

Invited paper

Climate change adaptation strategies for agro-ecosystem – a review

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ABSTRACT

Agriculture the major economic and social activity in the globe. It is understood that agriculture is highly sensitive to climatic variability and likely to be affected most to predicted climate change. The fourth assessment report of Intergovernmental Panel on Climate Change (IPCC) has reconfirmed that the phenomenon of existence of climate change in recent decades is due to anthropogenic activities. It is also revealed the availability of wide array of adaptation options for agro-ecosystem to cope up with the impact of climate change. However, it is important to design more extensive adaptation strategies to reduce vulnerability of agriculture and rural poor to impacts of climate change. Climate change impacts and responses are presently observed as autonomous adaptation in the physical and ecological systems as well as in human adjustments to resource availability and risks at different spatial and trophic levels. But these strategies are not enough to reduce the current anthropogenic driven climate change, so there is a need to adopt the planned adaptation. This paper reviews the findings based on the series of studies carried across the globe on the potential adaptation strategies to alleviate the impact of climate change by improving the resilience of the agro-ecosystems. Adaptation strategies have to be in place to reduce vulnerability to climate change through developing consensus between industrialized countries and developing countries at global scale, whereas new public policies in place at national regional and local level is prudent to support adaptation research, insurances, incentives to farmers to adapt new technologies.

Key words: Climate change, impact, adaptation, Agro-ecosystem, livestock

Sensitivity of wheat crop to projected climate change in non-traditional areas

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ABSTRACT

An attempt has been made to quantify the effect of projected climate change on wheat production in non-traditional wheat areas comprising states of Gujarat, Maharashtra, Madhya Pradesh and Rajasthan that contribute about 20 per cent of national wheat production. InfoCrop model was calibrated and validated using research farm data of Vasad, District Anand (Central Gujarat) and were used for climate change impact study using PRECIS downscaled, weather data of baseline period (1961-1990) and A2a scenario for projected period (2071-2100). Different crop management were tried for simulation in order to identifying adaptation options. Average annual maximum temperature for the projected period is likely to be higher than the base period by 3.96°C with maximum of 5.78°C for November and minimum 2.44°C for May. Similarly, the average minimum temperature is likely to rise by 4.36 °C with maximum increase of 5.94°C during December and minimum rise of 2.76°C during July. Average annual rainfall for central Gujarat region is likely to increase by 36 percent.

Under irrigated condition, each degree rise in average temperature over crop growing period will take toll of 3.02 q of wheat in already low yield area, similarly under restricted managements conditions one degree rise in temperature will reduce yield by about 2.0 q ha⁻¹ under restricted irrigation management conditions. Further already short crop duration (100-105 days) is likely to further shorten by 15 to 20 days under projected climatic condition for A2a scenario. None of the management practices like shifting in sowing date, number of irrigation and amount of nitrogen tried for adaptation options was found beneficial and in all cases there was substantial yield loss.

Key words: Non traditional areas, climate change, impact study, baseline, adaptation

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Effect of projected climate change on mustard (*Brassica juncea*)

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ABSTRACT

Mustard is one of the most important *rabi* season oilseed crops and contribute about 30 per cent of total oilseed production. It is very sensitive to weather variable. The likely climate change may have varying effect on mustard production. Info Crop a process based crop simulation model was calibrated and validated with experimental crop data of 2003-04 to 2006-07 *rabi* seasons with different dates of sowing at IARI, New Delhi. PRECIS downscaled, baseline weather data for period 1961-1990 and projected A2a scenario data for the period 2071 to 2100 for the grid covering experimental site were used for computing magnitude of climate change and the same was used for computation of weather data for period of 2071 to 2100 using actual observed data of baseline period. Annual maximum temperature is likely to rise by 5.25°C with maximum of 7.55° for November and minimum 3.21°C for May. Similarly minimum temperature is also likely to rise by 4.83°C with highest increase of 6.34°C during February. Crop simulation suggests no or little change in mustard production under unlimited soil moisture and nitrogen conditions, but higher coefficients of variation (33%) shows unstable crop performance. Under rainfed condition which is marked by either one pre-sowing irrigation or sowing on favourable residual moisture mostly practiced in significant part of mustard growing area, crop yield is likely to reduce by 81% and crop performance is highly unlikely to be stable (116 % CV). Crop duration is also likely to reduce by 25 to 30 days, mainly due to fast accumulation of thermal unit (GDD) required for crop maturity.

Key words: Mustard, Climate change, Baseline, Projected period, Adaptation.

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Spatial wheat yield prediction using crop simulation model, GIS, remote sensing and ground observed data

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ABSTRACT

A study was conducted with a broad objective of developing and demonstrating a methodology for crop growth monitoring and yield forecasting which can provide periodical crop growth assessment with spatial information. The procedure was developed to generate grid-weather, link the point based simulation model WOFOST (World Food Studies) to spatial inputs like crop, soil and weather and predict wheat yield at grid and administrative scale. Two approaches were adopted to predict wheat yield; a) the regression approach, in which simulated potential yields were regressed with final estimated yields by Directorate of Economics and Statistics (DES) for

each of the six major wheat growing states and b) forcing approach in which LAI for each grid (25km x 25km) derived from remote sensing was forced into the simulation model to divert the simulation output and final grain yield into right direction. The deviations between the estimated state yield and reported yield were more in case of the forcing (0.7 – 25.4 %) as compared to regression approach (0.5 – 9.2 %). However, the spatial variability at grid level was explained more in case of forcing approach. Results indicated that regression approach is suitable for in season yield forecasting at state level and forcing approach is better for spatial crop condition assessment and crop growth monitoring.

Key words: Wheat yield, crop simulation, WOFOST model, LAI, remote sensing

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Evaluation of CANEGRO Sugarcane model in East Uttar Pradesh, India

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ABSTRACT

The sugarcane crop growth simulation model was calibrated and validated in Eastern Uttar Pradesh (UP) region of Indo-Gangetic Plains of India using 12 years field experiment data conducted in several places. The results reveal that the CANEGRO Sugarcane model satisfactorily simulated the potential growth and yield of sugarcane crop. The model simulates the stalk height, stalk fresh mass and sucrose yield within ± 15 % of range in comparison to the observed values. Therefore the validated CANEGRO Sugarcane model can be further used for applications such as prediction of crop growth, phenology, water management, potential and actual yields, performance of sugarcane under climate variability and change scenarios etc. The model may also be used to improve and evaluate the current practices of sugarcane growth management to achieve enhanced cane production and sugar recovery.

Keywords: CANEGRO model, Sugarcane, Genetic Coefficients, Simulation, Climate.

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Temperature trends in different regions of India

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ABSTRACT

Time series analysis of annual mean, maximum and minimum temperature revealed of 47 stations spread across different regions in India revealed the increasing trend in maximum temperature, lowest in 20 per cent stations in north zone and highest in 75 percent of the stations in south zone. On the other hand, increase in minimum temperature is observed in above 60 per cent of stations over all zones of India. Same trend is noticed in average temperature trend except in north zone where 45 per cent of stations have shown increasing trend.

Key words: Climate change, temperature change, global climate models, green house gases

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Prospects of growing yellow sarson under rainfed condition in the new alluvial agroclimatic zone of West Bengal

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ABSTRACT

Using 100 years of weekly rainfall data for Baharampur, profile moisture at sowing were simulated for coarse, medium and fine textured soils for six different sowing weeks starting from 38th (Sep 17 – 23) standard meteorological week (SMW) at two weeks interval and associated climatic risk was quantified using climatological water balance approach for yellow sarson, an important *rainfed rabi* crop of West Bengal. Same database was also used to run a FAO crop specific water balance model at weekly time steps to assess model outputs for *Binoy* variety. Yield prospects were estimated from water requirement satisfaction index (WRSI). At least 100 mm moisture is present to start sowing upto 42nd and 46th SMW in medium and fine textured soil respectively, at 75 percent probability level, for good initial growth of the plant. At least mediocre crop yield, in every alternate year, is possible when sown upto 40th SMW in medium and upto 44th SMW in fine textured soil. Prospect of getting good yield exist in more than 20 percent of the year if sown within 7th October in fine textured soil.

Key words: Profile moisture, water balance model, climatic risk, water requirement satisfaction index (WRSI).

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Evaluation of LARS-WG for generating long term data for assessment of climate change impact in Bihar

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ABSTRACT

Long term weather data is requisite to drive physically based hydrological and crop growth models to assess climate change impacts. However, lack of sufficient historical weather data many a times restrict use of these models. Realization of above facts has resulted in development of a range of weather generators such as WGEN, CLIGEN, ClimGen and LARS-WG. Any generator must be tested to ensure that the data that it produces is satisfactory for the purposes for which it is to be used. The aim of this paper is to test a commonly used weather generator, LARSWG (version 4.0) at three sites at Bihar. Statistical test were conducted, including *t*-test and *F*-test, to compare the differences between generated weather data versus 30 years observed weather data. In recent years the weather generators have also been employed to construct climate change scenarios for impact assessment. The results showed that the generated weather series was similar to the observed data for its distribution of monthly precipitation and its variances, monthly means and variance of minimum and maximum air temperatures.

Key words: Weather generators, weather data, climate change.

Forecasting models for seasonal rainfall for different regions of Gujarat

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ABSTRACT

The large spatial variability in monsoon rainfall over India demands for regional models for predicting the seasonal rainfall. Hence, models were developed for predicting seasonal (June-September) rainfall of three regions (north, middle and south) of Gujarat using multiple regression technique. The monthly weather data of 30 years of Anand (1980-2009), 22 years (1987-2009) of Navsari and 27 years (1983-2009) of SK Nagar were used. The models were validated with independent data set of four year (2006-2009). The best models were selected based on higher R^2 and lower model error. Four models were obtained; 2 for Anand (middle Gujarat) and one each for SK Nagar (north Gujarat) and Navsari (south Gujarat). Different models explained 74 to 93% variability in seasonal rainfall with models error ranging between -2.5 to 5.1%. During the validation period the performance of model was quite satisfactory with model error ranging between -12.6 to 2.6%. All the models were used to predict the rainfall for 2010 season. Results suggested that the rainfall would be higher than the normal rainfall in all the three regions. Navsari (south Gujarat) is expected to receive 1529.0 mm (14.5% higher than the normal), Anand (middle Gujarat) is expected to get 1294.0 to 1363.0 mm (62-71% higher) and SK Nagar (north Gujarat) is expected to receive 770.0 mm (40% above normal) rainfall during June to September period of year 2010.

Key words: Rainfall prediction, monsoon rainfall, seasonal, regression model

Micro-level spatial variability and temporal trends in reference evapotranspiration (ET_o) at a semi-arid tropical station

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ABSTRACT

Micro-level spatial variability and temporal trends in annual and seasonal (weeks 23-39) reference evapotranspiration (ET_o) were analyzed across three locations in Hyderabad. The mean ET_o was highest (1694.2 mm) at ICRISAT and lowest (1489.0 mm) at Rajendranagar. It was 1555.7 mm at Hayathnagar. The coefficient of variability (C.V.) ranged between 6.8 to 8.7 % for annual and 8.3 to 12.3 % for seasonal ET_o. The non-parametric (Mann-Kendall's 'δ') test showed significant decreasing trend across all three locations in Hyderabad on annual as well as on seasonal ET_o basis. Parametric 't' test confirmed this as it brought out that the difference in mean reference evapotranspiration during 1975-1992 and 1993-2009 were highly significant (P=0.01) on annual basis and significant (P=0.05) on seasonal basis. The ET_o on an average decreased between 9-10 mm per annum on yearly basis and between 1.9 to 3.1 mm per annum on seasonal basis during the period of analysis (1975-2009) at these three locations. The trends in governing weather parameters were also analyzed. The wind speed was the major parameter that showed significant decreasing trend both on annual and seasonal basis. Sunshine hours also showed significant decreasing trend on annual basis across all locations.

Key words: Variability, trends, reference evapotranspiration

Sensitivity of CERES-Rice model to different environmental parameters on the productivity of aromatic rice in middle Gujarat

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ABSTRACT

The present investigation was carried out during *kharif* season of 2007 and 2008 to develop genetic coefficients of four different genotypes of aromatic rice (cv. Pankhali, Narmada, GR-104 and Pusa Basmati-1) transplanted on three different dates viz., D₁ (8th July), D₂ (22nd July) and D₃ (8th August). The sensitivity analysis of CERES-Rice model with respect to different scenarios of duration of photoperiods, solar radiation, CO₂ concentration, maximum and minimum temperatures were carried out. The simulated grain yield increased linearly with incremental unit increase in day length, solar radiation, reduction of maximum temperature and vice versa. Simulated grain yields increased up to 27.9% under elevated scenarios of CO₂ from 380 to 410 ppm by the model. Large yield reductions were observed on decreasing plant population. However, model did not show any significant change due to increase in the plant population. The model was found enough sensitive to account for the effects of transplant age of seedlings on simulated grain yield in comparison with the base yield.

Key words: CERES-Rice, genetic coefficient, aromatic rice genotypes, transplanting dates, sensitivity analysis.

Effect of thermal stress on wheat productivity in West Bengal

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ABSTRACT

An experiment was carried out during winter seasons of 2005-06, 2006-07 and 2007-08 at the Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India with five wheat varieties (PBW 343, HD2733, HW 2045, PBW533 and K9107) on three dates of sowing (18th November, 3rd December and 18th December) in a split plot design, keeping dates of sowing in the main plot and varieties in the subplot with the objective to find out the effect of temperature change on the duration of different phenophases of wheat crop and its productivity. The phenophases (CRI, tillering, flowering and milk) were delineated and the duration of exposure of the crop to higher maximum and minimum temperature than the normal and extent of high temperature were worked out. The 18th November sown crop had to tolerate a higher maximum and minimum temperature than their normal to the tune of 2° and 3.5°C respectively. When the sowing was delayed the crop was exposed to more maximum and minimum temperature than the earlier sown crops. On second date, the crop had to tolerate a 3.9 and 5.3°C more maximum and minimum temperatures than their normal values. The December sown crop was also exposed to higher maximum and minimum temperature than the normal values. Ear weight at the milk stage could be significantly explained through the variation in cumulative maximum as well as minimum temperatures at the flowering stage. The cumulative maximum temperature (as predictor) explained 20% variation in ear weight at the milk stage whereas 15% variation was explained through the cumulative minimum temperature for the same phenophase. The cumulative minimum temperature at the flowering stage explained 20% variation in LAI significantly.

Key words: Minimum and maximum temperature, phenophase, leaf area index, ear weight, wheat

Crop weather model for sustainable groundnut production under dry land condition

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ABSTRACT

A crop weather model to predict the growth and pod yield of groundnut based on the dry matter accumulation at each growth stages has been developed. The multiple linear regression equations relating to GDD, SSH and AET with the accumulated dry matter production during each growth stage and also the final pod yield of kharif crop were generated by using the field experimental data for the period of 2000-2008. The coefficient of determinants indicate that the climatic parameters and the initial TDM used to estimate the final TDM in each stage and could be able to predict an extent of 77 to 98 per cent (coefficients of determinants) in different growth stages. Comparison of the observed and the predicted yields indicates the close agreement between them in all the stages. Considering the observed TDM up to the first four stages and predicted the Total Dry Matter at the harvesting stage. The model has been validated for the year 2009, and there is a good agreement between the observed and the predicted crop yield. The favorable influence of AET at the beginning of peg initiation and peg formation stage, and higher GDD during pod formation and harvest stages were noticed. The increase in AET during pod filling stage did not favor to the pod yield.

Key words: SSH, AET, GDD, dry matter multiple linear regression, groundnut

Assessment of seasonal efficacy of different evaporation retardants in semi-arid tropics

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ABSTRACT

An experiment was conducted in 2007-08 at Arjia, Rajasthan to evaluate the efficacies of different evaporation retardants viz., Maize stover (6 kg m⁻²), Burnt oil (2 mm thick film), Poly film (50 micron), Cetyly alcohol (2.2 kg ha⁻¹) and Control in reducing evaporation from surface of water bodies. Results revealed that there was significant relation between evaporation retardants and control treatments in pre-monsoon, monsoon and post-monsoon seasons. Due to application of different evaporation suppressants, on an average, maize stover resulted in lowest evaporation of 2.75 mm day⁻¹, followed by poly film (2.94 mm day⁻¹) and burnt oil (3.89 mm day⁻¹). As compared to control, cetyly alcohol as surfactant resulted in the lowest mean reduction (31.3%) in evaporation. On an average, the maize stover caused mean reductions in evaporation to the tunes of 59 and 58% over different seasons in comparison with open pan evaporation and control treatments, respectively. Thus it is concluded that application of maize stover is proved to be the most effective method for suppression of evaporation from free-water surfaces.

Key words: Seasonal efficacy, evaporation retardants, poly films, maize stover, correlation

Utilization of high resolution short range weather forecast for agro advisory services

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ABSTRACT

Agriculture is heavily weather dependent in India. The economy of the country is largely synchronized to the success of agriculture every year, as it contributes nearly 25% to gross domestic product (GDP). Farming community, planners and line department people always look forward to the accurate forecast from the weather men for decision making process in the event of natural disturbances. The district level agro advisories provided by IMD using medium range forecast (3-10 days) are good but covering large area. The advent of mesoscale model (Mesoscale Model (MM5) & *Weather Research and Forecasting* (WRF) etc) with high resolution (available at 9×9 sq km or below) enable the weathermen to give forecasts at village level and also location specific. This requires verification before value addition to it. Mesoscale model forecast data at 9×9 sq km grid have been generated by Department of meteorology and oceanography, Andhra University was collected for verification over Andhra Pradesh. The verification skill scores, ratio scores, correlation coefficient and RMSE have been analyzed. Majority of the stations are showing good correlation for maximum and minimum temperature and relative humidity, where as rainfall forecast have desirable skill scores for most of the stations.

Key words : MM5, WRF, short range weather forecast agro advisory services.

Modulation of wild marigold (*Tagetes minuta* L.) phenophases towards the varying temperature regimes – a field study

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ABSTRACT

Field experiments were conducted during 2007 and 2008 at experimental farm of Institute of Himalayan Bioresource Technology, (CSIR) Palampur (HP), India to study the performance of wild marigold (*Tagetes minuta*) under changing temperature regimes over the crop growth period. The established agroclimatic indices for temperature studied elsewhere in the domain viz., relative temperature disparity (RTD), growing degree days (GDD), heliothermal units (HTU) and photothermal units (PTU) were computed for different varied dates of sowing the crop. Distinct changes in weather parameters concomitant to different sowing time consequently caused significant variation in the performance of the crop. The results indicated that the early sown crop had longest crop span (224 days) than the late sown crop (102 days), from sowing to harvesting. The mean GDD accumulation from sowing to harvest ranged from 1378 to 2518°C days HTU from 6781 to 15706°C days hour and PTU from 17400 to 33052°C days hour. Total biomass, and content and yield of essential oil were correlated with different heat units calculated during the crop growth seasons. All the agroclimatic indices had positive correlations with biomass, oil content and oil yield. Thus, these indices seem to be effective in taking into account and expressing the effect of varying ambient temperature on the duration between the phenological events for comparing the crop response to the ambient temperature between different phenological stages.

Keywords : Wild marigold, temperature, photoperiod, GDD, PTU, HTU.

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Agrometeorological indices in relation to phenology of aerobic rice

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ABSTRACT

Field experiment was conducted during *kharif* seasons of 2003 and 2004 at College farm, College of Agriculture, Rajendranagar, Hyderabad to study the phenology and, heat and radiation use efficiency in aerobic rice. Crop was sown on four different dates viz., 16 June, 26 June, 07 July and 18 July as main plots and two varieties viz., Jagtiala Sannalu and Polasa Prabha as sub-plots in split plot design and replicated thrice. Results revealed that, from emergence to physiological maturity, Jagtiala Sannalu has accumulated mean growing degree days of 2017 ± 55 and heliothermal units of 11526 ± 817 with coefficient of variation of 3% and 7%, respectively. While Polasa Prabha has accumulated 2102 ± 33 mean growing degree days and 12031 ± 716 heliothermal units from emergence to physiological maturity with coefficient of variation of 2 % and 6%, respectively. In both the cultivars i.e., Jagtiala Sannalu and Polasa Prabha higher heat use efficiency (6.61 and 6.29), heliothermal use efficiency (1.30 and 1.19) and radiation use efficiency (6.28 and 5.88) were obtained in crop sown on 16 June. In Jagtiala Sannalu and Polasa Prabha, physiological maturity can be predicted using AGDD HTU which accounted for 84% and 86% variability.

Key words: Aerobic rice, GDD, Phenology, HUE, RUE

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Short communication

Rainfall probability modeling for Chandrabanda area of Raichur, Karnataka (India)

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Short Communication

Onset, end and duration of rainy season in two districts of North Bihar

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Short Communication

Influence of environmental factors on spawn run and biological efficiency of *Pleurotus* species

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Short communication

Extreme temperature events over Kullu Valley

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Short communication

Development of crop coefficient curves for different growth periods of *kharif* groundnut

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Short communication

Rainfall probability analysis for different agroclimatic zones of Bihar

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Short communication

Weekly, monthly and seasonal rainfall at Bengaluru in Karnataka

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Short communication

Annual and seasonal rainfall variability in coastal district of Karnataka

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Short communication

Weekly rainfall for crop planning in northern coastal region of Goa

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