NICRA-INTEGRATED MODELLING: SIGNIFICANT OUTPUTS

(2016-2026)

NICRA

ICAR

Participating Institutions

ICAR-IARI, New Delhi (coordinating))
ICAR-CRIDA, Hyderabad
ICAR-CMFRI, Kochi
ICAR-CIBA, Chennai
ICAR-IISS, Bhopal
ICAR-IIHR, Bengaluru
IIT-Chennai

Till 2021

ICAR-IISWC, Dehradun
ICAR-IIFSR, Modipuram
ICAR-DOGR, Rajgurunagar
ICAR-NBSS&LUP, Nagpur
ICAR-RC-NEH, Barapani
ICAR-IIWM-Bhubaneswar
ICAR-CPRI, Shimla
ICAR-NRM, New Delhi

Integrated modeling

NICRA-INTEGRATED MODELLING PUBLICATION

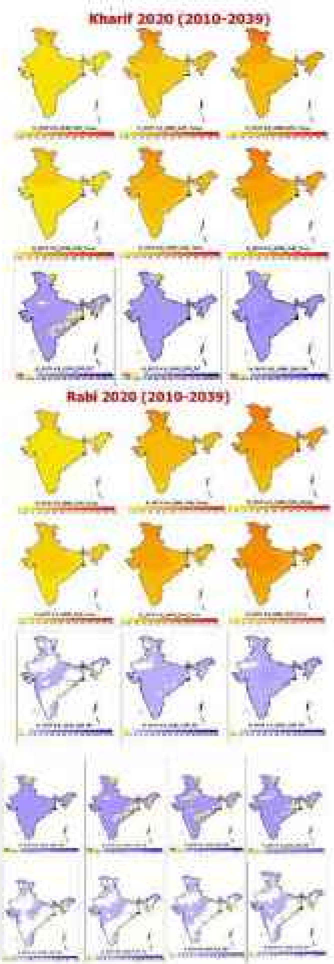
Climate change research provides strategic information for building adaptation and resilience of systems. In addition to field and wet-lab experimentation, simulation modelling is essential to come-out with several possible situations, their impacts, delineation of vulnerable areas and possible adaptation strategies at regional level. This will help in decision making and policy setting for building resilience. In India, simulation analysis has been used for quantification of impacts of climate change on several sectors such as water, forests and agriculture. The simulation studies on annual and even on perennial crops provided essential insights on impacts of climate change. Studies also concentrated on quantifying the adaptation gains. Though these simulation efforts have led to overall understanding of the gravity of climate change impacts, and led to prioritization of climate change research in India, there is a need to use these leads for making Indian agriculture climate resilient. For doing so, the potential role of simulation modelling has to be exploited to the maximum so that adaptation strategies are derived and implemented in more scientifically integrated way. In the digital era, food production systems are fast moving towards harnessing the potential of digital agriculture.

The climate resilient systems can be developed when the climate change impacts and adaptation strategies are well-delineated. Keeping this in view an Integrated Modeling team was commissioned in 2016 under NICRA with 12 Institutes and later the team was further expanded. From 2021, the team consisted of seven institutes. The team has specific objective of integrated modelling of the climate change regional impacts and derivation of adaptation and vulnerable regions using model ensembles. Major outputs are summarized in this folder.

NICRA

ICAR

CMIP 5- 33 GCM-Ensemble seasonal climate scenarios



Seasonal projections on change in temperature and rainfall in India (Naresh Kumar et al., 2019).

Climate change projections for agricultural seasons

CMIP 5 GCMs bias-corrected ensemble scenarios

Seasonal climate change projections for Indian region were derived from the bias corrected probabilistic ensemble of 33 global climate models. Based on the analysis it is projected that

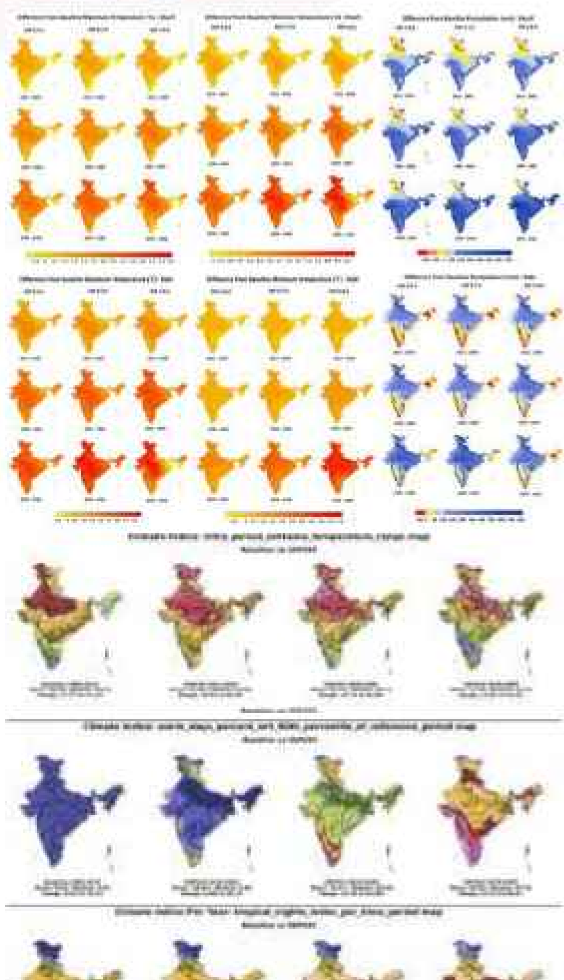
- Rise in minimum temperatures is to be more than rise in maximum temperatures;
- Rise in temperatures to be more during rabi than during kharif;
- During kharif, minimum temperatures to increase in the range of 0.946 - 1.061 ºC (2020), 1.345-2.42 ºC (2050) and 1.358-4.067 ºC (2080) in different RCPs, while projected increase during rabi is 1.096-1.207 ºC (2020), 1.5422.759 ºC (2050) and 1.546-4.652 ºC (2080);
- Maximum temperatures during kharif to increase in the range of 0.741 – 0.847 ºC (2020), 1.145-2.004 ºC (2050) and 1.265-3.533 ºC (2080) in different RCPs while the projected increase in rabi is 0.882-0.947 ºC (2020), 1.317-2.308 ºC (2050) and 1. 389-4.01 ºC (2080);
- Rise in temperatures are projected to be more in the northern regions of India than in the southern region;
- Rainfall projections, though less robust, indicate an increase during kharif and rabi seasons;
- Kharif rainfall is projected to increase in the range of 2.3-3.3% (2020), 4.9-10.1% (2050) and 5.5-18.9% (2080), while rabi rainfall is projected to increase in the range of 12% (2020), 12-17% (2050) and 13-26% (2080);
- Rainfall increase (%) is projected to be more during rabi than increase during kharif but the variability is projected to increase significantly in both seasons;
- Variability in terms of coefficient of variation for minimum and maximum temperatures is more during rabi than during kharif;
- The variability for maximum temperatures is projected to rise during both seasons;
- The variability for minimum temperatures to rise in kharif; while it may remain high in rabi season.

This analysis indicated a progressive climate change and increase in variability during kharif and rabi seasons in India towards the end of the century.

CMIP 6 GCMs bias-corrected ensemble scenarios

- Kharif seasonal mean maximum and minimum temperatures are projected to increase up to 3 $^{\circ}$C and 1.4°C, respectively by the year 2039 compared to the baseline (1980-2014) period, with more warming projected towards the end of the century (4.8-6.6/2.8-4.4 $^{\circ}$C) under SSP2-4.5, 3-7.0 and 5-8.5.
- Rabi seasonal mean maximum and minimum temperatures are projected to increase up to 1.6 $^{\circ}$C and 1.9°C by the year 2039 compared to the baseline (1980-2014) period, with more warming projected towards the end of the century (3.3-5.4/4.4-7.1 $^{\circ}$C) under SSP2-4.5, 3-7.0 and 5-8.5. The variability in minimum temperatures is projected to be higher, particularly in the Rabi season.
- Precipitation is projected to change significantly, and the rainfall variability is projected to increase significantly in future climates, particularly during the Rabi season. The Consecutive wet days and rainfall extremes are projected to increase significantly.
- Climate extremes such as heat waves are projected increase by 5 to 17 times and days above normal by 6.5 times over the Indian region as compared to the baseline period (1985-2014).
- During the Kharif season, a significant increase in warm spells, tropical nights, extreme warm days, and warm nights, as well as extreme rainfall events, is projected. The Himalayan Region and North-west India are projected to have significantly higher hot days.
- During the Rabi season, warm spells and warm nights are projected to increase by up to 20 times by the year 2100 over the baseline period. Similarly, the number of cold waves, their duration, frost events, and rainfall are projected to increase. The frost events are also projected to increase in northern and parts of central India.

All these mean changes and extremes have significant spatio-temporal variations. In general, warming is projected to be more in central and western India, while the variability is more in the northern parts of India. South and central India may receive more rainfall, while the northern parts are expected to be drier in Kharif, with significant interannual variability. During Rabi, the rainfall is projected to increase more in northern and central India, while rainfall over the western ghats and the north-eastern region is projected to decrease marginally.



Source: Naresh Kumar et al 2026

NICRA

ICAR

Projections on impacts, adaptation and vulnerability of crops

Regional impacts of climate change, adaptation gains and adaptation options are developed for major crops.

Wheat

Without adaptation, climate change is projected to affect the wheat productivity by about -3.2 to -5.3% in 2020 (2010-2039); -8.4 to -19.3% in 2050 (2040-2069); and -18.9 to -41% in 2080 (2070-2099) under different representative concentration pathways (RCPs 2.6, 4.5, 6.0 and 8.5). States like Bihar, Jharkhand, West Bengal are particularly vulnerable. Adaptation will improve the yield at state level in the range of 10 to 40% in major wheat growing states. Varieties that maintain current crop duration can improve yield in north-west India in future climates. Developing short-duration heat tolerant varieties is important for sustaining wheat yield in central India.

Rice

The irrigated rice yield during kharif season is projected to be affected by about -3% in 2020, -2 to 3.5% in 2050 and 2 to 5% in 2080 climate scenarios in all RCPs (2.6, 4.5, 6.0 and 8.5). Rainfed rice productivity is projected to change in the range of 7 to -28% in 2020, 2 to -20% in 2050 and -10 to -47% in 2080 climate scenarios in different RCPs with significant spatial variation. Irrigated rice in states such as Haryana, Karnataka, Kerala, Maharashtra, Tamil Nadu and West Bengal is to be affected significantly without adaptation. Growing heat and water stress tolerant and short duration varieties with improved nutrient and water management can enhance the productivity up to 28% or even more till 2050 climate scenarios. However, strategy of growing short-duration varieties than the current ones in north-west India may not prove beneficial even in the near future.

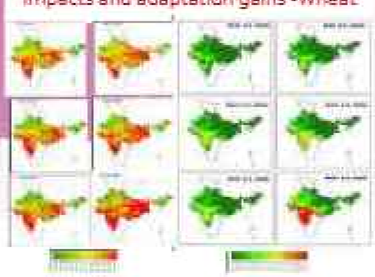
Maize

For maize, under RPC 4.5 scenario a reduction of 9-10% yield (in 2020), 10 - 19% (in 2050) and > 20% (in 2080 scenario) in comparison to baseline (year 2010) in the major maize growing districts is projected. Change in sowing time is one of the adaptation options tested.

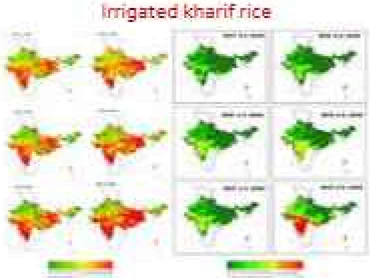
Sorghum

Based on the regression model, majority of kharif sorghum districts in Madhya Pradesh and significant number of districts in Tamil Nadu and Karnataka are found to have adverse effect of climate change in 2050s as well as 2080s. Almost all *kharif* sorghum districts in Maharashtra, all Andhra Pradesh districts are expected to be benefited with yield gain due to climate change in 2050s as well as 2080s. All the rabi sorghum districts of Karnataka are expected to witness adverse effects of climate change in 2050s as well as 2080s. All the rabi sorghum districts in Tamil Nadu are expected to be benefited with yield gain due to climate change in 2050s as well as 2080s.

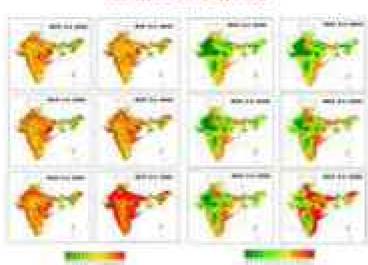
Impacts and adaptation gains -Wheat



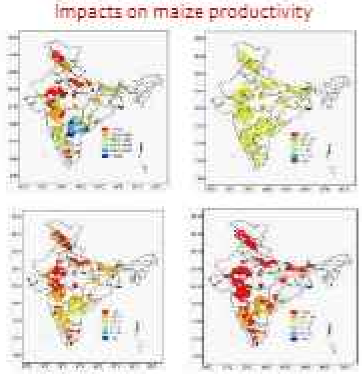
Irrigated kharif rice



Rainfed kharif rice



Impacts on maize productivity



Deviation in 2050 | Deviation in 2080

Pearl millet:

Climate change will lead to substantial yield reductions in pearl millet, with an average decrease of 12-25% by the end of the century under the moderate-emission RCP4.5 scenario. Agronomic adaptation options: potential to reduce yield losses by 20-40% under RCP4.5 and by 15-30% under RCP8.5. Areas experiencing temperature increases above 2.5°C and rainfall reductions exceeding 10% showed limited adaptation benefits

Soybean

Soybean productivity is projected to increase despite climate change, marginally by 2.5 to 5.5% in 2020 scenario across all RCPs; while in 2050 scenario the projected increase is in the range of 3-10% and in 2080 scenario, the projected change is up to 14% across all RCPs (2.6, 4.5, 6.0 and 8.5). This increase in yield, however, has a significant inter-annual variability. Adaptation with short-duration varieties, supplemental irrigation, raised bed method of planting, etc can significantly reduce the inter-annual variability as well as improve the yields up to 40%.

Mustard

Without adaptation, climate change is projected to change all India productivity of mustard up to -13%. Short-duration varieties are likely to perform better under future climates, as the winter period suitable for mustard growth and development is shrinking.

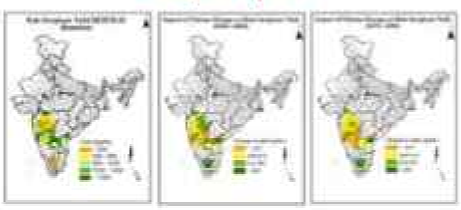
Pigeon pea

Climate change impact assessment for pigeon pea was undertaken for these 15 districts projected climate indicated an increase in pigeonpea yield under all the future scenarios when compared to that of the baseline. Climate change will lead to a substantial yield increase in pigeonpea, with an average increase of 480 kg/ha by the mid-century under the moderate emission SSP 2-4.5 scenario and upto 650 kg/ha under the high-emission scenario.

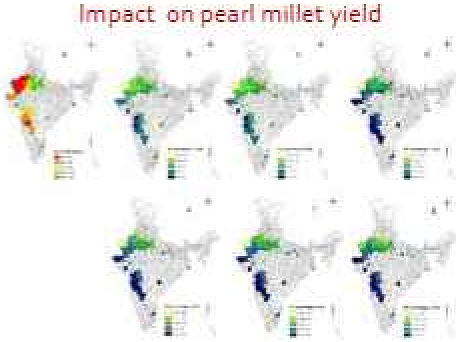
Potato

The yield potential of potato varieties is projected to decrease spatially from Punjab to West Bengal and also in part of MP and Gujarat. Delaying the planting up to 2 weeks in 2050's and 1 to 3 weeks in 2080's can offset the reduction in yield at most of the locations. Under low elevations the stolon initiation may delay by 10 days as compared to higher altitude (1600-2400 m above MSL). Kufri Girdhari performed better in higher altitude as compared to Kufri Jyoti, which was found to perform better in low altitude. Climate change is projected to impact productivity of potato up to -13%.

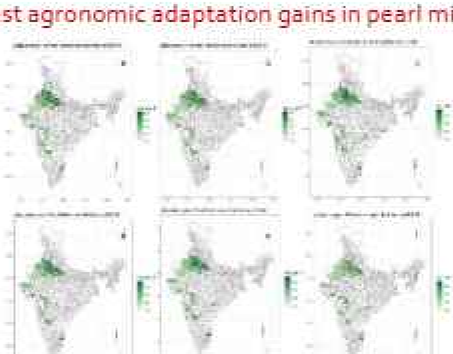
Impact of climate change on rabi sorghum yield



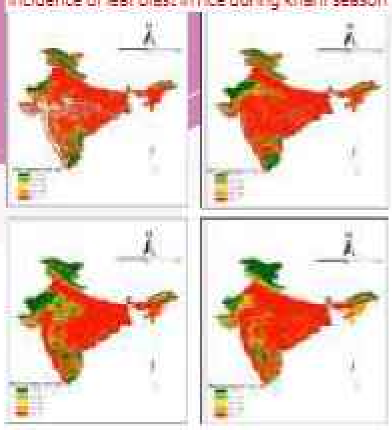
Impact on pearl millet yield



Best agronomic adaptation gains in pearl millet



Incidence of leaf blast in rice during kharif season

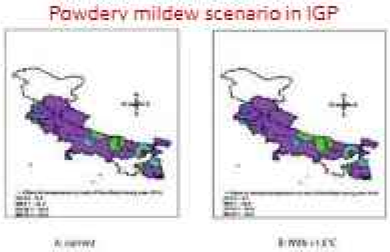


Future habitat suitability of rice false smut under SSP 2-4.5 scenario: A) 2030 B) 2050 and C) 2070

Future habitat suitability of rice false smut under SSP 5-8.5 scenario: A) 2030 B) 2050 and C) 2070

Powdery mildew scenario in IGP

Powdery mildew scenario in IGP



Onion

The InfoCrop-onion model was calibrated and validated satisfactorily for south and central Indian regions. The onion yield is projected to be affected in Bangalore and Indore regions, while in Dharwad and Pune regions, marginal yield advantages are projected for kharif and late kharif season. In Nasik region, late kharif and rabi yields are likely to decline.

Cotton

Cotton productivity is projected to increase by up to 8.4 to 13.6%.

Studies and projections on diseases and insect pests

- Developed a disease forecasting system for spot blotch of wheat and leaf blast, false smut and sheath blight of rice. The climatic conditions in western zone are favorable for powdery mildew incidence in wheat only during March. The simulation analysis indicated that the disease is likely to be restricted in the western zone, and marginally change in the eastern plains in future climates.
- Developed and validated BPH forewarning methodology that specifies that more frequent rains during June-September months (≥30 days) might play significant role in BPH outbreaks. Higher rainfall accompanied with cloudy weather and lower sunshine hours results in favorable temperature and relative humidity conditions for BPH development.
- Population dynamics simulation model of wheat aphids was developed to couple with InfoCrop v2.1-wheat model to simulate crop-pest interactions. The forewarning system of brown plant hopper is validated for Delhi region.

Expert system for leaf blast management advisory (Decision Support System/Process development)

A heuristic prediction algorithm is developed to simulate leaf and panicle blast infection in rice. Daily leaf wetness hours and dew deposition hours are assessed to check whether infection periods are satisfied or not (Yoshino's criteria). Proportion of infection is predicted based on SEIR model. Blast infection monitoring automated information process uses daily maximum – minimum air temperature easily accessible for the past 10 days and next 10-15 days. Information processing system has been automated for decision about blast infection periods/conditions. The neural network based deep learning model quantifies the stages of infection based on spectral indices from high-resolution RS images. The model has a training accuracy of 90.40% and a validation accuracy of 85.34% for forecasting the disease grade on the enhance vegetation index parameter. Upon pan-India validation the modelled pest incidence has ~70-75% agreement with actual incidence in September.

A model for cotton leaf curl incidence dynamics based on a population dynamics model is developed.

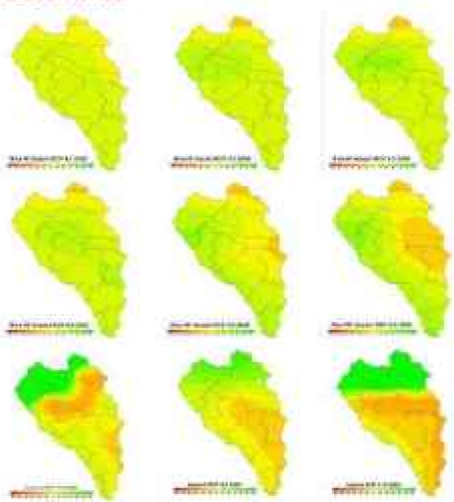
Habitat suitability maps under the SSP 2-4.5 and SSP 5-8.5 scenarios indicate a progressive increase in potential risk zones for rice false smut. The analysis projected that higher temperatures and precipitation under SSP 5-8.5 lead to more aggressive disease spread. Northern regions may become less suitable over time due to extreme heat and risk increases over time across central, southern, and eastern India, particularly in 2050 and 2070 projections.

Projections at river basin level (river flows, irrigation water requirement, soil erosion, crop management)

Ramganga

Integrated assessments for river basins indicated that in Ramganga river basin, maximum mean monthly water yield is projected to increase by 8 to 41 % in monsoon months, while during months of March, October and December maximum decrease in mean monthly water yield by 1 to 59 % during the 2020s, 2050s and 2080s is projected. Wheat yield may improve in upper catchment areas even with current management conditions. But in middle and lower catchment areas, wheat yield is projected to reduce substantially. Irrigation water scarcity during December to affect wheat yield in middle and lower sub-basins.

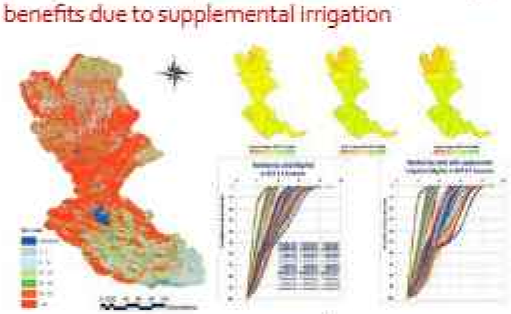
Impacts on productivity of irrigated (top) and rainfed (middle) rice, and wheat (bottom) in Ramganga river basin in RCP 4.5 2020, 2050 and 2080 scenarios



Brahmani

In Brahmani river basin, the simulation analysis projected an increase in stream flow that varied from 1.4 to 2.4%, 8.0 to 13.2%, and 7.0 to 21.3% except during January and February during 2020, 2050, and 2080 climate scenarios of all RCPs. An increase in high flows is also projected. Further, shifting of low erosion class to moderate to high erosion class was indicated. The potential soil loss in the Brahmani river basin is projected to be up to 320 t $ha^{-1} yr^{-1}$ where maximum area has soil loss rate more than 80 t $ha^{-1} yr^{-1}$ and these are extreme erosion potential areas. Crop simulation analysis indicated that during kharif season, application of one supplemental irrigation provides an opportunity to improve yield from 4.5 Mg ha^{-1} to 6 Mg ha^{-1} at a similar probability level of 40%.

a) Soil erosion potential & b) climate change impacts on kharif rice in Brahmani river basin and yield benefits due to supplemental irrigation



a b

Betwa

The composite hydrologic indices (CHI) were developed for evaluating the recharge potential in the Betwa river basin. More than half of the basin area is dominated with high runoff potential zone and is suitable for selecting rainwater harvesting structure. Suitable sites for water harvesting structures in each hydrologic response Unit (HRU) having possibilities to increase the groundwater level are identified.

Cauvery

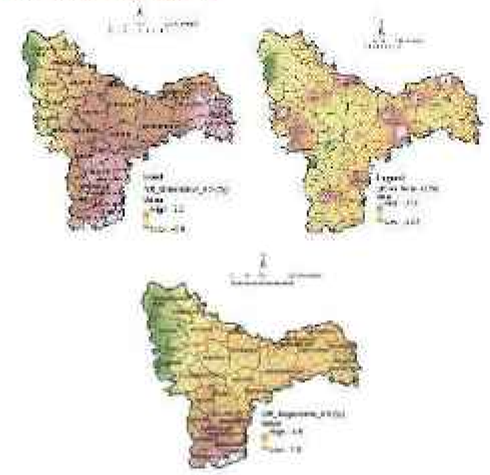
Simulation results indicate unmet water demand reduction during 50% of the time period spanning from 1976 – 2005 with maximum unmet demand during 2002, 2003 in Cauvery river basin, A reduction in the magnitude of flows in future is projected with possible influence on acreage under rice and sugarcane crops. Altering acreage under water-intensive crops such as sugarcane increases the possibility of successful production of other crops. Water rotation, crop diversification with less water requiring crops, implementation of water saving techniques and augmentation of existing reservoirs through inter-basin diversions are possible ways to ensure effective water management in Cauvery river basin.

Water management options in Cauvery river basin

Krishna

Irrigation water requirement of crops in Krishna river basin under RCP 4.5 and 6.5 in 2030 climate scenarios is projected to change for chickpea (increase by 1.8 to 3.2 %; 1.9 to 5.4%), rabi sorghum (-7.1 to 10.6 %;-0.2 to 14.5%), pigeon pea (-10.7 to 7.6 %; -9.3 to 12.7%), maize (-29.8 to 17.5%; -28.3 to 17.9 %), pearl millet (-2.5 to 7.2 %; -0.9 to 9.1%), sunflower (-9.6 to 9.9 %; -10.4 to 11.9%), ground nut (-5.9 to 3.0%; -4.2 to 3.5%), kharif rice (-3.0 to 2.3%; -2.5 to 1.5%) and sugarcane (1.9 to 4.5%; 1.4 to 4.0%).

Impacts on irrigation water demand of groundnut, irrigated kharif maize and sugarcane in Krishna river basin



Mahanadi

The SSP-RCP scenario-based analysis indicated that hydrological extremes will gradually worsen across all scenarios. Under SSP3-7.0 and SSP5-7.0 scenarios, climate-induced hydrological instability is pronounced, with dry spells, floods, and altered runoff patterns, whereas SSP2-4.5 shows controllable increases in flow and moisture availability.

These findings highlight the need for sustainable planning and adaptable water management in the Mahanadi Basin under changing climates.

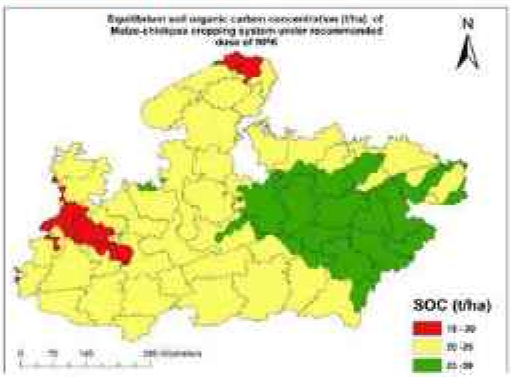
Percentage change in water yield in Mahanadi river basin under SSP2-4.5 scenarios w.r.t baseline period (1985-2014)

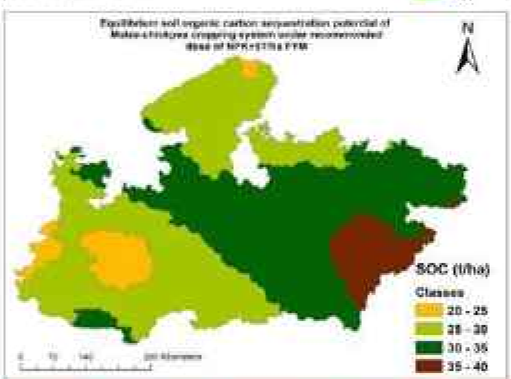
Watershed-level modeling

In Brapani of Meghalaya, soil loss in eight micro-watersheds is projected to increase in future climate scenarios.

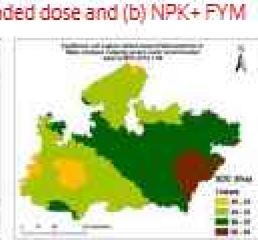
NICRA

Equilibrium soil organic carbon concentration in maize–chickpea cropping system (a) general recommended dose (b) NPK+ FYM





Equilibrium SOC concentration in maize – chickpea cropping system with (a) recommended dose and (b) NPK+ FYM



An optimization program was developed for the Badajor watershed in Brahmani river basin area and found that 28% allocation of groundwater in the monsoon season and 72% allocation of groundwater in post-monsoon season were found optimum for maximization of net return.

Farm-level modeling

The farm level modeling projected a decline in sugarcane yield in 60% of the farms in the range of 10-15 % in Meerut region in Uttar Pradesh. However, in remaining farms the yield increase is projected to be around 7-10 % compared to baseline.

Soil health management

The simulation analysis indicated that for soils low in soil organic carbon (SOC), threshold value to maintain SOC is ~10% residue retention for adequately fertilized crops (100% N applied). For a N limited crop, it is as high as 30%. The conditions where SOC were higher (1%), approximately 60% residue retention is the threshold level for N limited condition. This level is 30% and 20% in case of medium and high level of N management, respectively. Addition of inorganic fertilizer in combination with FYM could be an important strategy in maintaining the SOC and thus the soil quality.

Soil

Soil organic carbon (SOC) sequestration potential under the changing climatic scenarios in different agroecosystems of India was assessed using the RothC model and Long-Term Fertilizer Experiment (LTFE), The equilibrium concentration of SOC was markedly higher when nitrogen was applied in conjunction with FYM. The reductions in SOC sequestration rates were most pronounced under the high-emission scenario of RCP 8.5, followed by RCP 6.0, RCP 4.5, and the least impact observed under RCP 2.6.

Estimation of soil organic carbon stock in central India under maize-chick pea and maize-wheat cropping systems and nutrient management practices indicated that total soil organic carbon stock in maize-chickpea cropping system under NPK+FYM is estimated at 0.875 Pg, In maize-wheat cropping system, estimated increase of SOC stock is to the tune of 49.44, 36.65, 25.29 and 22.24% in shallow medium black soil, deep black soil, mixed red-black and alluvial soils, respectively. Similarly, in the maize–chickpea cropping system, increments of 28.10, 23.50, 22.96 and 16.00% are estimated for alluvial, shallow medium black, deep black and mixed red- black soils of Madhya Pradesh, respectively. APSIM based results indicated that equilibrium SOC content under the 100%NPK and 100% NPK+5t ha-1 FYM ranged from 15-30 Mg ha-1 and 20-40 Mg ha-1, respectively. The continuous use of 100% NPK + 5 Mg ha-1 FYM over time will boost the SOC stocks over the central India.

Marine fisheries

The impact of environmental variables on the Catch Per Unit Effort (CPUE) of Indian oil sardine along the Kerala coast (1998-2023) was assessed using a Generalized Additive Model. The combination of sea surface temperature (SST), Chlorophyll, and sea surface salinity (SSS) has the greatest impact on oil sardine CPUE. Projections under various SSP scenarios indicated a declining trend in oil sardine CPUE.

During the ENSO period, temperatures over the south-west coast go beyond 27 °C while during co-occurred events of El Niño and the Positive IOD temperatures go beyond 28 °C. Co-occurrence and strong events of IOD and ENSO lead to a decrease in the fishery of Indian oil sardine along the south-west coast of India (example 1990 to 1999 years).

Oil sardine fishery will increase due to the increase in upwelling intensity and chlorophyll-a enhancement while it will decease along the southwest coast of India due to the strong events of ENSO and IOD (example, 2000 to 2007 years).

Assessment of cumulative impact of climate change and sustainable fishing levels using Monte Carlo Catch- Maximum Sustainable Yield and Bayesian Schaefer Models, on the long-term sustainability of threadfin breams, along the South-Eastern Arabian Sea (SEAS) indicated that six species of threadfin breams were identified in the SEAS region, with *Nemipterus japonicus* and *N. randalli* being the most dominant.

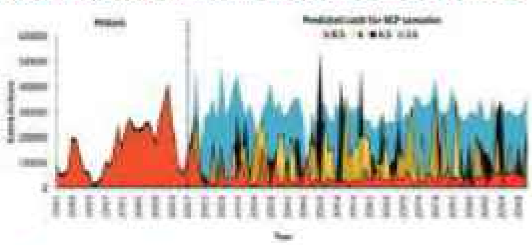
The analysis indicated that the catch rate of threadfin bream stock was favorably impacted by precipitation and the U current. The SST, SSS, and Mixed Layer Depth (MLD) had a negative impact on this fish stock. The rising SST along the coast negatively influences this vulnerable stock, further exacerbated by higher fishing pressure. As the threadfin bream stock shows moderate resilience, optimizing fishing practices could help replenish the stock and foster future sustainability.

Of the five important environmental variables selected, salinity was the only significant environmental parameter that affected the abundance of Bombay duck in the region. The maximum sustainable yield (MSY) was lower than the current harvest rates, warranting management measures for the resource in the region. The Bombay duck is adapting its diet to changes in prey abundance, indicating trophic plasticity driven by climate change.

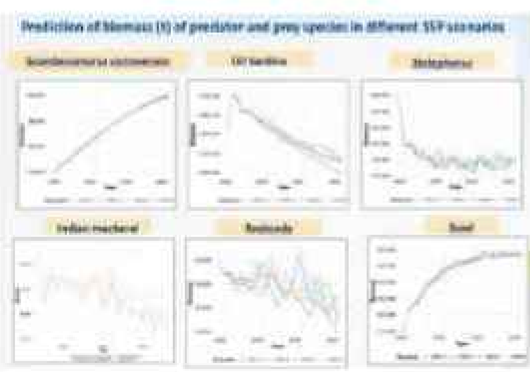
Predator–prey multispecies model based projections facilitated the development of appropriate harvest control rules to sustain marine fisheries in the region.

A modified version of biomass dynamic model based study indicated that the variations in SST accounted for about 13.44% of the annual additions to Indian mackerel biomass in the southeastern Arabian Sea, while precipitation contributed only 1.32%. These influences were minimal for scads and *Stolephorus* sp. The fisheries along the southeast coast and northeast coast were the most vulnerable among the four regions. The mechanized sector is the most vulnerable to climate change, underscoring the need for region- and gear-specific adaptation and management strategies.

Catch forecast of Indian oil sardine under all RCPs



Prediction of biomass of predator and prey in various SSP scenarios



NICRA

ICAR

Shrimp aquaculture

The study aims to determine the minimum data requirements of climatic and culture parameters for accurate forecasting of shrimp diseases, White Spot Syndrome Virus (WSSV), and Enterocytozoon hepatopenaei (EHP) with seven machine learning models. Based on 290 shrimp farms across Tamil Nadu, Andhra Pradesh, and Odisha, the Random Forest and XGBoost consistently emerged as the most reliable models for both WSSV and EHP predictions, with accuracies of 87.9% & 86.2% and 84.5% & 81%, respectively.

In Tamil Nadu during November, frequent extreme weather events are projected and it is suggested to complete the shrimp crop harvest early. Similarly, increasing temperatures with no significant change in rainfall at many places indicate less availability and poor quality of water for aquaculture.

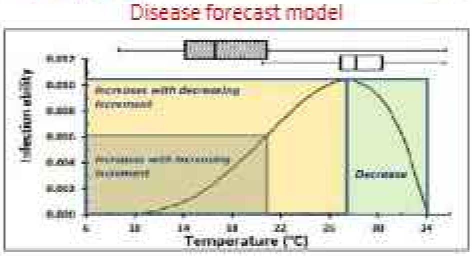
The Life Cycle Assessment studies indicated the **need to reduce or find an alternative to fish meal use in shrimp feed production, and use efficient pumps and generators.**

Models developed/ updated under NICRA

- **InfoCrop 2.1:** updated and released. More than 2500 scientists/ students in 46 countries have downloaded this model.
- **InfoCrop-Onion:** The models is revised, calibrated and validated for south and central India.
- **Crop-pest coupled models**: Pest population dynamic models for rice-BPH and wheat-aphids were coupled to InfoCrop-wheat and rice models, respectively to simulate crop-pest interactions.
- **Disease forecast models** have been developed for spot blotch of wheat and leaf blast of rice.
- Loose coupling of hydrological model with crop model is done
- **InfoCrop Spatial Model** is a geospatial simulation framework that combines InfoCrop growth models with spatial data (soil, weather grids, administrative boundaries, crop management for crops and varieties etc.) to run simulations over large geographic areas - such as districts, states, or countries for multiple years.
- **IKSHU** is sugarcane crop simulation model used to simulate its growth, yield, water use, etc. in response to climate, soil, management, and variety.
- An **optimization model** was developed for the Badajor watershed area for optimal conjunctive water allocation of canal and groundwater for maximization of net returns.
- A software **"SQI CAL"** for rapid calculation of soil quality index is developed.
- The **multi-gear biomass dynamic model** (multi-species) is developed, calibrated and validated the model for selected fishery resources of India.
- **System dynamic models** were developed for growth, feed digestion, and carbon and nitrogen dynamics of **shrimp aquaculture.**

InfoCrop v2.1 Home Page

Disease forecast model



Spatial v1.0 Home Page

IKSHU Beta v1.0 Home Page

NICRA

ICAR

- **CarryCap,** a web based tool is updated to estimate the optimum farming area for brackish water species on a particular water source.
- **NeerPasanam**, a mobile application for irrigation scheduling and for providing irrigation advisory in Gadananathi-Ramnadhi Basin.

Contributions/ papers/ bulletins/ trainings/ HRD

- Part of these studies are contributed to India's Third National Communication to UNFCCC and IPCC reports, etc.
- Research papers published: 62 (highest NAAS rating- 17.47 (impact factor 11.47); papers with NAAS rating > 8- 18, papers with NAAS rating > 6-8- 34.
- ICAR Technology certificates: 2
- Copyrights: 3
- Technical Bulletins: 6
- Book Chapters: 20
- Training programmes organized: 8 (over 250 students and scientists are trained).
- Students trained (MSc/ PhD): 6; RA/SRF/YP trained: 35

Team (2016-2026):
Dr S. Naresh Kumar (Coordinator), Dr M Khanna, Dr DK Singh, Dr Parimal Sinha, Dr Purakayastha, Dr Bidisha Chakraborti (ICAR-IARI, New Delhi); Dr AVM Subba Rao, Dr KV Rao, Dr Sharat Chandra (ICAR-CRIDA); Dr RH Laxman (ICAR-IIHR); Dr Nishant, Dr M Mohanty (ICAR-IISS); Dr Muralidhar, Dr Ashok (ICAR-CIBA, Chennai), Drs Zachharia, Dr Verghese (ICAR-CMFRI, Kochi) and Dr Balaji (IIT-M, Channai). Members up to 2021: Dr Sena (ICAR-IISWC, Dehradun), Dr N Subhash (ICAR-IIFSR, Modipuram), Dr Tangasamy (ICAR-DOGR, Rajguru Nagar), Dr A. Islam (ICAR-NRM, New Delhi) Dr P. Tiwari (ICAR-NBSSLUP, Nagpur), Dr B Choudhary (ICAR-RC-NEH, Barapani), Dr VK Dua, (ICAR-CPRI, Shimla)

For more details, contact

Prof S. Naresh Kumar
Head and Principal Scientist
ICAR-Indian Agricultural Research Institute, New Delhi-12
Email: soora.nareshkumar@icar.org.in
nareshkumar.soora@gmail.com

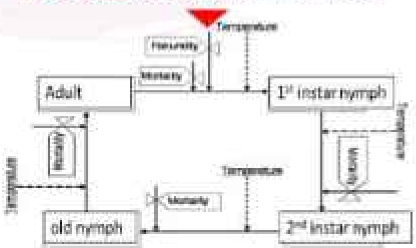
or

Dr. M. Prabhakar
Principal Investigator, NICRA,
ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
pi.nicra@gamil.com

or

Director, CRIDA, Hyderabad

Pest population dynamics model



SQI CAL

Carry Cap

NeerPasanam