes across Food Security spectrum;
- Employ 14 PDRA in India in allied research programmes;
- Offer up to 6 month exchanges for over 40 researchers
- Provide 40 PI Exchanges between UK and India

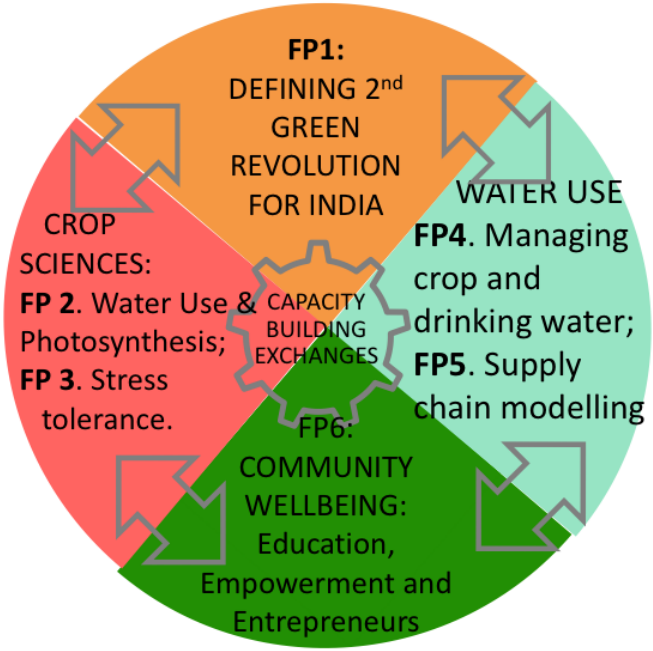
TIGR²ESS Vision and Objectives:

Key Research Questions, Cross-disciplinary Partnerships and Collaborations bridging Science and Society

VISION: framed by key research questions posed by Management Team with joint contributions from India and UK partnership organisations:

TIGR²ESS will integrate these four thematic questions through 6 fully interlinked Flagship Projects:

- **FP1: Defining a Second Green Revolution for India**
- **FP2: Crop Sciences- Water use and Photosynthesis**
- **FP3: Crop Sciences- Heat and Drought Resilience in Wheat**
- **FP 4: Water use and Management in a Changing Monsoon Climate**
- **FP5: Supply Chains: modelling water use for sustainable livelihoods**
- **FP6: Impacting Well-being in Rural & Urban communities**



The TIGR^{2}ESS programme intends to achieve the following key outcomes:

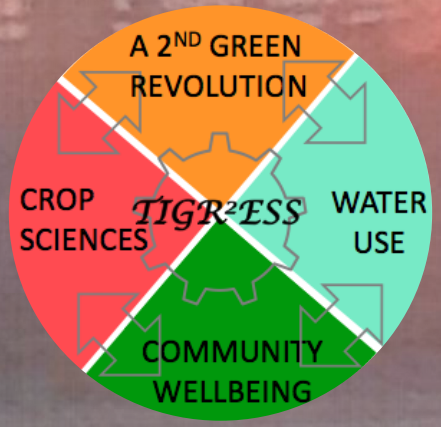
- Enhance India's capacity to:
  - address sustainable agriculture challenges
  - translate findings into crops and cropping practices
  - develop supply chain and entrepreneurial opportunities engage and empower rural communities
  - put project results into practice
  - enhance gender equality for farmers
  - improve health understand food & nutrition across rural communities
- Enhance UK's:
  - integration of research capacity in food security
  - understanding of societal & scientific challenges for sustainable agriculture in India
  - Integration across NGO networks and Development expertise (Lara Allen and Centre for Global Equality)

- Outcomes
  - drive forward molecular technology to increase plant productivity and minimize crop losses due to drought, salinity, pest or pathogen (conventional breeding, GM vs Gene editing debate)
  - Model water use along supply chain; Develop targeted irrigation systems and water applications
  - How to protect diversity and intensify production (Land sparing and sharing debate)
  - provide educcational resources torebalance diets
  - reduce waste (post harvest crop losses in India)
  - education and empowerment of women to improve nutrition and health in rural communities
  - stimulate rural entrepreneurship amongst younger generations and reduce urban migration
  - Costing of food production: how to account for the cost of water and carbon footprints?

Longer term outcomes

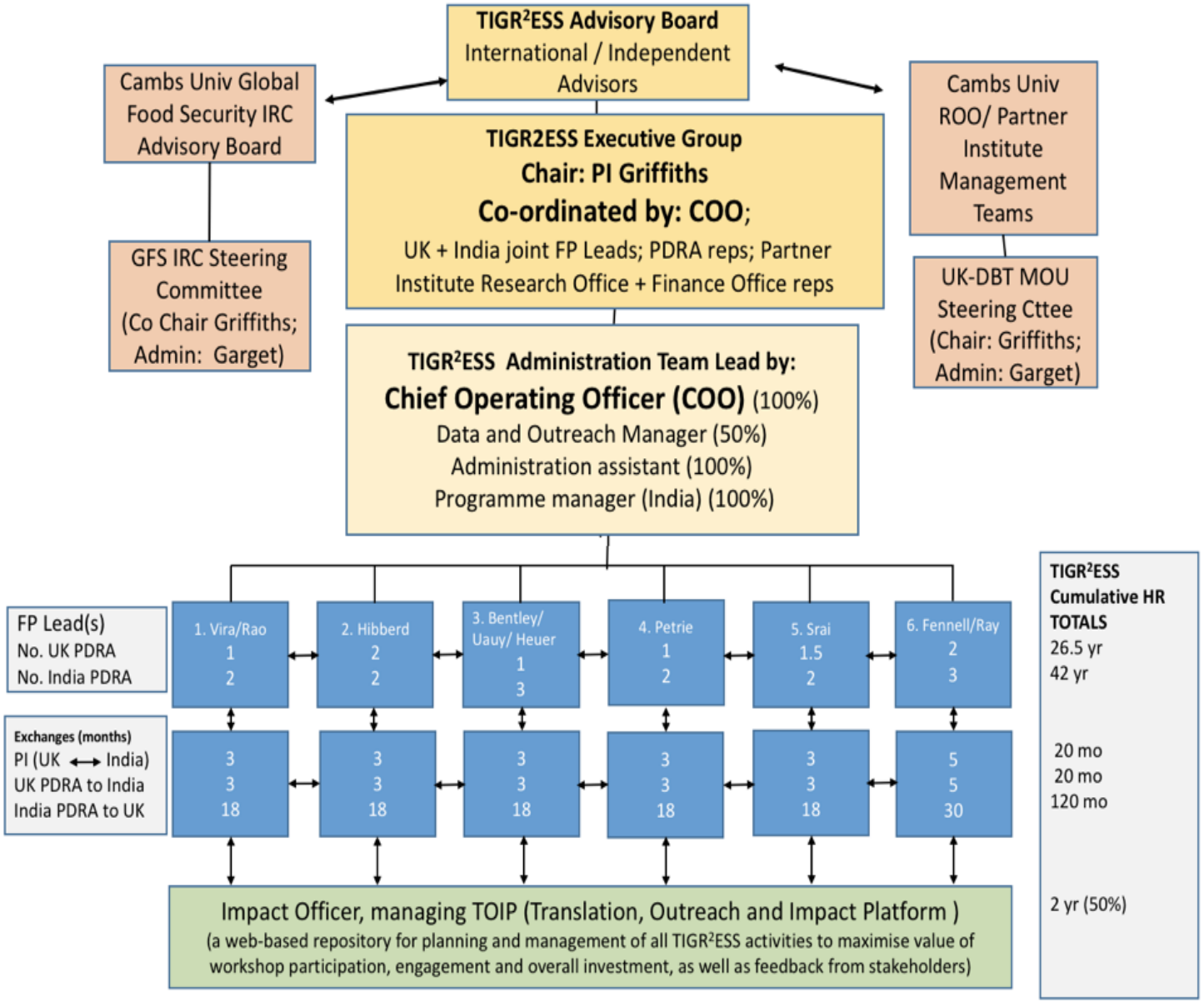
- Integration:
  - policy outputs derived from primary research inputs, and need for links to regional and national government partnerships
  - Interdisciplinarity: social science and fundamental scientific investigations
  - Outreach: Workshops and engagement with local experts and rural community health clinics and farmer demonstrations
  - Dissemination- use of mobile phone networks to harvest data and disseminate findings
- Education and training:
  - Need to build on existing academic relationships
  - Co-creation of primary research programme with researchers as Co-Investigators
  - Capacity building with university and research institutions through joint research programmes
  - Exchanges, short-term placements build on initial partnerships
- Engagement and buy-in from Government ministries and Industry
  - Extend programme beyond life of initial project
  - Develop links with industry and entrepreneurial enterprise
  - create new funding opportunities
  - Apply lessons from successful partnerships for future funding applications (University of Cambridge)

TIGR²ESS:
Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies



India and the UK are on the move:
TIGR²ESS combines capacity-building
fundamental research with a development agenda
to impact and empower rural populations

Programme management schematic



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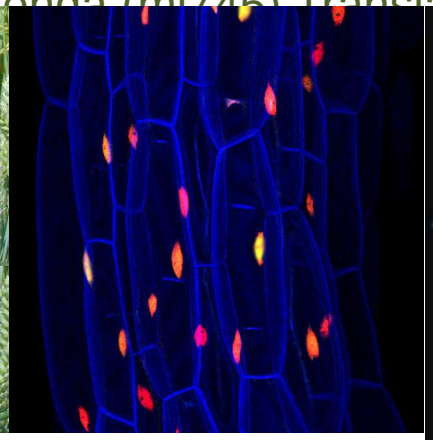
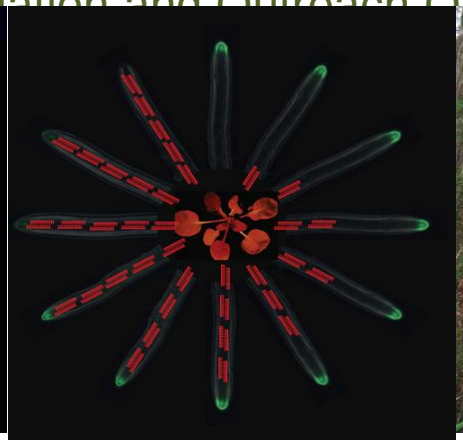
Plant Sciences in Cambridge

Professor Sir David Baulcombe (dcb40)
Head of Department and Regius Professor of Botany

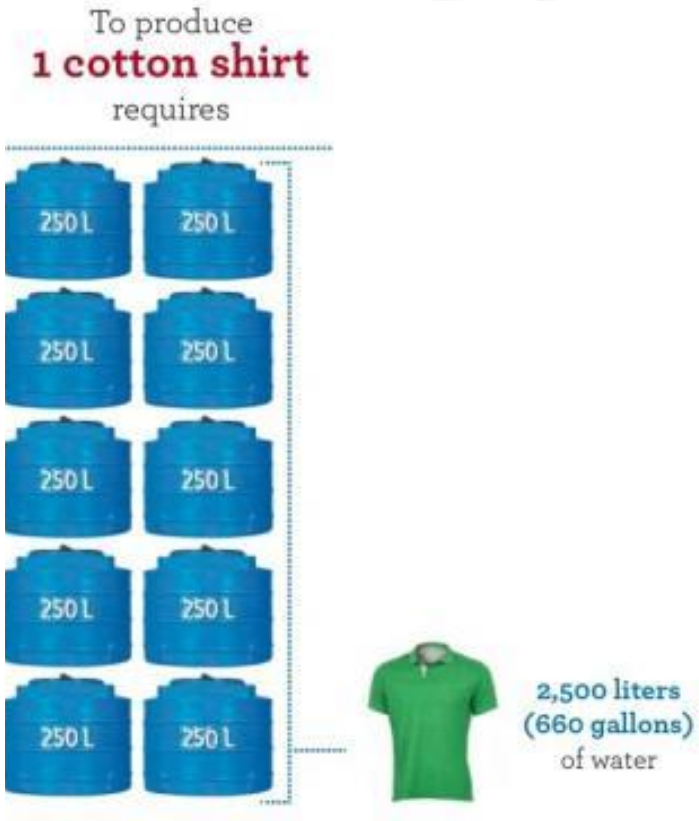
Dr. Mariana Fazenda (mlf45) Translation and Outreach Officer


Sainsbury Laboratory Cambridge University

Director: Prof Dame Ottoline Leyser FRS

- A focus on self-organisation in plant form and function
- Housing 10 world leading research groups
- Training PhD students and post-docs
- In an award-winning building positioned for synergy with the research, education and public engagement of the botanic garden



About 10,000 litres (some estimates x2 this value)!

https://yourwaterfootprint.me/tag/water-footprint/

National Institute for Agricultural Botany (3CS coalition partner)

- Conventional wheat breeding and wheat transformation (GM) expertise
- Links to breeders, seed companies, farmers, biodiversity agencies
- NIAB Innovation Farm provides a showcase for academic research to farmers and breeders
- And a pipeline for translation of academic research