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Horti.com

for Climate Resilience, Nutritional Security and Wellbeing

Prof S. Naresh Kumar

nareshkumar.soora@gmail.com
nareshkumar@iari.res.in

9968768178
8826963224

Environmental Sciences Division
Indian Agricultural Research Institute, New Delhi 110012

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Horticultural systems are sensitive to climatic stresses, but are the best options for building climate resilience

Climate extremes
- Heat-waves
- Cold waves
- Extreme rainfall
- Dry spells, etc

Affect horti-systems
- Growth
- Crop area
- Yield loss
- Quality deterioration
- Loss of farm income

Horti-systems enhance climate resilience of farmers
- Yield & income enhancement
- Income diversification
- Nutritional security

Horticultural systems
- Aggravate climate change
- Excess ferilizers-N_2O
- Crop biomass-in water stagnation, methane
- Pesticides-GHGs
- Energy use-CO_2

Horticultural systems help mitigate GHGs
- Carbon sequestration

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Bias corrected probabilistic GCM ensemble based projections:

Progressive climate change in Kharif and Rabi seasons in India towards the end of the century

1) Tmin to rise more than rise in Tmax
2) Rise in temperatures to be more during rabi (Nov-April) than in Kharif (June-Oct)
3) Rise in temperatures to be more in north parts of India than in south
4) RF increase (%) to be more in rabi than during Kharif
5) Variability in temperatures and rainfall to increase

Increase in frequency of droughts, floods, costal area inundation, heat and cold waves to challenge food security

Kharif (June-Oct)

Tmin (°C)

0.946 - 1.061 (2020)
1.345-2.42 (2050)
1.358-4.067 (2080)

Tmax (°C)
0.741 – 0.847 (2020)
1.145-2.004 (2050)
1.265-3.533 (2080)

RF (%)
2.3-3.3 (2020)
4.9-10.1 (2050)
5.5-18.9 (2080)

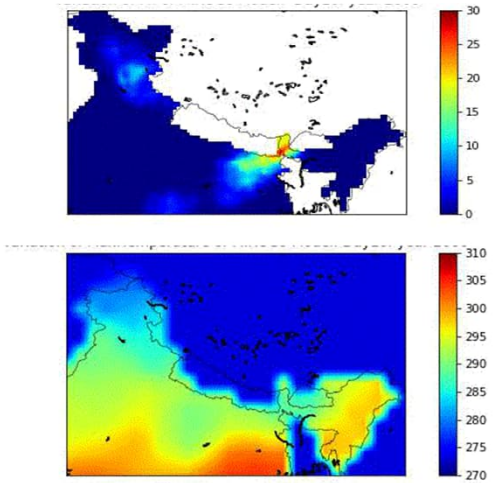
Rabi (Nov-April)

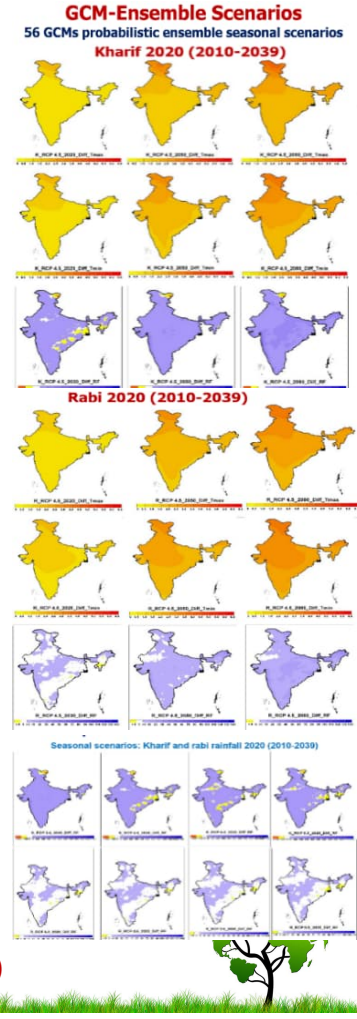
Tmin (°C)

1.096-1.207 (2020)
1.542-2.759 (2050)
1. 546-4.652 (2080)

Tmax (°C)
0.882-0.947 (2020)
1.317-2.308 (2050)
1. 389-4.01 (2080)

RF (%)
12 (2020)
12-17 (2050)
13-26 (2080)





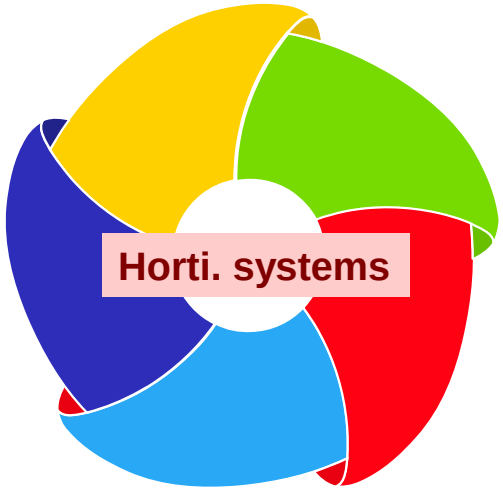
Naresh Kumar et al., 2019; 2024 (com)

Climate change affects horti-systems

CO_2
Benefit growth and yield
Increase fruit/ bulb size, no.
Increase Pn, WUE, SOD, Proline, Phenols, etc

High temperature
Affects growth and yield
Reduced fruit set
Increase hermaphrodite flowers, delayed curd initiation, non-fulfilment of chilling requirement in temperate fruits, sunburn, bolting, floral abortion, increase secondary metabolites

Low temperatures
Delayed /early flowering
Cracking, seedling mortality
Snowfall coinciding flowering affected yield and quality of pome and stone fruits



High rainfall
Flower and fruit drop, affect pollination, alter morphogenesis, promote vegetative flushes, delayed bud break, damage developing fruits,

Water stagnation
Plant and fruit rotting, bulb rot, yield loss

Dry spells
Flower drop, affects fruit set
sun burn and cracking
Button shedding

Community Environmental Horticulture

- **Mini-ecosystems**
  - Balconies, indoor planting, yards, and allotments
  - Gated housing communities
  - Public gardens, public places, big gardens
  - Schools, educational Institutions, University campuses, etc
- **Macro-ecosystems**
  - Community fruit-tree plantations- peri-urban
  - Community-based fruit tree plantations in rural landscapes
  - Government lands
  - Wasted and marginal lands

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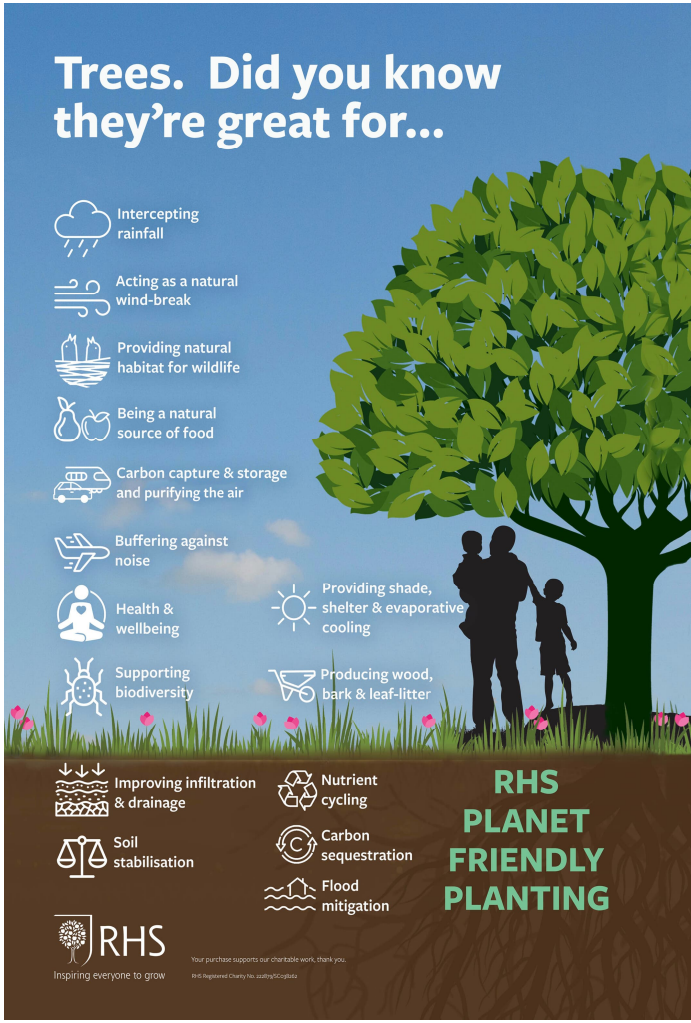
Growing 'Plants for Purpose'

- **Major Fruit plant species in India: 68**

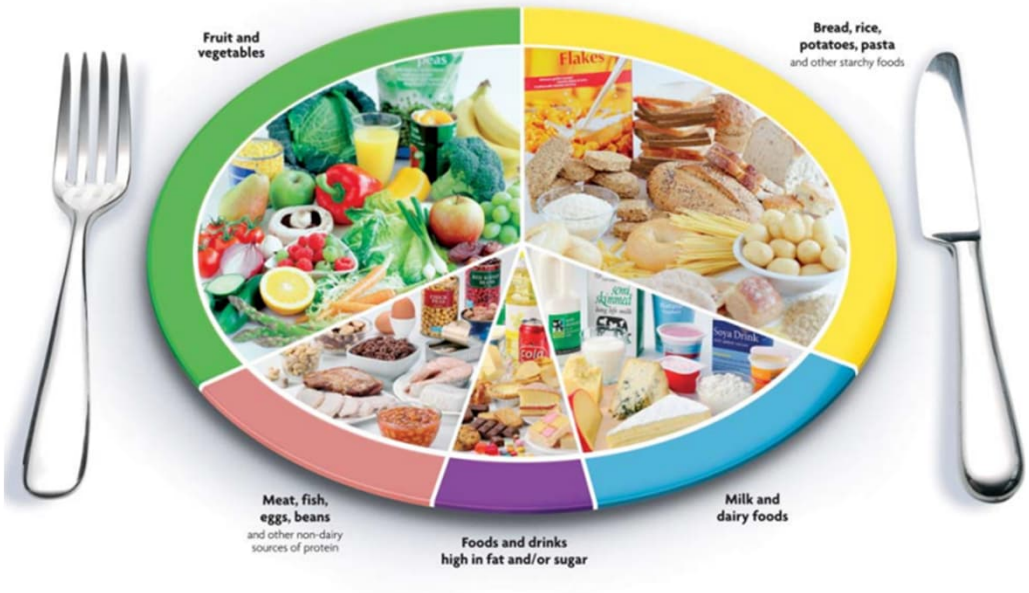
- **Wild edible fruit tree species**
  - **Eastern India: ~150**
  - **South India:**
    - Tribal communities: **237**
    - Western Ghats:**344**
    - Kerala:**184**
  - **Central India: >72**
    - Maharashtra: 55
  - **North India**
    - Eastern Himalayas: **300**

  - **All India>800**

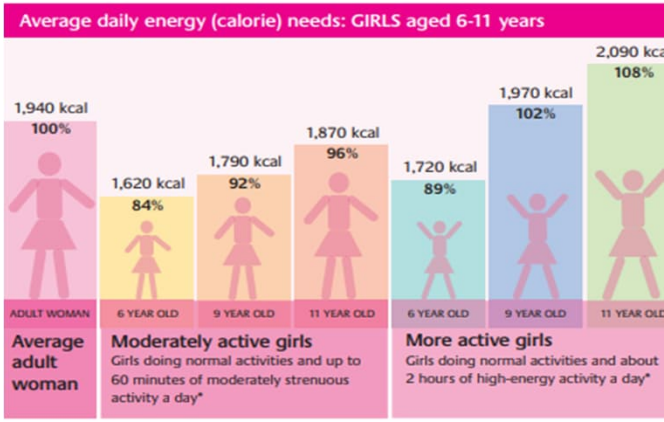


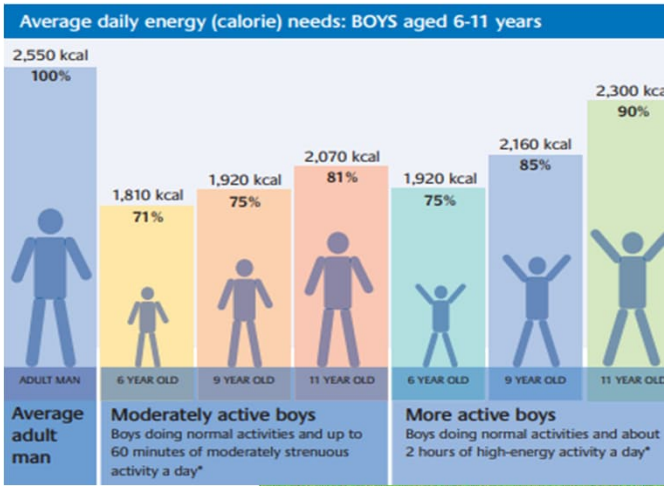
Growing 'Plants for Purpose'

- **Nutritional security for children: 14.72 lakh (1.47 million) schools, 24.8 crore students, with a workforce of about 98 lakh (~18% of population)**
  - **Pre-adolescent child grows, @6-7 cm and 1.5 to 3 kg/ year**
  - **10-12 yrs age child grows at 9-10 cm and 8-10 kg/ year**
- **Only 2.5% of the household food expenditure is on fruits**



Food.uk.gov





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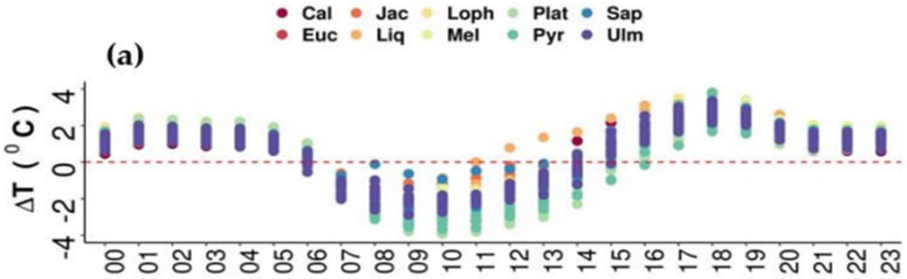
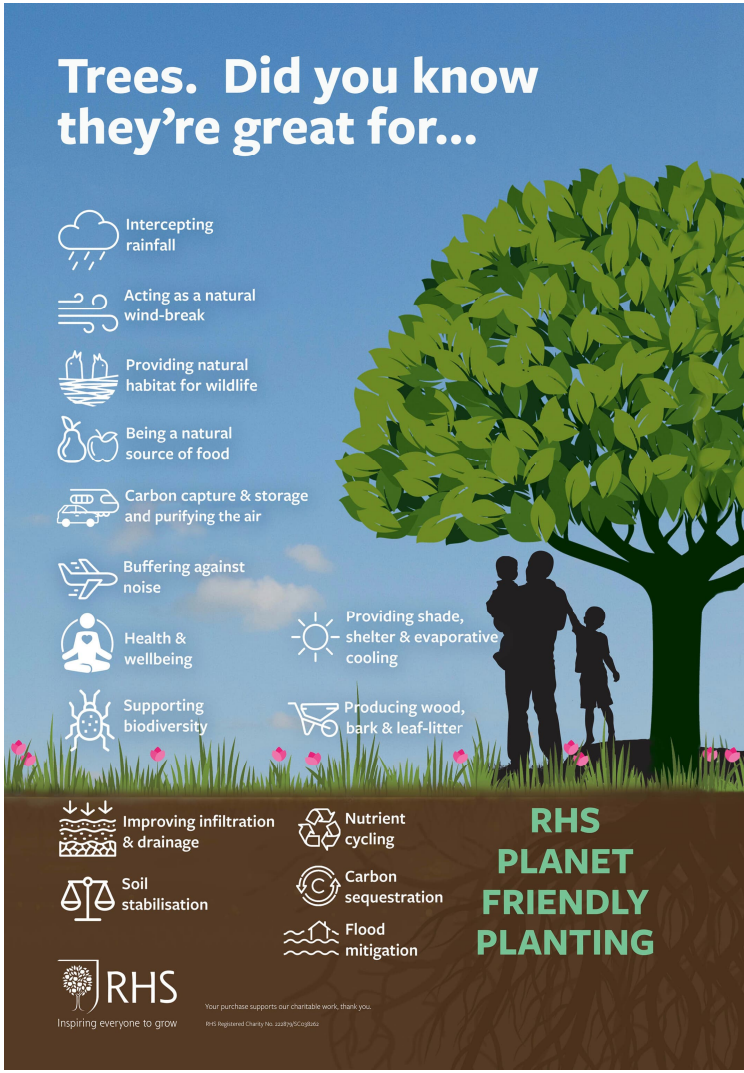
Growing 'Plants for Purpose'

- **Trees cool the surrounding area directly by blocking solar irradiation and transpiring water**
- **Daytime maximum air temperatures reduce by 3.1 to 5.8 ◦C**



Sharmin et al., 2023

- **Trees with dense (high LAI) and wide canopies were associated with the most significant cooling**
- **Human takes @ 550 L O_2/day**
- **Tree @ 5000-150000 liters O_2/day**
- **Allow growing high-value crops such as anthurium, strawberry**



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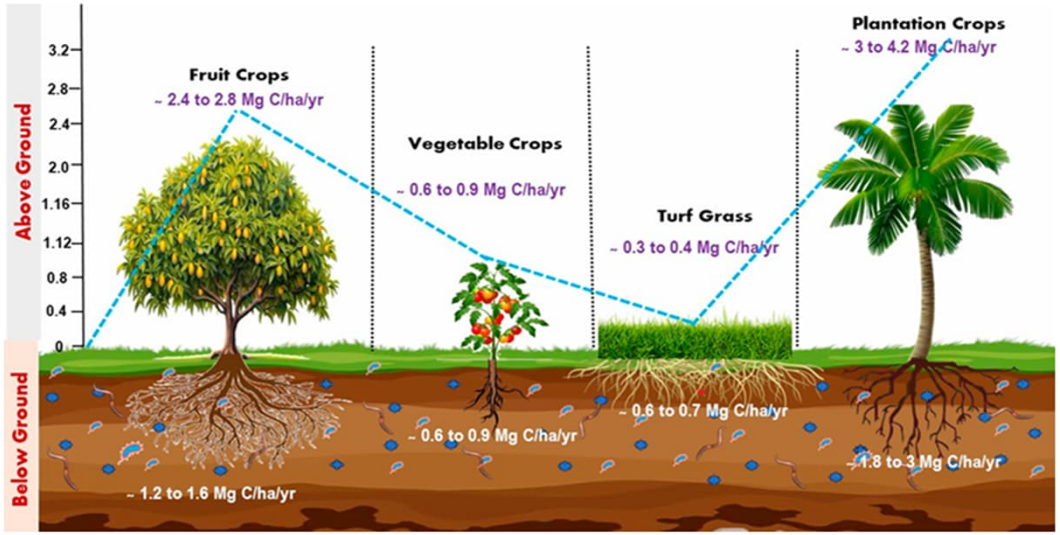
Perennial horticultural crops for the mitigation of GHGs

Carbon sequestration (above & below ground)

- Coconut plantation: C sequestration in above-ground biomass 8-12 Mg CO_2/ha/year,
- Cocoa plantations: 2.02-3.89 Mg CO_2/ha/year
- Arecanut plantations: 5.14-10.94 Mg CO_2/ha/year,
- Mango 10-15 Mg CO_2/ha/year



Naresh Kumar, 2004, 2008; Bala & Naresh Kumar 2010; Ilakiya et al 2024

Prevented emissions of N_2O, CO_2 and CH_4

- Drip irrigation
- Solar-power-based micro-irrigation
- Fertigation
- Slow-release fertilizers
- Precision farming
- Energy use efficiency
- Lase leveling
- Broad-bed cultivation
- Drainage
- Green-cold stores

1-2 or more Mg CO_2/ha/ year due to the above tech

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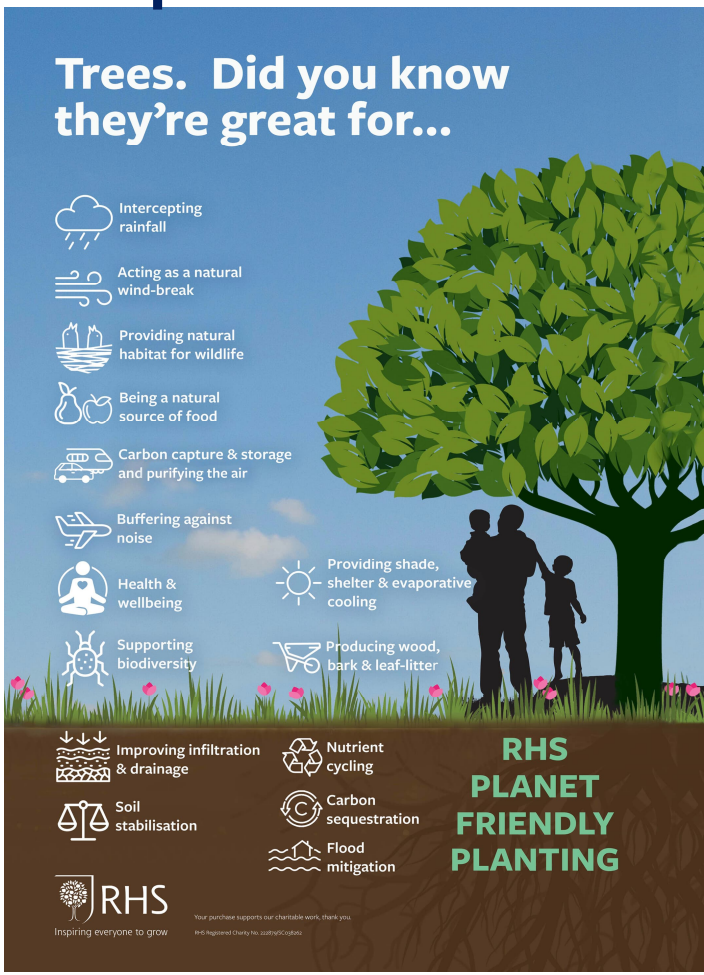
A quick analysis of the potential of community fruit plantation in 1.47 million schools in India

- School grounds
  - Urban areas: At least 4000 m^2
  - In hilly regions or smaller cities: 2400 to 3200 m^2
  - Rural areas: ~8000 m^2
- 1 lakh km or 1 lakh ha of fruit plantation is possible
- 10 million mango plants can be planted
- C sequestration ~50 kg/tree/year
- Potential CO_2 seq 1.848 $MtCO_2$ eq



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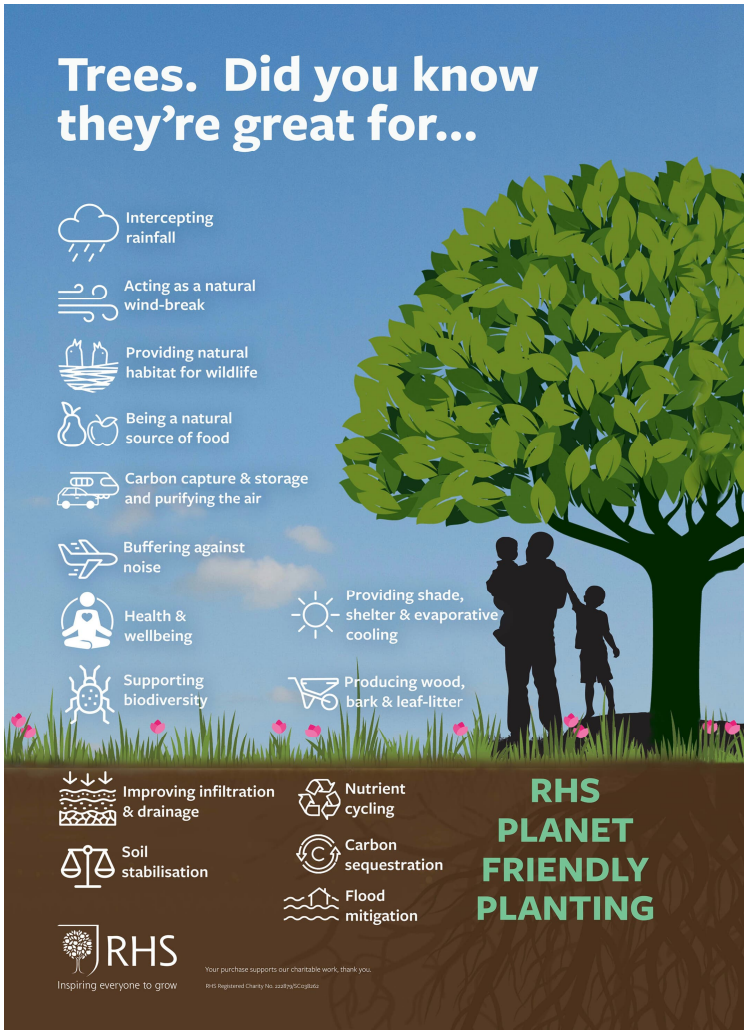
- **Green credits (MoEF&CC)**
- **Carbon credits**

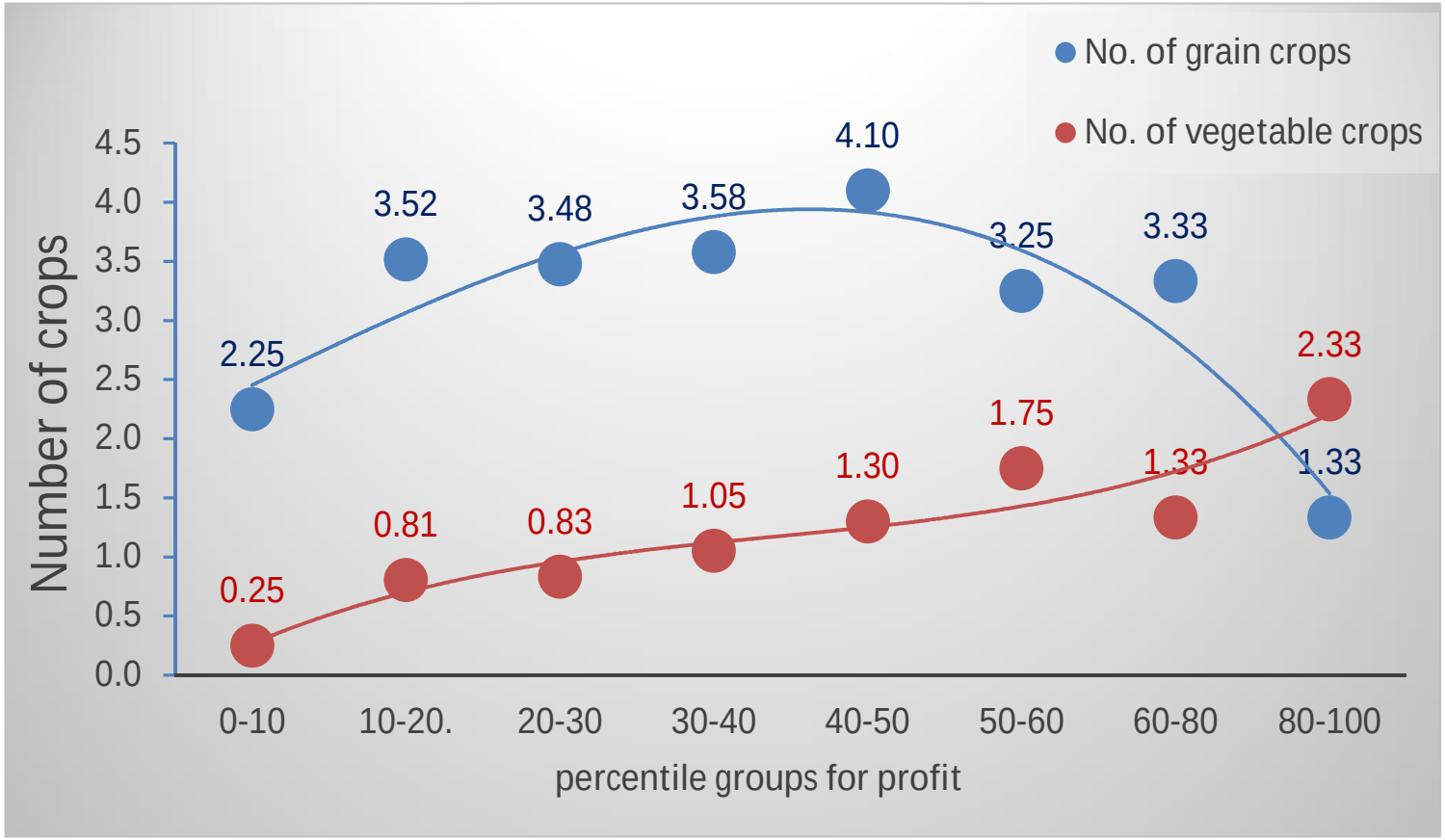
- **Community fruit plantations in**
  - **Waste lands:55.76 Mha**
  - **Cultivable wasteland: 11.59Mha**
  - **Fallow Land other than Current Fallows is 11.16 Mha**

Jharkhand (41.2%), Rajasthan (21.1%) and Tamil Nadu (21.1%)

  - **Panchayat lands**

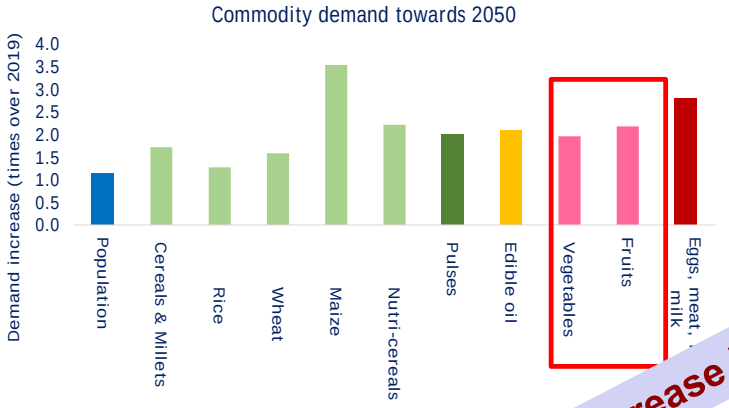


Horticultural crops enhance farm profit



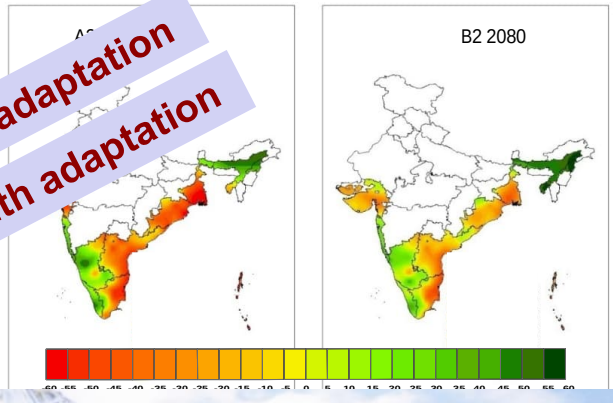
Naresh Kumar et al., 2016

Projected increase in agricultural commodity demand and adaptation gains



ICAR, 2024

Impacts on coconut plantations



1.3 to 1.6 times increase in production with simple adaptation

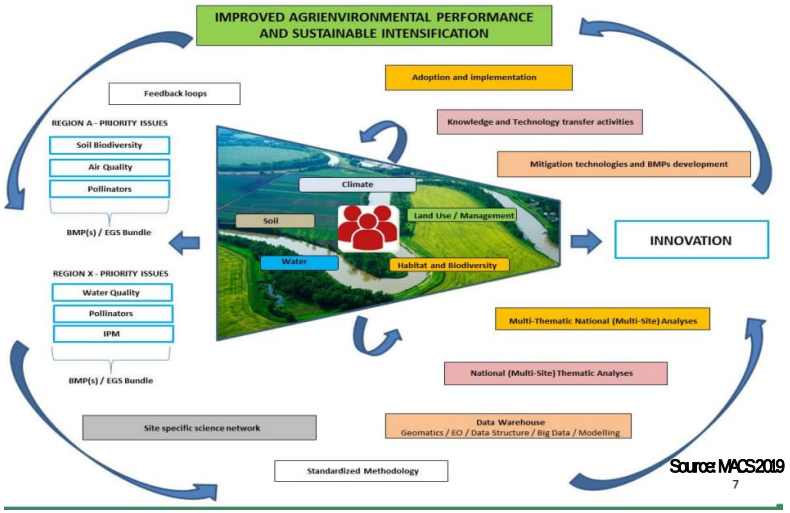
>2 times increase in production in plantations with adaptation

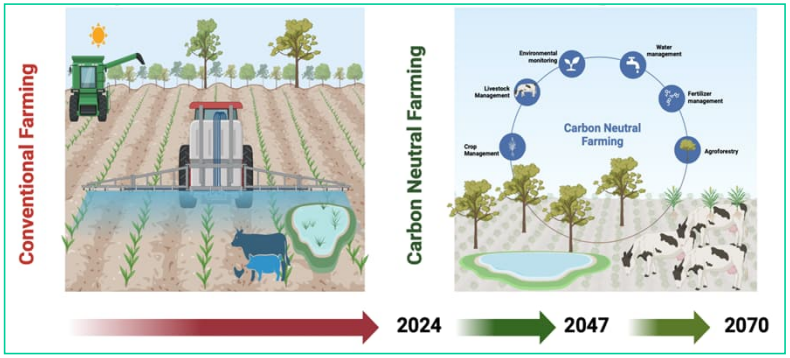
Naresh Kumar et al, 2013;2016;2023;2024

Technological interventions can lead to adaptation gains, which vary with region, landholding size and management.

However, the small and marginal farmers incur significant adaptation cost

Ecosystem and One Health-based adaptation: Restoring positions





Basic approach of ecosystem-based adaptation

1) transdisciplinary approaches,

2) Participatory adaptation

3) monitoring, evaluation and research in real systems

Naresh Kumar et al., 2014, 2016, 2023

Rao et al., 2024, in press

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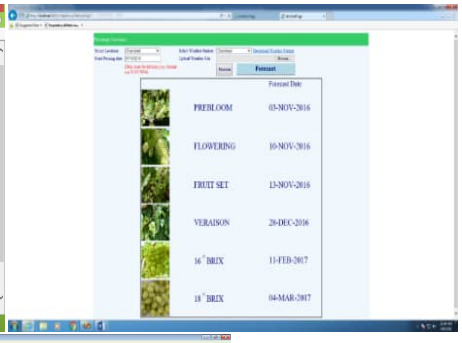
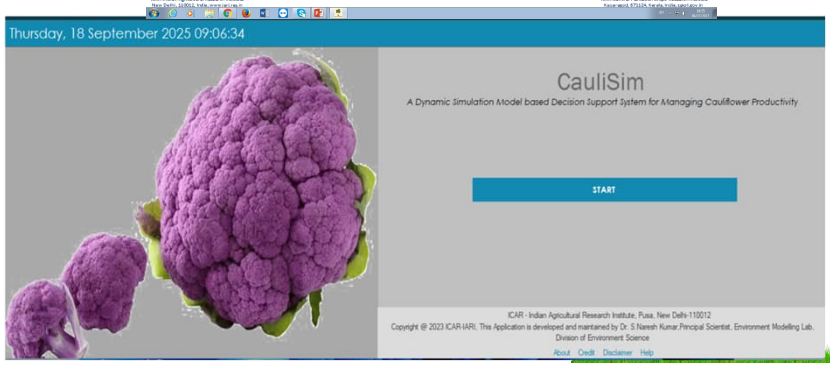
Digital Horti: Simulation models for horticultural crops developed at the Environmental Modelling Lab, Div Envi Sci, IARI

- Potato (InfoCrop-POTATO)
- Coconut (InfoCrop-COCONUT, CocoSim)
- Onion (InfoCrop-ONION in progress)
- Tomato (InfoCrop-TOMATO in progress)
- Spinach (IvSim)
- Grapes (VitisMod)-phenology
- Cole crops (cauliflower, cabbage and broccoli)
- Root vegetables (carrot, beetroot, radish, etc.)
- Capsicum,
- French bean

Working on

- Mango
- Apple
- Citrus

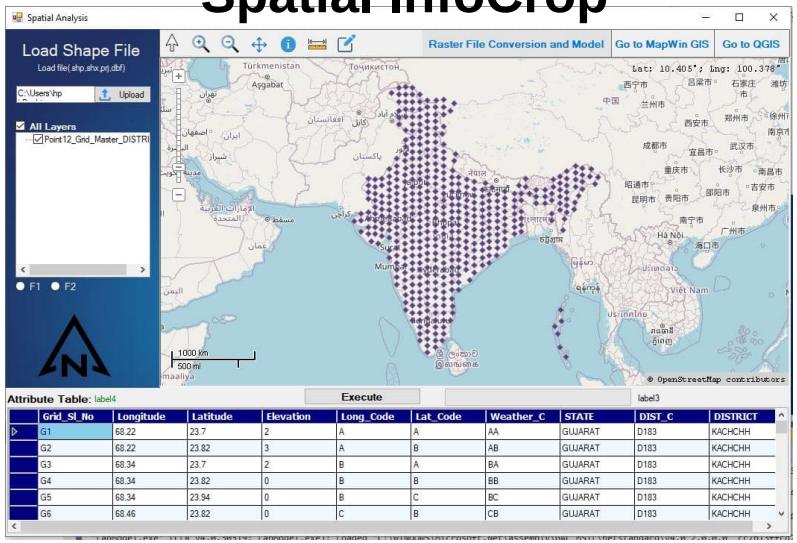




Other dynamic Simulation Models developed at Environmental Modelling lab, Div Envi Sci, IARI

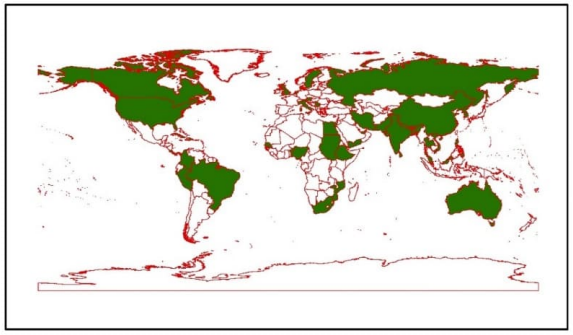
http://www.iari.res.in/index.php?option=com_content&view=article&id=1334&Itemid=1198

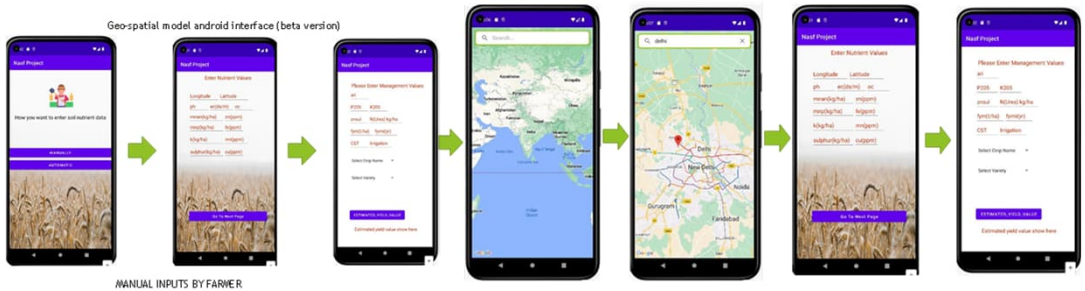
Spatial InfoCrop



Grid_Sl_No	Longitude	Latitude	Elevation	Long_Code	Lat_Code	Weather_C	STATE	DIST_C	DISTRICT
G1	68.22	23.7	2	A	A	AA	GUJARAT	D183	KACHCHH
G2	68.22	23.82	3	A	B	AB	GUJARAT	D183	KACHCHH
G3	68.34	23.7	2	B	A	BA	GUJARAT	D183	KACHCHH
G4	68.34	23.82	0	B	B	BB	GUJARAT	D183	KACHCHH
G5	68.34	23.94	0	B	C	BC	GUJARAT	D183	KACHCHH
G6	68.46	23.82	0	C	B	CB	GUJARAT	D183	KACHCHH

Geo-spatial model android interface (beta version)





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Thank U.....

Climate change research facilities at IARI

Welcome to connect ..let us make a difference together

nareshkumar.soora@gmail.com; 9968768178