

Changing agro-climate: Tropical Tubers and Roots as a challenge for Sustainable Livelihood in India

Abstract:

Climate change impact at the global level has become a major concern today. In the regional context, climate change has contributed to unpredictable or erratic rainfall pattern, drying up of local springs and streams, species migration to higher elevations, shift of sow in and harvesting period of crops emergence of invasive species an incidence of diseases/pests in crops. There is a need to develop a comprehensive master plan for strategically planning conservation, addressing poverty and food security in the wake of climate change impacts. Tropical root and tuber crops contribute 6% of the average daily considered as third important crop constitute cheap source of food and energy particularly suitable for the poor section of human population and capable enough to withstand biotic and a biotic stresses. This study has identified the primary challenges farmers for ensuing adaptive capacity and sustainability of tuber crop in changing agro-climate. Experiments were conducted with short season variety of sweet potato in fluctuating agro-climate like change in temperature, humidity. Sweet potato was grown varying temperature, humidity treatment independently, individually in different time .The result shown that in different agro-climatic parameter treatment lead to no significant yield loss in sweet potato. Along with science, changing agro-climatic parameter application to tuber roots and crops are therefore, the key to pursue our progress towards sustainability.

Executive summary:

Indian agriculture is facing challenges due to severalfactors such as increased competition for land, water andlabor from non-agricultural sectors and increasing climaticvariability. The latter

associated with global warming will result in considerable seasonal/annual fluctuations in food production. All agricultural commodities even today are sensitive to such variability. Droughts, floods, tropical cyclones, heavy precipitation events, hot extremes and heat waves are known to negatively impact agricultural production, and farmers' livelihood. It has been projected by the recent report of the IPCC and a few other global studies that unless we adapt, there is a probability of 10–40% loss in crop production in India by 2080–2100 due to global warming^{1–4}, despite beneficial aspects of increased CO₂. A recent meta-analysis of CO₂ enrichment experiments in fields has shown that in the field environment, 550 ppm CO₂ leads to a benefit of 8–10% in yield in wheat and rice, up to 15% in soybean, and almost negligible in maize and sorghum⁵; but increase in temperature may alter these results.

The root and tuber crops cassava, yam and cocoyam are important sources of energy in our daily diets and constitute a major part of the rural Indian staple diet. With an estimated per capita consumption of 15.4 kg of cassava, 43.3 kg of yam and they account for 28% of the per capita food consumption; making them a major source of food and government savings on revenue. Root and tuber crops as part of the agriculture exports generate about 1.5% of government earnings and employ 10% of the population. Experimental research has shown that root crop yield response to climate change varies widely, depending on the species or cultivar, soil properties, pest and pathogens. The need to assess the effects of climate change on root crop demand, farm incomes, and price cannot be overemphasized.

This report is a scientific assessment of the consequences of, and adaptation responses to climate change. This report;

- Evaluates evidence that observed changes in climate have on sweet potato crop production.
- Identifies and discusses how adaptation options may lessen adverse effects.
- Identifies and analyzed linkages with other aspects of the economy and describes

A positive correlation exist between temperature and root crop yield, this relationship gave a correlation less than 40%. Scenarios for rainfall amount in the various ecological zones. This means that less amount of rainfall should be expected in future. The number of rainy days and total rainfall was found to be highly correlated for some ecological zones, years with high number of rain days have higher total amount of rainfall. The current state and trends in root crop production was assessed; yields were found to be positively correlated to total rainfall with a correlation factor R . Climate factors identified and perceived to be stressors within the limits of the study includes the following;

- Rain fall within the community was unreliable, irregular and unpredictable. Duration of rain has been medium duration and it is either too much (flooding) or too little (drought) as phrased by the community.
- Daily temperature was perceived as hot or high when the sun shines too much, thus scorching crops. They attributed this condition to indiscriminate deforestation.
- Poor or degraded soils as a result of intensive and bad cultivation practices, erosion and deforestation subsequently reduce yields.
- Prolonged drought increases the population of variegated grasshoppers which destroy sweet potato.

Introduction:

The general consensus is that changes in temperature and precipitation will result in changes in land and water regimes that will subsequently affect agricultural productivity. Although estimates suggest that global food production is likely to be robust, experts predict tropical regions will see both a reduction in agricultural yields and a rise in poverty levels as livelihood opportunities for many engaged in the agricultural sector become increasingly susceptible to expected climate pressures. While contemporary policy dialogue has focused on mitigating emissions that induce climate change, there has been relatively limited discussion of policies that can address climate impacts. First, climate variability is already a problem both in developed and developing countries. Second, even moderate climate change provides added impetus to promoting local adaptation options concurrently with the pursuit of global efforts on mitigation strategies. That is, adaptation to climate change and variability (including extreme events) at the national and local levels is regarded as a pragmatic strategy to strengthen capacity to lessen the magnitude of impacts that are already occurring, could increase gradually and may be irreversible. Consequently, several key themes have emerged from the current literature on adaptations to climate change. First, given the range of current vulnerability and diversity of expected impacts, there is no single recommended formula for adaptation. Second, responsibility for adaptations will be in the hands of private individuals as well as government. Third, the temporal dimension of policy responses is likely to have a significant role in the effectiveness of facilitating adaptation to climate change. One set of measures will decrease the short-term vulnerabilities of the agricultural sector through adaptations to weather effects. These measures will therefore address concerns with climate variability. Another set of strategies that reduce vulnerability to climate change will thus be necessary. This second set of adaptation measures

include options such as improving water management practices, modernization by adopting and utilizing new technologies, and changing crop types and location.

Procedure:

The interactions between impact of climate change on root and tuber crop yields and factors that determine final output such as national policies and economic issues or the indirect effects of climate change was examined. The methods used include the following; Computer aided modeling, Scenario analysis, Simulation gaming, Participatory assessment and qualitative assessment based on existing experience and expertise.

Field experiment was carried out at specified region on experimental basis in small plot in Agribusiness management department of Orissa university of agriculture and technology as assignment for project work as management course in Utkal university of Odisha in year 2011 taken to study the effect of water level (humidity) and varied temperature on potato yield (*Ipomoea batatas*). Sweet potatoes grow best in loose, sandy, well-drained soil (well drained is an absolute must for success). Strategy was to plant slips in raised beds with a center ridge 10-12 inches higher than the surrounding area. Each slip should be planted at a depth of approximately 2-3 inches (with the leaves sticking above the ground). Within a row, It was planted successive slips every 12 to 18 inches, but kept rows about three feet apart so that the plants have adequate room to spread out. After transplanting, it is needed to water each slip immediately and do so every few days until the plants have established themselves. Typically It need not to irrigate the plants after they are established unless it was live in an area with limited rainfall. Weed early and often as this allows the vines to produce large tubers that do not have to compete for nutrients.

When the plants get fairly large, they will shade out any new weeds that might try and emerge. About one month after transplanting. Lastly, with respect to planting, it will absolutely needed to protect sweet potato vines from deer if they tend to be a problem in that area. Speaking from experience, it is extremely frustrating to have a beautiful bunch of sweet potato vines one day and nubs the next morning. Treatment comprises of three water levels like (80%, 100%, and 150%) and temperature like low temperature 20-25°C and high temperature 45-50°C. date of planting was April 15, 2011 for change in humidity. All the agricultural practices were conducted by college of agriculture student. Plot size was of 4 decimal approximately. Chemical and physical properties of soil were analyzed before cultivation. The permanent wilting point (PWP) and field capacity (FC) of the trial soil was determined before. Plant distances were 30 cm apart. A distance of 1.75 m was left between two irrigation treatments. Total amount of irrigation water was calculated by class A pan equation. The normal agro metrological data of class A pan evaporation was obtained and expressed in mm/day. Drip irrigation was used the cultivation season. The total amount of drip irrigation was applied by water flow-meter for each treatment. (EC of water irrigation 0.8 DS/m). Irrigation treatments were named as low, medium and high respectively. The EC OF the irrigation ranged 0.7 to 0.9 DC/m. Sweet potato were harvested in last of September i.e. 30th and total yield for each treatment were estimated separately.

Water use efficiency (WUE) was calculated accordingly to the following equation:

$$\text{WUE (kg/m}^3\text{)} = \text{Total yield (kg/fed)} \div \text{total applied water (m}^3\text{/fed)}$$

Variable temperature treatment was done three different ways like keeping plants in normal growing season other in low temperature treatment like growing plant in controlled condition in green house and also followed for high temperature. All plots were same in dimension i.e. 4 decimal.

Table (1) the chemical and physical properties of soil analyzed before cultivation.

Chemical properties						
EC	pH	Ca ⁺⁺	Mg ⁺⁺	Na ⁺⁺	K ⁺⁺	Cl ⁻
m/moh		meq/1	Meq/1	Meq/1	Meq/1	Meq/1
2.5	6.8	25	11	12.5	1.5	11.5
Physical Properties						
Sand%	Clay%	Slit%	Texture	FC%	PWP%	Bulk Density
73.2	12.2	24.6	Sandy loam	20.34	7.45	1.957

Varietal coefficients:

Simulations were carried out assuming that successfully optimized resources in terms of humidity and sowing time. Respective coefficients for the crops were taken for the dominant Indian varieties from the previous published studies. These were calibrated for each grid by simulating the performance of low, medium and high temperature tolerant varieties grown during very late, late, and timely sown periods respectively. The best combination was taken for the baseline and impact assessment.

Result discussion:

Agricultural production and marketing policies have been found to affect food availability and food security. These concerns about future productivity growth, if correct, mean that simple extrapolation of yield for impact assessment may be overoptimistic. The implication is that confidence in predictions of food demand and supply balance and price trends beyond the early part of the 21st century will be low. Climatic conditions often interact with socio-economic conditions to undermine food security. Climate variability tends to have the greatest impact on people who are landless, poor, or isolated. Changes in socio-economic conditions can lead to dramatic changes in food security. Disadvantageous terms of trade, poor infrastructure, and armed conflict also make it more difficult for people to cope with the effects of climatic extremes. For example, while food security would anyway have been a problem during severe famine 1950s and 1960s in India, economic recession and civil strife were major causes of the widespread famine.

Effect of different irrigation levels on sweet potato yield was illustrated in table(2) below. Regarding the effect of different irrigation treatment, it was found that 100% irrigation yields highest followed by 80% irrigation which was shown from data. The lowest yield was obtained by 150% irrigation treatment.

Relevant to the effect of different irrigation levels on water use efficiency show that increasing irrigation led to decrease in water use efficiency for all irrigation treatment which was found out in data that is mentioned in table(2)

The result in this study generally agreed with increase in water level above 100% lead to decline in water use efficiency.

In case of different temperature treatments, result found in the way that high temperature treated vine yields highest followed by low temperature during growth period, lowest yield obtained by low temperature treatment as per data that was cited in table (3).

But in every case i.e. either varied temperature or varied water treatment lead declining yield is very small. That is the wonder in case of sweet potato. Both production and productivity are declining in adverse climatic condition but calculated very low in amount.

Table (2): Effect of different irrigation percentage on water use efficiency as well as actual and estimated sweet potato yield.

Water Treatment			Vine Fresh Yield(Kg/Ha)		
		WUE Kg/m ³ water	Actual	Estimated	Yield Change %
80%	2505	5.42	18296	18324	-0.028
100%	3267	5.01	20211	20225	-.01
150%	3756	2.9	16798	16846	-0.06
Mean	3176	4.43	18435	18498	-.031

Correlation Coefficient = .9989

T Value= --.169

P Value= .132

The correlation coefficient was significant (P- value 0.000); this means same trend was found in predicted and observed data. P test value was not significant (p –value .132); this means no

difference between observed and predicted value. Result of validation of the experiments indicates that the SUBSTOR –sweet potato crop model is validated to grow in odisha. It was noticed that the output data from SUBSTOR –sweet potato crop (predicted data) were in harmony with the observed data in fresh vine yield.

Table (3): Effect of different temperatures on actual and estimated sweet potato yield.

		Fresh vine Yield(Kg/Ha)		
Temperature treatment	Yield	Actual	Estimated	Yield Change %
20-25°C	2023	22553	22783	-.02
30-35°C	2556 2556	23412	23457	-.045
45-50°C	2401	26999	27329	-.033
Mean	2316	24321	24553	-.031

Correlation coefficient t= .989

T value = -.189

P value = .154

The correlation coefficient was significant (P- value 0.000) ;this means same trend was found in predicted and observed data. P test value was not significant (p –value .154); this means no

difference between observed and predicted value. Result of validation of the experiments indicates that the SUBSTOR –sweet potato crop model is validated to grow in odisha. It was noticed that the output data from SUBSTOR - sweet potato crop (predicted data) were in harmony with the observed data in fresh vine yield in case of varied temperature. Effect of different irrigation levels on sweet potato was illustrated in table(3) below regarding the effect of different irrigation treatment, it was found that 30-35° C temperature treatment yields highest followed by 45-50 °C temperature treatment which was shown from data. The lowest yield was obtained by 20-25 °C temperature treatment. The result in this study generally agreed with increased and decreased in temperature above 30-35 °C lead to decline in yield.

Conclusion:

Overall result: could be concluded that SUBSTOR model for sweet potato yield can successfully use in odisha. Highest yield is found in case of 80% moisture treatment and in case of temperature treatment is 30-35°C. Though yield is reduced due to varied temperature and moisture treatment but negative impact of those parameters are very negligible .Hence it can be concluded that impact of climate change on fresh yield of vine cannot impact adversely.

Reference

Kurukulasuriya, Pradeep; Rosenthal1, Shane (June 2003) Climate Change and Agriculture A Review of Impacts and Adaptations, The world bank environment department, India.

Medany, Mahmoud (Final Report, 2006) Assessment of impact of climate change and adaptation on potato production, Agricultural research center, Ministry of Agriculture and Land Reclamation, Egypt.

Naresh Kumar¹,S;Aggarwal¹,P. K;Rani,Saxena;Jain¹,Surabhi and Chauhan¹,Nitin(August 2011)Impact of climate change on crop productivity in Western Ghats, coastal and northeastern regions of India.

Sagoe, Regina (February 2006) Climate change and root crop production in Ghanaa,Crop research institute,Kumasi,Prepared for environmental protection agency(EPA),ACCRA-Ghanaa.