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Adaptation and mitigation measures for climate change by the dry land farmers

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ABSTRACT

Due to climate change, there was significant impact on agriculture and allied areas and led to biotic and abiotic stresses. The study focused on the analyzing the awareness of the dryland farmers on the climate change and also the extent of adoption of adaptation and mitigation measures for climate change. Study was conducted in Chittoor district of Andhra Pradesh with 120 dryland farmers by following appropriate sampling procedure. Structured schedules were prepared for both awareness and adoption of measures for climate change. There was 84.47 percent of awareness on climate related changes followed by 74.27 percent on crop related changes, 73.61 percent on animal husbandry related changes and 61.11 percent on soil& water related changes. The item wise analysis indicates that delayed onset of monsoon, rainfall, temperature, availability of ground water, pests & diseases, drought conditions were the major areas in which farmers were well aware. Increased crop weed competition, reduced quality of produce, Increase in disease transmission, Decreased fertilizer use efficiency were the areas where farmers were not well aware. Intercropping was ranked first in extent of adoption followed by alteration in sowing/ planting dates, micro irrigation systems, use of drought tolerant varieties and use of pest and disease resistant varieties, etc. Very meager percent adoption was observed for crop rotation, high yielding and drought resistant forage crops/varieties, integrated weed management practices, use of suitable breeds/varieties. Strategy consisting of ten broad areas was designed for achieving climate resilient agriculture in dry land areas.

KEY WORDS: Adoption, climate change, farmers, rainfed agriculture

INTRODUCTION

Climate is the determining factor for agriculture and it is the more vulnerable factor in dryland farming. Radical developments were made in agriculture to meet the rising demands for food grains and also towards achieving the economic growth of the country. With the use of the latest management practices in the area of nutrients, pests and diseases, irrigation water, weeds etc.., there was significant impact on climate and led to biotic and abiotic stresses on crops. Due to significant changes in climate during the past two decades noticed substantial affect on the agricultural production especially in dryland areas. It has been projected that a 2.5^0C to 4.9^0C temperature rise in India, will reduce the yields of different crops by 40 to 50%. This would cause GDP to fall by 1.8%-3.4% (GOI, 2011; Guiteras, 2007). In this context, the protection of natural resources became priority area for agricultural development. The technologies invented for higher

productivity succeeded in increasing the production of different crops. On the other side, there was remarkable change in the climate necessitated the stake holders of agricultural production to alter the production recommendations as per the changed climatic conditions.

Planned adaptation and mitigation measures are imperative to increase the resilience in dryland farming for climate change. Adaptive capacity of a farmer is determined by various factors including recognition of the need to adapt, his willingness to undertake adaptation, availability of the resources (Brown, 2010). Several improved agricultural practices particularly for dryland farming were evolved by the scientists for diverse agro-ecological situations. Keeping in view of the above concept, the present study was taken up with the following objectives

1. To analyse the dryland farmer's awareness about the consequences of four broad related areas of climate change viz. climate, soil& water, crop and animal husbandry.
2. To identify the extent of mitigation/ adaptation measures followed by the dryland farmers to meet the changing climatic conditions and
3. To design an appropriate strategy by involving all the stakeholders towards achieving climate resilient agriculture in dryland areas.

METHODOLOGY

The present study was conducted in Chittoor district of Andhra Pradesh which is having high dryland area coupled with diversified farming situations and farming systems with a blend of traditional and modern approaches in farm production. In the district, groundnut is the major crop grown under rainfed conditions. Dairy, sheep rearing were the potential allied occupations for the farmers. Four mandals were selected based on the highest rainfed area; three villages from each mandal were selected at random to form 12 villages for the study. Ten farmers from each village were selected by following simple random sampling procedure to form a sample of 120 farmers for the study as respondents.

Farmer's awareness about climate change was analysed through a schedule developed for the study consisting of 28 items and were grouped under four broad categories viz. climate, soil & water, crop and animal husbandry. Out of which, eight climate related, six soil& water related, eight crop related and six animal husbandry related items were included to measure the farmer's awareness about climate change. This was measured by following a scoring pattern of 'aware' – 1 and 'Not aware' – 0. Then the items were ranked based on the scores obtained.

A well structured schedule was developed consisting of twenty Adaptation/mitigation measures for Climate change and they were measured in terms their extent of adoption by the farmers by following a scoring pattern of 'adopted' – 1 and 'Not adopted' – 0. Then each Adaptation/mitigation measure for Climate change was ranked based on the scores obtained. Keeping in view of the farmer's awareness and also their extent of adaptation/mitigation measures for Climate change, an appropriate strategy was designed by involving all the stakeholders towards achieving climate resilient agriculture.

FINDINGS AND DISCUSSION

I. Farmers awareness on climate change

The extent of awareness of the dryland farmers on the climate change and

its impact on soil& water, crop and animal husbandry was presented in the table-1. The results revealed that, there was 84.47 percent of awareness on climate related changes followed by 74.27 percent of awareness on crop related changes, 73.61 percent of awareness on animal husbandry related changes and 61.11 percent of awareness on soil& water related changes. The above trend clearly indicates that, farmers are more aware on climate related changes followed by crop related, animal husbandry related and soil& water related changes.

As the climate change is more visible through the climatic aberrations in environment which is directly experienced by the farmers. The majority of the crop and animal husbandry related changes were been observed by farmers as they were regularly monitoring the growth and development over the period of time. On the other side, the soil& water related changes could not be properly observed by the farmers due to lack of technical competency by the farmers.

Under climate related changes; Fluctuations in onset of monsoons, Decrease in average rainfall, Increase in average temperature, Uneven distribution of rainfall, Increased frequency of heat waves, Long dry spells, Prolonged cold weather and Increase in maximum and minimum temperatures were in the order their extent of awareness by the farmers ranging from 91.66 percent to 70.00 percent. With regard to soil and water related changes; Depletion of ground water, Reduced soil fertility, Disturbed soil texture, Reduced water holding capacity, Reduced quality of water and Increased soil and water erosion were in the order their extent of awareness by the farmers ranging from 90.00 percent to 69.16 percent.

For crop related changes; Increased incidence of pests and diseases, Susceptibility of the crop for drought, Reduction in crop duration, Reduction in average productivity, Decreased fertilizer use efficiency, Increased water stress, Reduced quality of produce and Increased crop weed competition were in the order their extent of awareness by the farmers ranging from 90.83 percent to 60.00 percent. With regard to Animal Husbandry related changes; Low productivity of livestock, increased mortality, Susceptibility to pests and diseases, reduced milk/ meet yield, and Increase in disease transmission were in the order their extent of awareness by the farmers ranging from 80.00 percent to 67.50 percent.

The item wise analysis on the awareness of farmers on climate change indicates that delayed onset of monsoon, rainfall, temperature, availability of ground water, pests & diseases, drought conditions were been closely observed by the farmers than the other changes. This might have motivated them to take up adaptation/mitigation measures in tune with changed climatic conditions. The results are consistent with that of Kemausuor *et al.*, (2011) and Ravi Shankar *et al*., (2013).

Table 1: Extent of awareness on climate change

n=120

S. No	Climate changes	frequency	percent	rank	Category wise average percentage
I. Climate related					
1	Increase in average temperature	108	90.00	3	84.47
2	Decrease in average rainfall	109	90.83	2	
3	Long dry spells	97	80.80	6	
4	Fluctuations in onset of monsoons	110	91.66	1	
5	Uneven distribution of rainfall	101	84.16	4	
6	Increased frequency of heat waves	99	82.50	5	
7	Increase in maximum and minimum temperatures	84	70.00	8	
8	Prolonged cold weather	94	78.33	7	
II. Soil & water related					
9	Reduced soil fertility	94	78.33	2	61.11
10	Depletion of ground water	108	90.00	1	
11	Reduced quality of water	84	70.00	5	
12	Disturbed soil texture	90	75.00	3	
13	Increased soil and water erosion	83	69.16	6	
14	Reduced water holding capacity	89	74.16	4	
III. Crop related					
15	Reduction in crop duration	96	80.00	3	74.27
16	Increased incidence of pests and diseases	109	90.83	1	
17	Susceptibility of the crop for drought	101	84.16	2	
18	Decreased fertilizer use efficiency	82	68.33	5	
19	Increased crop weed competition	72	60.00	8	
20	Increased water stress	81	67.50	6	
21	Reduced quality of produce	79	65.83	7	
22	Reduction in average productivity	93	77.50	4	
IV. Animal Husbandry related					
23	Low productivity of livestock	96	80.00	1	73.61
24	Increase in disease transmission	81	67.50	6	
25	Increased mortality	96	80.00	1	
26	Reduced quality and quantity of forage production	82	68.33	5	
27	Reduced milk/ meet yield	84	70.00	4	
28	Susceptibility to pests and diseases	91	75.83	3	

II. Extent of Adaptation/mitigation measures for Climate change by the farmers

It is clear from the table-2 that, there was 40.16 percent of adoption of different adaptation/mitigation measures for Climate change by the farmers. Among them, the Intercropping was found to be with 85.83 percent adoption and ranked first in extent of adoption. Alteration in sowing/ planting dates, Micro irrigation systems, use of drought tolerant varieties and use of pest and disease resistant varieties ranked 2^{nd}, 3^{rd}, 4^{th} and 5^{th} respectively with 71.66, 60.83, 55.83 and 52.50 percent of adoption.

Due to continues low productivity of rainfed groundnut during the past decade, as an adaptation/mitigation measure farmers adopted Groundnut + Redgram, Groundnut + Cowpea, Groundnut + Field bean as major intercrops which has shown sustainability. Hence the farmers might have adopted this practice as a mitigation measure to climate change. On the other side, there were frequent fluctuations in monsoon observed by majority of the farmers they might have altered their sowing dates keeping in view of the onset of monsoon.

Depletion of ground water and also the farmer's awareness on water stress has resulted adopting micro irrigation methods which will helps in judicious utilization of available water resources. Government also encouraging the farmers by providing subsidies for the micro irrigation systems. The results were also were found to be more satisfactory for farmers. Severe incidence of pests& diseases and also drought might be contributing for huge loss to the farmers. Hence they might have perceived this as a major threat for agriculture.

The measures such as Integrated farming system approach, Integrated nutrient management practices, Alteration in fertilizer/pesticide usage, Soil test based fertilizer application and Organic farming practices Establishing soil& water conservation structures, Measures towards disease resistance in animals, Crop substitution, Use of organic manures and Establishing wind breaks were found to be with less than fifty percent of adoption ranging from 49.16 to 30.00 percent of adoption respectively.

Table 2: Extent of Adaptation/mitigation measures for Climate change

n=120

S. No	Adaptation/mitigation measures for Climate change	frequency	percent	rank
1	Pest and disease resistant varieties	63	52.50	5
2	Drought tolerant varieties	67	55.83	4
3	Intercropping	103	85.83	1
4	Crop substitution	41	34.16	12

5	Alteration in sowing/ planting dates	86	71.66	2
6	Integrated farming system approach	59	49.16	6
7	Organic farming practices	44	36.66	10
8	Establishing wind breaks	36	30.00	15
9	Alteration in fertilizer/pesticide usage	49	40.83	8
10	Establishing soil& water conservation structures	44	36.66	10
11	Micro irrigation systems	73	60.83	3
12	Soil moisture conservation measures	18	15.00	20
13	Use of organic manures	38	31.66	14
14	Integrated nutrient management practices	52	43.33	7
15	Crop rotation	31	25.83	16
16	Soil test based fertilizer application	48	40.00	9
17	Integrated weed management practices	22	18.33	18
18	Measures towards disease resistance in animals	41	34.16	12
19	Use of suitable breeds/varieties for climate	20	16.66	19
20	High yielding & drought resistant forage crops/varieties	29	24.16	17
Overall percent of adoption of different adaptation/mitigation measures for climate change by the farmers			**40.16**	

Meager percent of adoption of adaptation/mitigation measures for Climate change such as Crop rotation, high yielding & drought resistant forage crops/varieties, integrated weed management practices, Use of suitable breeds/varieties for climate and Soil moisture conservation measures with 25.83, 24.16, 18.33, 16.66 and 15.00 percent respectively. These measures were found to be very marginal in adoption. Hence, there is a need for critical analysis of such measures for better adoption. The findings are in line with that of Swanson *et al.* (2008) and Ayanwuyi *et al.(*2010).

III. Strategy for achieving climate resilient agriculture

Keeping in view of the extent of awareness and also the extent of adoption of adaptation/mitigation measures, an extension strategy was designed with ten broad components by involving researchers, extension functionaries and farmers. Each component will have its own set of activities and outcomes which directly contribute for attaining climate resilient agriculture in dryland areas.

1. **Awareness programmes on climate change and its impact on agriculture**

As the climate change has shown visible affects on farming, it is essential to see that all the farmers should be aware of the changed climatic conditions but also its consequences on crop and livestock production. The results of the study also indicated that about 30 percent of the farming community needs awareness on this issue. Hence there is every need to design awareness programmes for farmers on climatic change and its consequences by organizing campaigns, exhibitions and also through mass media. Current trends in the climate change should be made available to the farmers so as to have better exposure on climate.

2. **Technical support in designing suitable farming systems to each district**

By taking district as a unit, with the available information on existing farming situations and also recommended farming systems, the compatibility and profitability of different farming systems has to be analyzed. Keeping in view of the changing climatic conditions, the integration of different farming systems needs to be designed and the same has to be disseminated among the farming community. This facilitates the farmers to select the suitable combination of farming systems based on their social and economic conditions. The comparative advantage and economic viability has to be thoroughly analysed.

3. **Establishing community based water conservation structures**

Due to the changed climatic conditions, water is becoming the most limiting factor. Apart from the proper utilization of water, it is also imperative to reduce the wastage of water by means of establishing different types of water harvesting structures. The Watershed development programmes needs to be strengthened by allocating enough funds for each district. The experts in the field of soil and water conservation and also the farming community of the village has to be involved in establishing and further maintenance of the structures.

4. **Development and dissemination of new varieties which are resistant to pesticides and drought**

Use of improved varieties resilient to climate change and development of varieties resistant to local pest and diseases and also tolerant to drought is another option to adaptation. The same varieties need to be popularized among the farming community. The example to quote is that, in the Chittoor district, due to climate change, the viral diseases like Peanut Stem Necrosis Disease (PSND) and Peanut Bud Necrosis Diseases (PBND) became more prevalent in groundnut crop for the past 6-7 years. The scientists of Regional Agricultural Research Station, Tirupati developed Dharani variety which is resistant to PSND and PBND and also tolerant to drought. This variety received very good response from the farmers.

5. **Prioritization of weather forecasting for timely information on rainfall and other parameters**

In the context of changing climate conditions, weather forecasting is becoming more predominant and informative tool for the farmer. Agro advisory service centers can take the lead

in providing this information to the farmers. It is essential to design the timely weather forecast alerts to farming community through mobile networking system. This system already has shown significant impact in Chittoor district among the progressive farmers. This approach needs to be strengthened by linking as many numbers of farmers as possible in the networking system. The timely weather forecast will help the farmers to take up needy adoptive mitigation measures to tune with the climate. The Krishi Vigyan Kendras, NGO's and other organizations working with Agriculture can adopt villages or mandals and the information obtained through Indian Meteorological Department (IMD) for specific locations can be disseminated through text messages or voice messages via mobile.

6. Capacity building to impart knowledge and the importance of organic farming for improving soil fertility

Improving soil fertility is one of the important adoptive measures in the context of climatic conditions. Adoption of organic farming is the only solution through which soil fertility can be improved. But the farmers are not having much competence on the different organic farming practices. Hence priority should be given to impart knowledge on organic farming practices such that the consequences can be perceived positively by the farming community. Organic farming must be focused by organizing capacity building programmes for the farmers. This system will help in improving the fertility status of the soil besides quality production. Various organic farming practices and their practical utilization including the mode of action of the different elements must be taught to the farming community.

7. Selection of key communicators in the village for effective dissemination of climate resilient technologies

System of Key communicators should be strengthened by identifying more efficient key communicators in the villages and organizing need based training programmes and other capacity building activities on climate change for the key communicator and in turn they must be motivated to convey the same message among the fellow farmers. Special training programmes on communication skills also need to be designed for the key communicators for the effective transfer of technology.

8. Educating the farmers on contingency crop planning

Contingency crop planning is another important area, which is essential to meet the changes in the onset of monsoons. The contingency plan for delayed onset of monsoon must be stressed. The scientists have to design contingency crop planning for a region depending on the soil type and the weather parameters. This strategy will act as a coping mechanism and allow the farmers to cultivate the crops in their productive lands based on the onset of monsoon without keeping them barren.

9. Imparting skills on soil moisture conservation measures

Research needs to be strengthened in developing different soil moisture conservation measures. Traditional methods are being adopted, where plastic or trash mulching is one of the best options for the farmers. Such techniques have to be popularized among the farming community. Micro irrigation like drip and sprinkler already gained popularity among the farming community. These irrigation systems need to be further expanded.

10. Infrastructural and financial support to the farming community for storage, post harvesting and marketing

It is not possible to achieve climate resilient agriculture only by the technological measures, but also requires the government support by adequate financial and infrastructural facilities for active adoption of adaptive/mitigation measures. Depending upon the nature of climate change and also its impact on crop and livestock; Crop insurance, subsidies, crop loans, other benefits may be extended to entire farming community. Infrastructural facilities like establishing godowns, service centres, processing units, transport and communication facilities need to be strengthened. Suitable marketing strategies also need to be developed.

All the components in the designed strategy must be implemented depending on the personal, socio-economic conditions of the farmers and also existing farming situation and climatic conditions, ultimately leading to climate resilient agriculture.

CONCLUSION

With the changed climatic conditions, there is every need to adapt or to go for mitigation measures to tune with climate change. The study focused on the awareness of farmers about the climate change and also adaptation and mitigation measures. The results will help in selecting appropriate areas for mitigating the climate change. The designed extension strategy will help in selecting right approach for effective implementation of activities for achieving climate resilient agriculture in dryland areas.

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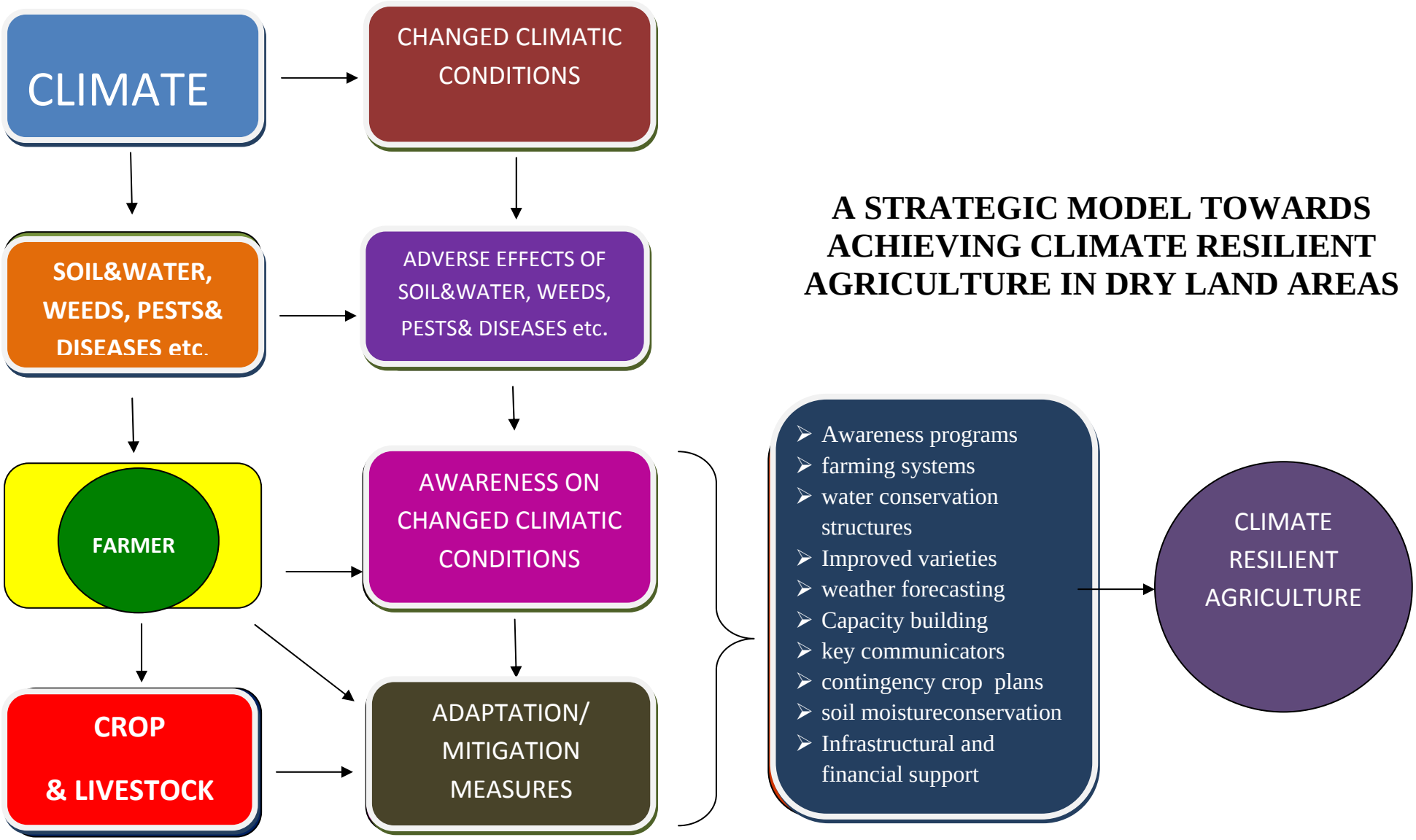
A STRATEGIC MODEL TOWARDS ACHIEVING CLIMATE RESILIENT AGRICULTURE IN DRY LAND AREAS
CLIMATE
CHANGED CLIMATIC CONDITIONS
SOIL&WATER, WEEDS, PESTS& DISEASES etc.
ADVERSE EFFECTS OF SOIL&WATER, WEEDS, PESTS& DISEASES etc.
FARMER
AWARENESS ON CHANGED CLIMATIC CONDITIONS
CROP & LIVESTOCK
ADAPTATION/ MITIGATION MEASURES
Awareness programs
farming systems
water conservation structures
Improved varieties
weather forecasting
Capacity building
key communicators
contingency crop plans
soil moistureconservation
Infrastructural and financial support
CLIMATE RESILIENT AGRICULTURE