INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

BENGALURU

EVALUATION OF RKVY PROJECTS

OF

UNIVERSITY OF AGRICULTURAL SCIENCES,

RAICHUR

"CLIMATE CHANGE AND ITS EFFECT ON IMPORTANT AGRICULTURAL CROPS OF HYDERABAD KARNATAKA REGION"

INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

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EXECUTIVE SUMMARY

The intensified human activities globally have resulted in the use of natural resources which has contributed significantly to the global warming (climate change). Global warming lead to the increase in the concentration of greenhouse gases, namely carbon dioxide, methane, chlorofluorocarbons and nitrous oxide in the atmosphere. On the basis of the increase of these greenhouse gases, climatic models predict a 1.4 ^{o}C to 5.8 ^{o}C average increase in global warming from 1990 to 2100, probably leading to a more rapid increase in temperature at the surface of terrestrial zones and more extreme local variations. Even if the annual flow of emissions did not increase beyond today's rate, the stock of greenhouse gases in the atmosphere would reach double preindustrial levels or 550 ppm CO_2 by 2050 and would continue growing thereafter (Bharath Kumar Neelaboina et al, 2018).

Agriculture is essentially a man-made adjunct to natural ecosystems and is weather and climate dependent. It is also a significant source of anthropogenic emissions of greenhouse gases. Global agricultural reforms are required to deliver the three essential policy objectives of energy, food security and poverty alleviation. Agriculture sector is most vulnerable to climate change due to its high dependence on climate and weather and because people involved in agriculture tend to be poorer compared with urban residents. More than 58 per cent of the population is directly or indirectly relying on agriculture as a source of livelihood in India. Indian agriculture sector is already facing many problems relating to sustainability. Consistent warming trends and more frequent and intense extreme weather events such as droughts, cyclones and hailstorms have been observed across Asia and the Pacific in recent decades (Rohitashw Kumar and Harender Raj Gautam 2014). Indeed, northern parts of Karnatakaare also subjected to such vagaries of climate.

Agriculture is identified within the Convention as particularly vulnerable and particularly critical in terms of global impacts. Agriculture and its allied sectors will inevitably face challenges caused by climate change in future which might lead to both global and local alteration. Enriched atmospheric carbon dioxide (CO_2) and temperature can have various effects at different tropic levels in ecosystems (plants, herbivores, predators and parasitoids).

Indian agriculture faces the dual challenge of feeding a billion people in a changing climatic and economic scenario. Even it is the main source of livelihood for almost 60% of the country's total population. The impacts of climate change on agriculture will be severely felt in India. It has been projected that under the scenario of a 2.5°C to 4.9°C temperature rise, rice yields will drop by 32%-40% and wheat yields by 41%-52% (Anupam Khajuria and N.H. Ravindranath, 2012). This would cause GDP to fall by 1.8%-3.4%. Agricultural productivity is sensitive in two broad classes of climate-induced effects (a) direct effects from changes in temperature, precipitation, or carbon dioxide concentrations and (b) indirect effects through changes in soil moisture and the distribution and frequency of infestation by pests and diseases.

It is against this background, the present project of **"CLIMATE CHANGE AND ITS EFFECT ON IMPORTANT AGRICULTURAL CROPS OF HYDERABAD KARNATAKA REGION"** has been taken up by University of Agricultural Sciences, Raichur at Centre of Agro-climatic studies, College of Agriculture, Raichur. The project was implemented from 2012-13 to 2014-15. The details of the project are as under:

1.	**Title of Project**	**:**	**"CLIMATE CHANGE AND ITS EFFECT ON IMPORTANT AGRICULTURAL CROPS OF HYDERABAD KARNATAKA REGION"**
2.	**Nodal officer and Principal Investigator**	**:**	**Dr. A. G. Sreenivas,** Professor of Entomology and Project Leader on Climate Change, College of Agriculture, University of Agricultural Sciences, Raichur
3.	**Implementing Institution (S) and other collaborating Institution (s)**	**:**	Centre of Agro-climatic studies, College of Agriculture, Raichur
4.	**Date of commencement of Project**	**:**	2012-13
5.	**Approved date of completion**	**:**	2014-15
6.	**Actual date of completion**	**:**	2014-15
7.	**Project cost**	**:**	Rs. 50 lakhs

The objectives of the study are:

1. Collection, compilation, archival and characterization of historical weather parameters of Hyderabad Karnataka Region.
2. To downsize the regional climate change scenarios to local level at a higher resolution of about 50 km on spatial scale as well as daily resolution on temporal scale.

3. To identify and evaluate vulnerable components of various agricultural systems including pests and diseases, and to develop resource management strategies to mitigate climate change impacts.
4. To disseminate the available technologies to the farmers and planners on real time basis through effective communication networking on the adverse effects of climate towards improving the socio-economic status.
5. To identify and develop crop genotypes adaptable to climate change scenarios by utilizing available genetic resources/land races and crop growth simulation models.
6. To develop weather and climate based agro-advisories through GIS medium.

The focus of Evaluation is:

1. to understand the past trends and variability in rainfall, minimum and maximum temperature in Hyderabad Karnataka since the knowledge on the past could provide guidance for the future and also to downsize the regional climate change scenarios to local level at a higher resolution of about 50 km on spatial scale as well as daily resolution on temporal scale..
2. To assess whether vulnerable components of crop growth for adaptation to climate change have been identified for analysis of vulnerability in the face of current climate variability.
3. To examine whether farmers are educated on the resource management strategies to mitigate the effect of vulnerable components on real time basis through effective communication networking besides developing required genotypes to meet the requirements of climate change.

FINDINGS

The focus of Evaluation was to understand the past trends and variability in rainfall, minimum and maximum temperature in Hyderabad Karnataka since the knowledge on the past could provide guidance for the future. However, no serious efforts appear to have been made to understand the past trends and variability in rainfall and temperature. A summary of the past trends as indicated in the report mentions that in the new millennium, Northern Karnataka has faced successive drought years and has also been at the receiving end of many extreme climatic situations, particularly high maximum temperatures in 2004 (more than 40 oC for 10 days during March 2004), lower minimum temperatures in 2007 (5.6 to 8.2oC from November 22-25, 2007), hail storms in 2005 (March 5, 2005), very heavy rainfall on 12th October 2009 (280 mm in Raichur and more in other areas) and unseasonal rains and cloudy conditions during April 2012 (more than 40 mm). The details are very sketchy and need more strengthening in data base.

The studies on crops have shown that, C3 crops like pigeon pea and Bt cotton and C4 crop like maize showed good response to climate change in terms of more growth, yield and yield parameters. However, C3 crops were more benefitted by enriched CO_2.

Biochemically, nitrogen related compounds viz., leaf nitrogen, proteins, amino acids, pigments have decreased while, and the carbon related compounds viz., leaf carbon, C: N ratio, carbohydrates, fatty acids have increased. Hence, these crops may yield more in the changed climatic situations which might be beneficiary to the farmers. Never the less, the studies on insects has given evidence that, climate change in the form of increased CO_2 and temperature have substantial impact on host-herbivore interactions leading to risks of increase in population of some pests and need for management strategies to tackle the problem by breeding resistant genotypes and ensuring that these aberrations do not lead to reduction in crop yields. However, no attempts have been made in this direction.

Studies on climate change provides scientific evidence that, due to climate change, induced stress can alter the endotoxin expression in transgenic crops like Bt cotton (up to 25% and 10 % reduction in endotoxin produced by cry 1Ac and Cry 2Ab2 respectively). This might be one of the reasons for pink bollworm outburst in Bt cotton in recent years in the country. The study needs to be taken up in different regions of the agro climatic zone based on soil type.

In mulberry, the changes in phytochemistry altered the biology of silkworm which was evidenced by decrease in larval weight, increased larval duration, decrease in size, increased pupal duration, decreased cocoon shell, cocoon filament weight, filament length, ERR, productivity, denier in eCO_2 conditions. This shows that in addition to reduction in cocoon yield, there will be increase in rearing period and decrease in quality of cocoons and silk quality.

While all the studies in different crops have revealed impact of yield and quality parameters of different crops, the studies have not identified vulnerable components of climate change and suitable management strategies to mitigate their impact.

To disseminate the available technologies to the farmers and planners on real time basis through effective communication networking, the strategies mainly involved enrolling the farmers in the weather based Agro-services and disseminating the knowledge of daily weather data. Six Automated Weather Stations were installed at all district headquarters of the Hyderabad Karnataka districts. Farmers from all the six districts were enrolled in the weather based Agro-services data base. Daily weather data of the respective districts was communicated to individual farmers of each district by SMS to their mobile phones. These services are reported to have helped to increase the knowledge of the farmers about the farming practices and also get real-time weather information to take up appropriate practices to increase yield and thus increase the monetary benefits. However, the impact of technologies need to be documented.

It is observed that the studies have not been able to identify vulnerable components so that suitable resource management strategies to mitigate the effect of vulnerable components could be developed. In the absence of the strategies to mitigate the effects of climate change, sharing the weather information on real time basis will not help the farmers to take up suitable remedial action to mitigate the impact of climate variability on crop growth. Strategies similar to contingent crop planning could have been developed to ensure that the climate variability does not impact the crop production. Simple strategies such as protective irrigation of crops under prolonged drought periods, sprinkler irrigation to reduce the ambient temperature could have been identified and communicated to farmers. While creation of a huge database of farmers in the Hyderabad Karnataka Area is a welcome and right step in educating the farmers, this database could have been used more effectively in educating the farmers in the area.

REFLECTIONS AND CONCLUSIONS

1. The topic selected for the study is highly relevant to the present-day problems being encountered by farmers in improving their income.
2. The outcome of the project is highly scientific and valuable. However, there is need for convergence of more departments in decision support system as climate change impacts various crop production activities.
3. Good number of technical papers have been published in answering some of the scientific reasons for findings specially in Indian dynamics. The scientists need to be complemented.
4. The study could have made a detailed analysis of past trends in climate variability and made detailed projections on crop production based on future climate variability projections.
5. The study could not downsize the regional climate change scenarios to local level at a higher resolution of about 50 km on spatial scale as well as daily resolution on temporal scale. This could have given a better understanding of the climate variability and helped in development of suitable resource management strategies to mitigate the effects of such variability and also to assess the impact of future projected climate variability and its impact of crop production so that suitable action plan could have been put in place to mitigate its impact.
6. While all the studies in different crops have revealed impact of yield and quality parameters of different crops, the studies have not identified vulnerable components of climate change and suitable management strategies to mitigate their impact.
7. More emphasis should be on C_4 plants response to elevated CO_2 concentration and temperature.

8. There is need for streamlining research in the area of water management and rainfed agriculture more so on climatic variability which is having impact on climate as well as humans.
9. While creation of a huge database of farmers in the Hyderabad Karnataka Area is a welcome and right step in educating the farmers, this database could have been used more effectively in educating the farmers in the area. In the absence of the strategies to mitigate the effects of climate change, sharing the weather information on real time basis will not help the farmers to take up suitable remedial action to mitigate the impact of climate variability on crop growth.
10. Economic impact on crop loss and quality are missing.

ACTION POINTS

1. The topic selected for the study is highly relevant to the present-day problems being encountered by farmers in improving their income. The study could have made a detailed analysis of past trends in climate variability and made detailed projections on crop production based on future climate variability projections. There is need to downsize the regional climate change scenarios to local level to have a better understanding of the climate variability and help in development of suitable resource management strategies to mitigate the effects of such variability. Besides, preparation of vulnerability area index is needed.
2. The outcome of the project is highly scientific and valuable. However, there is need for convergence of more departments in decision support system as climate change impacts various crop production activities.
3. Good number of technical papers have been published in answering some of the scientific reasonings of findings specially in Indian dynamics. The scientists need to be complemented.
4. There is need to identify and evaluate critical vulnerable components of various agricultural systems including pests and diseases, and to develop resource management strategies to mitigate climate change impacts.
5. The observations that induced stress on account of climate change can alter the endotoxin expression in transgenic crops like Bt cotton (up to 25% and 10 % reduction in endotoxin produced by cry 1Ac and Cry 2Ab2 respectively) which might be one of the reasons for pink bollworm outburst in Bt cotton in recent years in the country needs to be validated by a systematic study.
6. While creation of a huge database of farmers in the Hyderabad Karnataka Area is a welcome and right step in educating the farmers, this database could have been used more effectively in educating the farmers in the area by sharing the strategies to mitigate the effects of climate change.
7. Mating Disruption Techniques to control Pink Bollworm infestation in cotton and Direct Seeded Rice technology to save water and reduce methane generation

should be validated and encouraged in all intensive cropping areas of the State, more so in northern parts of Karnataka .

8. There is need for streamlining of research in the area of water management and rainfed agriculture more so on climatic aridity which is having impact on climate as well as humans.
9. Crop diversification in rainfed area and their responses to climate change is needed. Besides, dynamics of soil health status needs to be studied under increased temperature and rainfall distribution through multi-disciplinary approach.

RESEARCHABLE ISSUES

1. Need for research on climate policy on land use changes and long term impact on sustainability of production systems in terms of nutritional quality and economics.
2. Contingent crop planning through diversified farming systems/ cropping systems for climatic aberrations through multi-disciplinary approach.
3. Standardization of agronomic practices for climatic aberrations.
4. Strengthening of breeding strategy for short duration pulses to meet the climatic variations with special reference to biotic and abiotic factors.
5. Documentation of incidence of insect pests and diseases with reference to climatic variations and soil nutritional status.
6. Creation of carbon sink in campus by students.