# EXECUTIVE SUMMARY

Climate change, during the recent times, has become a global concern demanding attention and action due to the rising global temperatures, widespread melting of ice, changes in the intensity and frequency of occurrence of extreme events. In a densely populated country like India, particularly the effects of climate change are more detrimental in view of its highly vulnerable nature.

In order to minimize the negative effects of climate change, the focus from yield intensification was switched over to the adaptation to climate change. Practices which could enhance resilience by reducing the vulnerabilities are the best adaptation options available. In this scenario, it has become imperative to take action in encouraging the farmers to adopt the Climate Resilient Agricultural (CRA) technologies.

In view of the increased importance to address the development needs of highly vulnerable populations of the country, Indian Council of Agricultural Research (ICAR) has launched a major network project on February, 2011 *i.e.,* National Initiative on Climate Resilient Agriculture later renamed as National Innovations in Climate Resilient Agriculture (NICRA). It has paved the way to impart climate resilience in its project villages through various intervention modules *viz.,* Natural Resource Management (NRM), crop production, livestock & fodder production and institutional interventions amidst unanticipated climatic disturbances. But, the extent to which these CRA technologies are perceived to be effective by the farmers further decides the successful diffusion of these technologies in the social system.

In the above context, the present study on the effectiveness of climate resilient agricultural technologies as perceived by the farmers was undertaken with the following specific objectives.

## 1. OBJECTIVES OF THE STUDY

1. To analyse the climatic variability of Nalgonda district
2. To document various climate resilient initiatives by the farmers
3. To assess the effectiveness of Climate Resilient Agricultural (CRA) technologies as perceived by farmers
4. To identify the constraints faced by the farmers and suggest suitable strategies for effective adoption of CRA technologies

## 2. METHODOLOGY

The present study has adopted *ex-post facto* research design. Nalgonda district of Telangana State was selected purposively, as it is one among the 100 districts selected for the project implementation across the country with high climatic vulnerabilities *viz.,* drought proneness, heat stress, mid and terminal dry spells etc. Three villages namely Nandyalagudem, Boring thanda and Kotha thanda of Athmakur (S) Mandal in Nalgonda district were selected purposively as the NICRA interventions are being implemented in these villages. A sample size of 40 farmers were selected at random from each village thus comprising a total sample size of 120 respondents.

## 3. SALIENT FINDINGS

### 3.1 Profile characteristics of the respondents

- More than half of the respondents (54.2%) belonged to middle age category of 36-60 years followed by young age (28.3%) of below 35 years' age and old age (17.5%) of above 60 years.
- More than one-third (38.3%) of the farmers were found to be illiterate, 23.3 per cent had secondary education, 13.3 per cent higher secondary education, 12.6 per cent had primary education, 9.2 per cent had graduation and above, while 3.3 per cent of the farmers were functionally literate even without formal education. However, it was encouraging to note that more than 60 per cent of the respondents can read and write.
- More than three-fourth of the respondents were found to have a medium family size comprising 4-7 members.
- Nearly half of the respondents (48.3%) were found to have medium level of farming experience of 19-34 years followed by low farming experience (35%) of 2-18 years.
- Nearly two-fifth (38.3 %) of the respondents were found to have semi-medium farm holding size followed by more than one-fourth (27.6 %) of the respondents with small farm size. Whereas, a minimal 3.3 per cent of respondents were found to be holding large farm size.
- Nearly one-thirds of the respondents (30%) had either open well or bore well along with canal as the source of irrigation followed by both open and bore well (26.7%), bore well only (23.3%) and open well only (20%).

- Nearly two-third (38.3%) of the respondents were found to have medium annual income level whereas, around one-fourth (26.7%) of the respondents were found to have low level of annual income.
- Around three-fifth of the respondents (58.3%) were found to possess medium level of innovativeness followed by 29.2 per cent and 12.5 per cent of the respondents possessed high and low levels of innovativeness respectively.
- More than half of the respondents (55%) were found to have higher information seeking behavior whereas 35 per cent and 10 per cent of the respondents had medium and low levels of information seeking behavior respectively.
- Nearly two-fifth of the respondents were found to possess medium risk taking ability, whereas around 30 per cent of the respondents were found to possess high and low levels of risk taking ability under each category.
- More than half of the respondents (52.5%) were found to have average level of decision making behaviour, whereas more than one-fourth of the respondents (26.7%) possessed poor decision making behavior followed by one-fifth of the respondents (20.8%) with good decision making behavior.
- More than one- third of the respondents (38.33 %) were found to have membership in one organization and no membership in any organization (37%) followed by financial contribution for common work (19.17%).
- More than three-fifth (62.5%) of the respondents were found to possess high levels of achievement motivation, whereas around one-fourth (25.8%) of the respondents possessed medium levels of achievement motivation.
- Most of the farmers (42.5%) were found to fall in the category of medium WBAAS, whereas 36.7 per cent of the respondents were in low followed by one-fifth of the respondents in high WBAAS category.
- Majority of the respondents (64.2%) were found to have higher scientific orientation followed by 22.5 and 13.3 per cent of the respondents had medium and low scientific orientation respectively.

### 3.2 Climatic variability of Nalgonda district

- From the monthly seasonal rainfall variability of the Nalgonda district in the past three decades (1988-1997, 1998-2007, 2008-2017), it can be deduced that the recent decade has seen a steady increase in seasonal rainfall in nearly all the months compared to earlier two decades. However, this positive effect was contested by the least consistency

in rainfall during the recent decade, which shown the highest coefficient of variation of 29.03 per cent as compared to the past two decades. The results clearly indicated that, there was an obvious decadal change in rainfall trend.

- The September month was found to be the highest rainfall receiving month with respect to its median value. The risk of recording low rainfall was more as compared to August and July months.
- The coefficient of variation (2.38%) of the third decade (2008-2017) was higher than the first decade (2.24%), second decade (0.99%) and 30 years mean maximum temperature (1.96%) indicating the higher fluctuations in the maximum temperatures during the recent decade.
- A clear depiction of fall in the minimum temperatures in all the months from June to September was observed during the second decade (1998-2007) followed by a sharp rise in the third decade (2008-2017).
- The coefficient of variation of the first decade (3.41%) was very high than the second decade (1.68%), third decade (1.69%) and 30 years mean minimum temperature (2.54%) indicating higher fluctuations in the minimum temperatures during the first decade.
- The rainfall and rice crop yield during third decade (2008-2017) were found have positive significant association in September month and negative association in October month.
- The maximum temperatures of October and November months have shown significant negative association with the lint yields of cotton may be due to affected boll retention and enhanced abortion of squares and young bolls.
- The major finding realized was, there exists climatic variability and change in Nalgonda district and has significant effects on the crop yields of the district. Hence, providing assistance to the farmers for enhancing their preparedness to climatic aberrations by upscaling climate resilient technologies is need of the hour.

### 3.3 Documentation of climate resilient initiatives by the farmers

- In the category of weather forecasting practices, majority (91.67 %) of the respondents believed that if a severe hot summer is observed, then the upcoming rainy season would see heavy rains which helped them in planning their crop based on the expected amount of rainfall they may receive for the upcoming season. It is followed by 87.5 per cent of the farmers who were found to follow the practice of expecting a severe rainfall, if the

frogs in wells and ponds croaks loudly and in chorus and 85.83 per cent of farmers who observe the winds which blows from east to west (utthara gali) and understand the possibility of rainfall in few days which helps them in planning their sowing dates.

- In the category of soil, water and nutrient management, majority (82.50 %) of the farmers followed application of FYM (Farm Yard Manure) the crops to improve the fertility and water holding capacity of soil followed by 81.67 per cent of farmers practiced incorporation of crop residues into the soil and 79.17 per cent practice deep summer ploughing in order to prepare for unforeseen drought conditions.
- In the category of plant protection, majority (62.51 %) of the farmers used scary and reflecting structures in fields to scare the birds and protect from their attack followed by 44.16 per cent of the farmers practiced growing trap crops *viz.*, marigold in chilli, bhendi crop in cotton.
- In the storage practices category, majority (15 %) of the farmers followed the use of kuthir or huge ranjans (gummi) for storing food grains in their houses.

**3.4 Effectiveness of Climate Resilient Agriculture (CRA) technologies as perceived by farmers**

- The ranks assigned based on the mean scores to each technology under the NRM module revealed that renovation and/or use of farm ponds was highly adopted (I Rank) followed by soil test based fertilizer application (II Rank) and *in-situ* moisture conservation practices in crops *viz.*, cotton and red gram (III Rank).
- Under the module of crop production, majority of the farmers had fully adopted the introduction and raising of medium duration varieties in red gram *viz.*, LRG-52 (I Rank) followed by installation of sticky traps in cotton (II Rank) to protect the crop from sucking pest attack and cotton + red gram (6:1) inter cropping system (III Rank).
- Under livestock and fodder production, majority of the farmers had highly adopted preventive vaccination in livestock to protect from diseases (I Rank) followed by de-worming in livestock (II Rank) and popularization of backyard poultry (III Rank).
- In the module of institutional interventions, utilization of Custom Hiring Center (CHC) for timely field operations (I Rank) was highly adopted as it saved upto 80 per cent of field costs and enabled timely field operations followed by partial adoption of village seed bank/ fodder bank (II Rank) and low adoption of gaining climate literacy through village weather station (III Rank).

- Nearly two-fifth (39.17%) of the respondents were found to have high level of adoption of CRA technologies, whereas one- fourth (25.84%) of the respondents with medium extent of adoption followed by one-fifth (20%) of the respondents with very high level of adoption.
- Majority of the respondents (30.84%) in the selected NICRA villages were found to have medium level of exposure whereas 27.5 per cent had low exposure, 18.33 per cent had very low, 15 per cent had high exposure and 8.33 per cent had very high levels of exposure towards climate related stimuli.
- Majority of the respondents (30%) had low sensitivity, whereas 27.5 per cent medium sensitivity followed by 21.67 per cent very low and around 10.5 per cent each in high and very high categories of sensitivity.
- Nearly one-third (31.67%) of the respondents had medium level of adaptive capacity followed by very high level (29.17%) of adaptive capacity. Whereas, 18.33, 11.67 and 9.17 per cent of the respondents had high, low and very low levels of adaptive capacities respectively.
- More than one-third (36.67%) of the respondents had perceived the sustainability of CRA technologies to be very high whereas one-fourth (25.83%) of the respondents' had medium followed by 15.83 percent of the respondents perceived high sustainability.
- Majority of the respondents (35.83%) had perceived the CRA technologies as medium effective followed by very highly effective (29.17%), highly (19.17%), very less (12.5%) and less effective (3.33%).
- The profile characteristics *viz.*, education, farm size, annual income, innovativeness, information seeking behavior, achievement motivation, scientific orientation were found to have positive and significant association at one per cent level with the effectiveness of CRA technologies as perceived by the farmers.
- The profile characteristics of the farmers *viz.*, risk taking ability, decision making behaviour, sociopolitical participation, WBAAS were found to have positive and significant association with the effectiveness of CRA technologies as perceived by the farmers at five per cent level of significance.
- The results of multiple linear regression revealed that the characteristics *viz.*, education, farm size, innovativeness, information seeking behavior, achievement motivation and scientific orientation were found to be positively and significantly contributing at one per cent level.

- Multiple linear regression results revealed that the characteristics *viz.,* annual income, risk taking ability, decision making behaviour and WBAAS were found to be significantly contributing at five per cent level to the effectiveness of CRA technologies as perceived by the farmers.
- The $R^2$ value of the multiple linear regression analysis results pointed out that all the 16 variables had contributed to the tune of 76.90 per cent of variation in the perceived effectiveness of CRA technologies by the farmers.

**3.5 Constraints faced by the farmers in the adoption of CRA technologies**

- Under the category of technical constraints, the major constraints elicited by the farmers were poor maintenance & unavailability of implements in custom hiring centers at times of high demand, which was ranked first followed by poor availability of required agri-inputs and unpredictability and uneven rainfall ranked second and third respectively.
- In the category of labour and financial constraints, the major constraints faced by farmers were scarcity and high cost of labour, which was ranked first followed by inadequate financial support and low annual income ranked second and third respectively.
- The major constraints faced by the farmers under the category of personal and social constraints were lack of regular meetings by the community members, which was ranked first followed by poor coordination and reluctance to share ideas among the members of the community and incapability to wait for longer duration to get positive returns from adopted interventions were ranked second and third respectively.
- Under the category of others or situational constraints, the major constraints elicited by the farmers were lack of possible reach out and render services to all the farmers in peak season by the officials was ranked first, whereas insufficient number of need based trainings on CRA technologies and lack of support from line departments were ranked second and third respectively.

**3.6 Strategies for effective adoption of CRA technologies by the farmers**

- NICRA may focus on creating awareness among the farmers on monthly climatic variability pattern, climate change and the resilient practices to be followed to overcome it.

- Most of the farmers were found to be facing the problems of technical assistance which is needed to be addressed through increased training programmes, field trips, etc., in all the adopted villages.
- As majority of the farmers belong to semi-medium and small size land holdings, the CRA technologies developed should be of low cost, user friendly and compatible to increase the rate of adoption.
- The high levels of achievement motivation, risk taking ability and scientific orientation of the farmers can be best utilized by encouraging them towards taking up organic farming, floriculture, poultry, dairy enterprises etc.
- The escalation and improvement in the services provided by the CHC is necessary by systematic maintenance, increase in available number of units of existing machinery and addition of new machinery like ridge and furrow maker, tractor to enable ease in use of heavy equipment, combined harvester etc., which are required by the farmers.
- The maintenance and provision of equipment and management of CHC can be promoted by partnering with private companies under corporate social responsibility or other voluntary organizations.
- The farmers were found to be lacking in use of WBAAS, which can be addressed by integration of mass media, information communication technology and other new applications through which the farmers can gain information regarding the weather and plan their activities. Also, farmers can make better decisions on market and adopt new technologies.
- The officials may strive to network all the NICRA group farmers and instill team spirit among members to share any valuable information on climate resilient agricultural technologies to derive maximum benefit.
- Research should be location specific and need based in order to bring out effective technologies.
- Participatory research is to be taken up to validate the weather forecasting ITKs followed by the farmers and integrate them along with WBAAS for enhanced diffusion in the system.
- The documented and validated ITKs may be diffused to other villages with similar climate setting and socio-economic background.
- Provision of financial support to the farmers can empower them to take up new technologies, strengthen the functioning of CHC, fodder and seed banks.

- Convergence of line departments *viz.*, agriculture, horticulture, veterinary with NICRA.
- The farmers could be encouraged to take up community initiated activities, form commodity interest groups which can create a positive atmosphere of knowledge sharing among the farmers.
- Poor marketing facilities were observed to be the major problem faced by the farmers, which could be addressed by taking necessary actions to provide better marketing opportunities through organized markets which enable direct sale of produce to consumer.
- As the potential market for organic fruits and vegetables is growing, NICRA can encourage farmers to go for organic production of fruits and vegetables.

## 4. IMPLICATIONS OF THE STUDY

- The detailed climatic variability analysis of the Nalgonda district could aid in preparing contingency plans specific to each month for various crops grown in the district and provide advisory support to the farmers accordingly.
- The findings of the study provide feedback to the institutions engaged in the dissemination of the CRA technologies under NICRA, which would help in further redesigning the interventions for improving its output and outcome keeping in view the existing climatic variability pattern of the district.
- The documented ITKs may be studied to determine their scientific rationality and effectiveness by the agricultural scientists.
- The methodology of the present investigation can be used for assessing the perceived effectiveness of CRA technologies in other parts of the country.
- The effectiveness index developed as a part of the present study will be useful to the researchers for developing similar other composite indices like resilience index of the stake holders.
- The present study could help the researchers in reproducing the models in other villages in a way that could increase the rate of adoption by managing the constraints faced by the farmers.
- The strategies suggested for enhancing the adoption of climate resilient agricultural technologies will help the researchers and the policy makers in devising suitable policy framework.

## 5. POINTS SUGGESTED FOR FUTURE RESEARCH

1. The study is restricted to one district in the Telangana state. Similar studies can be undertaken in other districts and other agro ecosystems in various states across the country in order to assess the effectiveness of CRA technologies.
2. The sample size may be increased and research area may be expanded by selecting more number of districts in order to generalize the results.
3. The validation of the documented ITK's, their importance and contribution towards achieving resilience among the farmers may be studied and similar research can be taken up at various other districts.
4. The future research studies may focus on analyzing the factors contributing towards resilience among the farmers towards climatic variability and change for the benefit of researchers and policy makers.