Crop modelling and its role in minimising climate-related risks and maximising opportunities

Remembrances of Dr Mannava V. K. Sivakumar

International Society for Agricultural Meteorology (INSAM)

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WESTERN SYDNEY UNIVERSITY

Outline of Presentation

Guntur, Bapatla, Andhra Pradesh

Santiniketan, Visva-Bharati, West Bengal

IARI, New Delhi
ICAR Fellowship
High climate variability

GBPUAT, Pantnagar, Uttar Pradesh
ICAR Fellowship

Ames, Iowa, USA

National Scholarship, Govt of India

Columbia, Missouri, USA

Climate and Food security

1. Sharing International Experiences
2. Partnership Needs

Agroclimatological Research Needs for the Semi-Arid Tropics

International Agroclimatology Workshop
ICRISAT, Hyderabad
22–24 November 1978

Sitting (left to right) : K. Vijaya Lakshmi, C. Charreau, R. H. Shaw, J. S. Russell, W. Baier, R. C. McGinnis, L. D. Swindale, B. A. Krantz, R. P. Sarker, Ian Stewart, S. M. Virmani, J. G. Ryan, S. Gadgil.

Standing (Row 1) : S. K. K. Kahinga, M. V. K. Sivakumar, P. Franquin, S. Venkataraman, K. M. King, C. Dancette, A. C. S. Reis, B. C. Biswas, R. W. Willey, K. A. Edwards, M. B. Russell, A. K. S. Huda, J. R. Burford, S. J. Reddy.

Standing (Row 2) : K. S. Gill, W. Nicholaichuk, W. E. Scarborough, J. O. Mugah, G. M. Higgins, D. Rijks, D. Eldin, L. K. Fussell, F. R. Bidinger, H. Ph. van Staveren, M. Forest, G. D. Bengtson, G. Alagarswamy, N. Seetharama, G. E. Thierstein.

Crop Modelling: Process-Based

Purpose

Minimum Data Needs

Collaborative Multilocation Experiments (started 1979)

Coimbatore, Hyderabad, Sholapur, Parbhani, Rahuri, Delhi, Hisar, Ludhiana

Validation

Application : Research, Capacity Building, Decision - Making

Successful National and International Collaborative Projects: Australia, India, Bangladesh, Cambodia, China

1992-2004: Managing with Climate Variability

2004- Ongoing: Climate and Food Security Research Initiative (Key People Invited to UWS for Collaborative Efforts, 2004)

Dr R.P. Thakur, Plant Pathologist, ICRISAT, Hyderabad, India

Dr MVK Sivakumar, WMO, Geneva, Switzerland

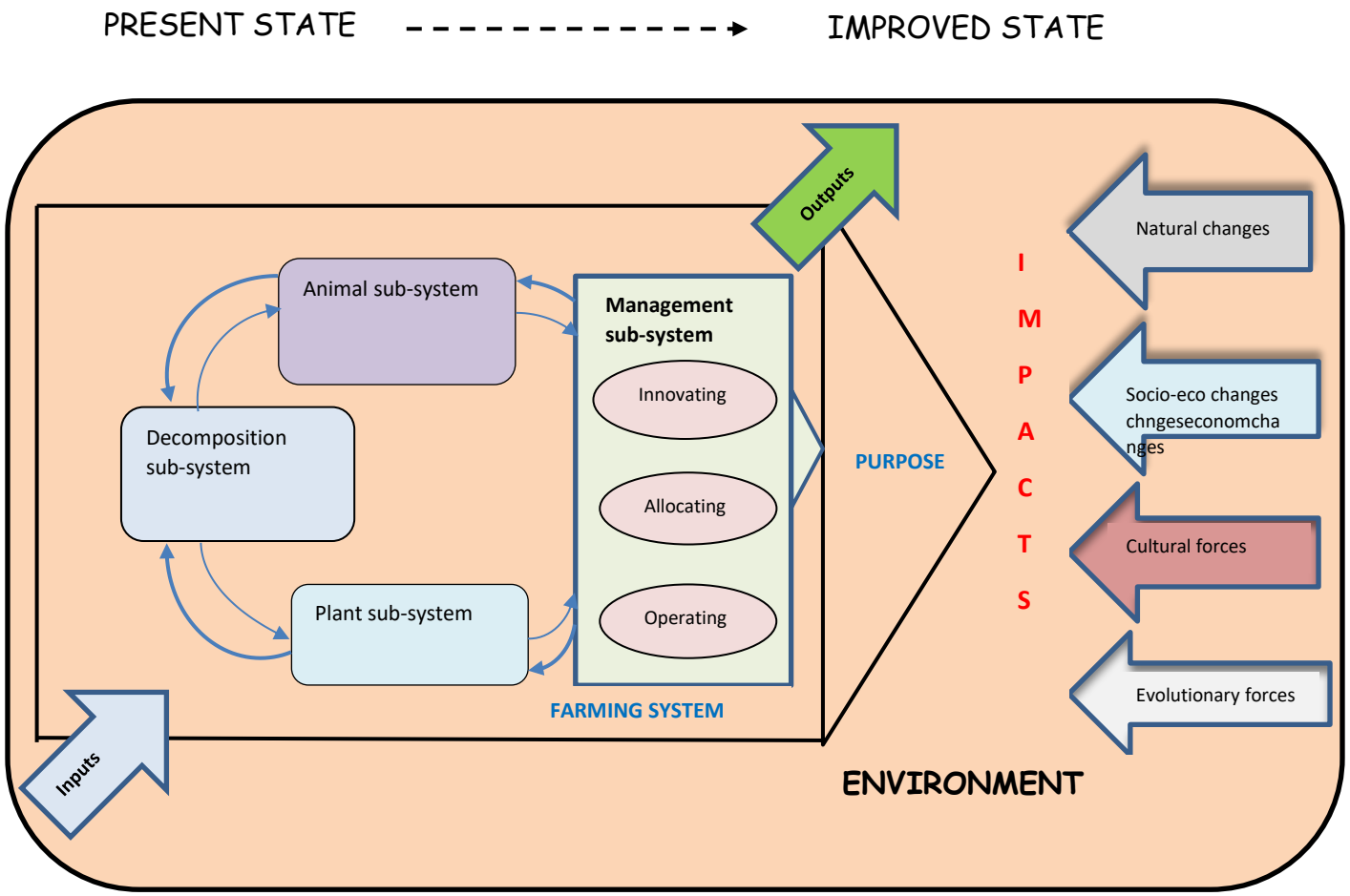
Dr Y.S. Ramakrishna, CRIDA, Hyderabad, India

Dr Holger Meinke, APSRU, Toowoomba, Australia

Assoc Prof Robert Spooner-Hart, Plant Protection, UWS, Australia

Dr Pete Jamieson, Plant and Food Research, Christchurch, New Zealand

What does Agriculture involve?



Modified adaptation from Bawden 1992

Environmental Sustainability

- The practice of environmental sustainability
- When nature is left alone, it has a tremendous ability to care for itself.
- Human actions can deplete natural resources, and without the application of environmental sustainability methods, long-term viability can be compromised.

Climate and Crop Disease Management Project Workshop , 2008, Dhaka

Climate and Food Security, 2008, CRIDA, Hyderabad

Farmer Adoption of Model Forecasts for Decision Making

Most farmers use heuristics ("rules of thumb") to assess climate risk. Commonly, the perceived average rainfall is compared against each season as it unfolds. Such heuristics are subject to numerous biases which can lead to serious misinterpretation.

The expression of forecast outputs as above/below median, quartiles, or percentiles—although it may convey useful information—is often misinterpreted.

Lellyett, Truelove and Huda (2022), Improving Early Warning of Drought in Australia, Climate Journal

Dr M.V.K. Sivakumar was Guest Editor, and he invited me to prepare and submit this paper.

Enabling Adoption of Model Forecasts for Decision Making

In Australia, considerable efforts have been directed towards educating farmers on basic statistics. Positive gains in this regard have been made over the past decade with the framing of probabilistic forecast outcomes as exceedance probabilities; that is, providing the probability that a specific threshold will be exceeded.

The framing of forecasts in this manner is more intuitively comprehensible without specialised climatological or statistical expertise and has rendered the use of climate forecasts in decision-making more accessible for many.

Enablement via Decision Support Systems

In recent years, drought policy and interventions by government have continued in the direction of self-reliance, but substantially higher levels of self-reliance have remained elusive

One reason for this is that the data provided by available drought early warning tools has not been well integrated into suitable Decision Support Systems (DSS) at either the farm level or by agricultural value chain stakeholders

Even to the extent of providing useful alternative heuristics for farmers, the DSS developed so far have not realised the full potential benefits that exist. In part this is due to the quality and representativeness of climate data and forecast inputs, the integration of those inputs into DSS models, and the framing of outputs in terms that can be readily understood and applied by users

Enhanced inputs, outputs and availability

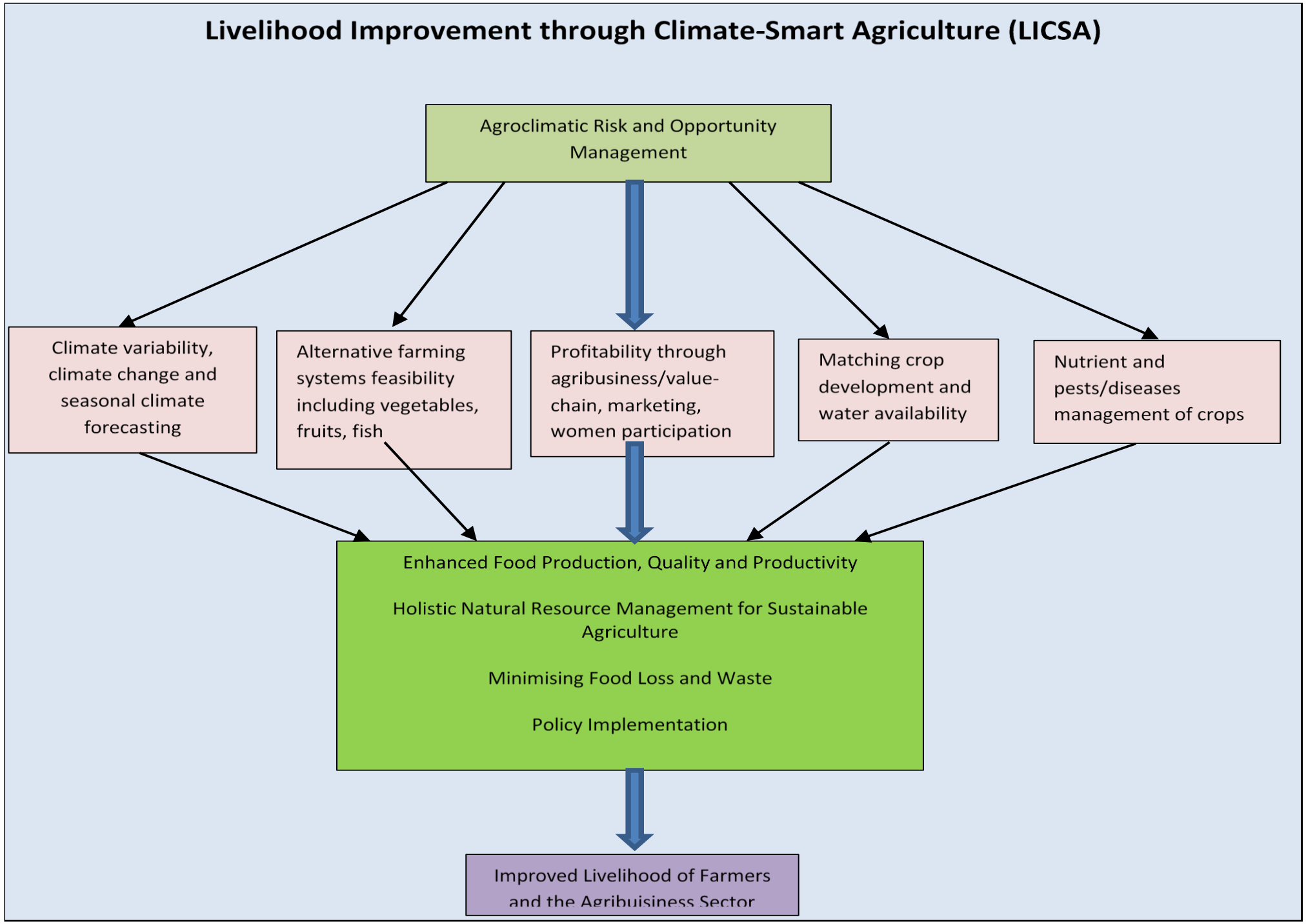
The good news is that improvements in weather- and climate-related science, data, forecasts, and technology now present potential to help overcome these fundamental challenges.

Information for each temporal domain should include explicit measures of uncertainty, a framework for end-user analysis, application and integration into decision-making and decision support systems, and sector- and activity-specific results and tools.

Such unification could be achieved through a single hub, because at present information tends to be widely dispersed across numerous organisations and websites. This dispersion renders very difficult the development of a comprehensive understanding of available information and a consistently robust application of information to decision making, for the majority of users.

Climate-Smart Agriculture practices

- Built agro-climatic risk and opportunity management (ACROM) framework for delivering Climate-Smart Agriculture developed by Huda et al. at Western Sydney University (WSU)
- Designed to enhance sustainable farming practices that improve livelihoods and food security, through agricultural diversification and increased production.
- Has empowered farmers, researchers and agribusiness in many countries


Livelihood Improvement through Climate-Smart Agriculture (LICSA)
Agroclimatic Risk and Opportunity Management
Climate variability, climate change and seasonal climate forecasting
Alternative farming systems feasibility including vegetables, fruits, fish
Profitability through agribusiness/value-chain, marketing, women participation
Matching crop development and water availability
Nutrient and pests/diseases management of crops
Enhanced Food Production, Quality and Productivity
Holistic Natural Resource Management for Sustainable Agriculture
Minimising Food Loss and Waste
Policy Implementation
Improved Livelihood of Farmers and the Agribuisiness Sector

Strategies for Policy Development for Sustainability

Adaptive climate-smart agricultural measures, from local practices to policy level initiatives to help address 2030 Sustainable Development Agenda, and future food security of Asia-Pacific region.

Scoping, design and implementation of measures necessitate collaboration between multi-disciplinary experts, governments and producers.

International collaboration, as best-practices in a number of areas might have been developed and implemented outside of the Asia-Pacific area.

Mukherjee, Saha, Lellyett, and Huda (2022), Impact of climate change and variability on food security in the Asia-Pacific region, Asia-Pacific Sustainable Development Journal

30 national and international projects with the following three Ongoing Research Projects 2020-2026:

- Enhancing vegetable production and quality in greenhouse and open field conditions in Qatar (Qatar Govt funding)
  - water and nutrient use efficiency improvement
  - Yield improvement and quality
    -
- Sustainable fertigation for high yield and quality in vegetable protected cropping , Australia and Qatar (CRC, Australia Govt funding)

- Climate and Food Security: Australia and India Collaborative Efforts in the Development of Innovative Agrifood Business Initiatives (Australia Alumni Grant)

Beneficiaries

Kheledanga village: 42 tribal families

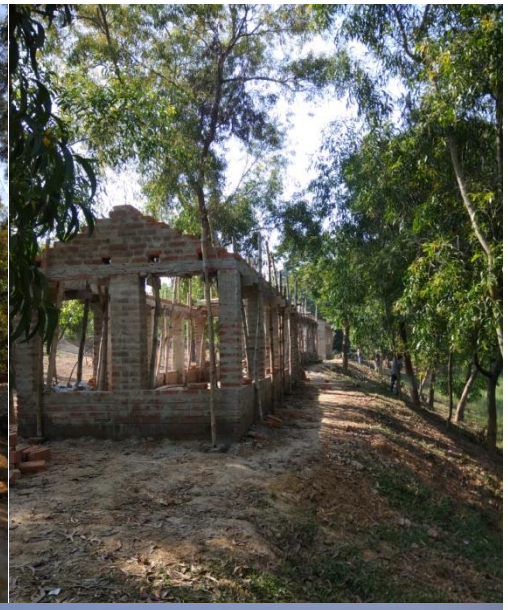
Sakkoda village : 252 families

Workshop at WSU & meeting with technocrats in Australia

(27 Feb to 6 Mar, 2018)

outcome

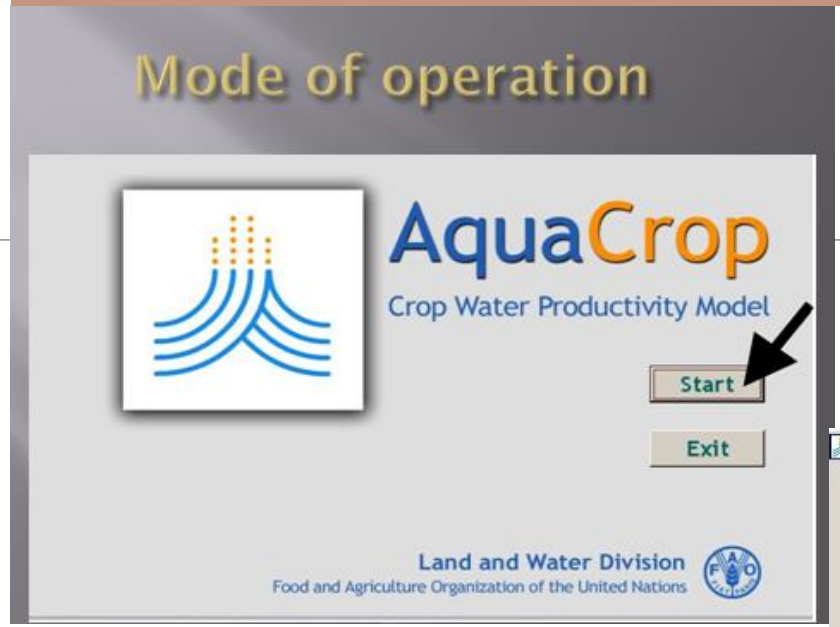


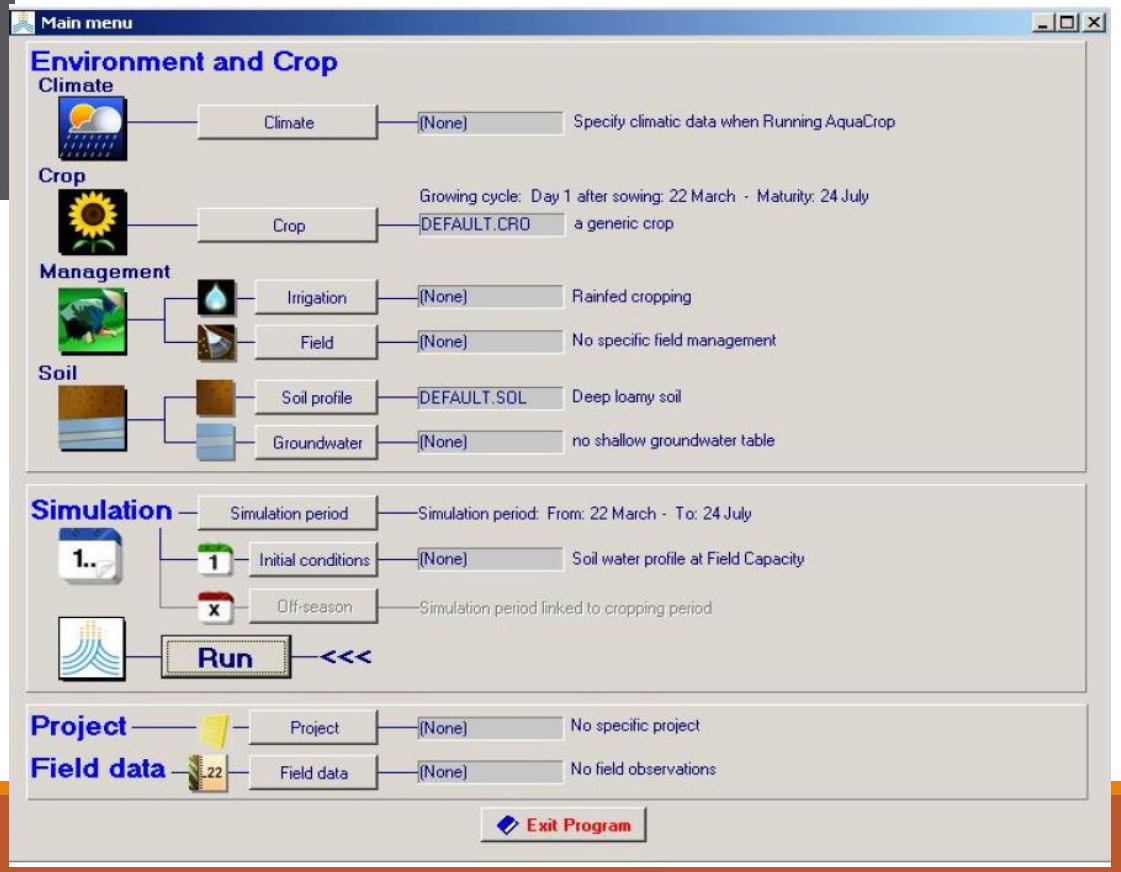


Qatar Food Security Project

Enhancing vegetable production and quality in greenhouse and open field conditions in Qatar	**Jointly funded by** • **Qatar National Research Fund (QNRF) and** • **Ministry of Municipality and Environment (MME), Government of Qatar** • **Future Food Systems Cooperative Research Centre, Australia**	• **Western Sydney University, Australia** • **Qatar University** • **Agrico for Agricultural Development, Qatar** • **Al Falah Group (AFG) College with The University of Aberdeen in Qatar** • **Producers/Farmers**

Aqua Crop


Mode of operation
AquaCrop
Crop Water Productivity Model
Start
Exit
Land and Water Division
Food and Agriculture Organization of the United Nations


Main menu
Environment and Crop
Climate
Climate
(None)
Specify climatic data when Running AquaCrop
Crop
Growing cycle: Day 1 after sowing: 22 March - Maturity: 24 July
Crop
DEFAULT.CRO
a generic crop
Management
Irrigation
(None)
Rainfed cropping
Field
(None)
No specific field management
Soil
Soil profile
DEFAULT.SOL
Deep loamy soil
Groundwater
(None)
no shallow groundwater table
Simulation
Simulation period
Simulation period: From: 22 March - To: 24 July
Initial conditions
(None)
Soil water profile at Field Capacity
Off-season
Simulation period linked to cropping period
Run
<<<
Project
Project
(None)
No specific project
Field data
Field data
(None)
No field observations
Exit Program

Partnership Activities

Greenhouse Experiments in Qatar (Agrico) and Australia (Western Sydney University)

Open Field Experiments (Qatar Farm)

Capability development in self- sufficiency in vegetable production for Qatar

Training qualified personnel including PhD and M. Sc students

Post-Doctoral Research Assistants (QU and WSU)

Qatar Project Outcomes

Improved cropping systems and practices for growing high quality locally produced vegetables using results from selected crops e.g. Capsicum, Cucumber, Eggplant and Tomatoes;

Increased availability of user-friendly decision support tools to inform sustainable agri-food systems (cultivation, production, enhancing nutrition values and freshness);

Building knowledge and capacity of University researchers and Industry Personnel through short, hands-on workshop program;

Conservation of natural resources and enhanced resource use efficiency resulting in an increased and stable locally-grown food supply.

Qatar Project Benefits

Enhancing national and international reputation through :

- Increased production
- Improved produce quality
- Enhanced water and nutrient use efficiency
- Publication in international journals
- Presentations at conferences

Driving future adoption and benefits

- Opportunistic uptake can change livelihoods for individual producers and their communities.
- Optimizing benefits

  → requires coordinated planning, implementation and investments at scales from states, to nations, and broader regional areas

  → each customized to suit their particular circumstances.
- Special attention to enabling small-hold farming communities

  → underpinning infrastructure, capacity building and finance

  → complement with assistance in opening and servicing new markets.

Engaging Partners Effectively

Depending on the problem, needs for engaging with right people and institutions

- Contextualising forecasts in ways that end users (e.g. Farmers) can understand and then apply
- Accessibility of information
- Coordinating implementation action on the ground

Government (Federal/National vs State/Province/Territory, vs Local/Council)

Private Institutions (Banks, Insurers, Input Suppliers, Logistics, Storage)

Farmers' Organisation (National, Coop, Farmers' Producer Organisation..)

Understand and accommodate each partner's interests

Engagement with international partners to capture and apply best practice

2025 January Hyderabad Workshop at PVNR Telangana Veterinary University

Climate and Food Security: Australia and India Collaborative Efforts in the Development of Innovative Agrifood Business Initiatives

Use of Agrometeorology Advisory Services

Role of Modelling in Enhancing Livestock Production and Quality towards Improving Food and Nutrition Security

Data needs

Collaborative Partnership Research and Development

Thank you