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# Climate Smart Village: An assessment of Indian initiatives

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## 1. INTRODUCTION

Climate change has emerged as one of the greatest challenges of our times. This phenomenon is a significant driver of change for food security in the developing world, because it threatens food production and its stability as well as other aspects of food systems such as storage, food access and utilization (Wheeler and Von Braun, 2013; Kirit Shelat, 2015a & 2015b; Robert Jordan, 2015). The impacts of climate change range from local to global levels (Ericksen et al., 2009) and interact with other change dynamics including economic, political, temporal and biophysical dimensions. These changes are marked by uncertainties that confound attempts to develop linear and unilateral policies (Funtowicz and Ravetz, 1993; Kriegler et al., 2012; van der Sluijs, 2005; Tushar Pandey et al. 2015). Its potential, to alter the course of development and human progress, poses grave concerns for the well-being of nature and even survival of human beings themselves.

India is one of the most vulnerable countries to the projected impacts of climate change. The Indian responses to climate change and its adaptation policies at best are "gender blind" or "gender neutral". In India, the climate change can severely affect marginalized and poor sections of the society especially farmers and woman. The climate change would cause erratic weather patterns which in turn make crops failures, undermining of livelihoods and food security. Climate change have also serious implications for women because of their greater responsibilities in household management starting from fetching water to fodder collection, less access to resources, less participation in decision making and developmental processes and their involvement in the agriculture activities. Therefore, the call of the hour is to devise a smart strategy in the form of Climate- Smart Village (CSV).

The CSV would be able to address the concerns of marginalized sections including farmers, fisherman and women thereby increasing the productivity and income, building climate change resilience, reducing green house gas emissions (GHGs) where possible and enhancing achievement of national food security and development goals. Climate smart village is a community-based approach to sustainable agricultural development. It broadly refers to an approach that strives to achieve synergies between productivity, adaptation and mitigation objectives. These are the sites where researchers and Development partners are working with small holder farmers-women and men to test climate smart agriculture interventions. CSVs act as learning grounds for researchers, policy makers, development practitioners and farmers. The CSV model brings together local institutions and climate-relevant local knowledge with state-of-the-art climate information, services and technologies through appropriate village level development plans.

The project climate-smart villages was launched in 15 sites of West Africa, East Africa and South Asia in 2011 by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). This number was increased to 22 by 2013, with more slated for Latin America (Guatemala and Nicaragua), Central America, South-east Asia (Vietnam), South Asia (Bangladesh and Nepal). All these sites are in high-risk areas, which will likely to suffer most from a changing climate. These are also places where partners have already established vital links with local communities (Aggarwal et al, 2013).

India is one of the 18 countries in the world which is using climate-smart technologies. The climate-smart villages is site specific and is not-one-size-fits-all. There is enormous scope for learning what works in one site and adapting it for others, an approach which is called as "knowledge smart". Therefore, the present study is attempted with the objectives- (i) to identify 'climate-smart' activities and options suitable for all type of households, (ii) to find out the steps taken by small holder farmers for adapting their agriculture to secure the food supply, (ii) to find the means for mitigating the emissions.

## 2. SETTING UP A CLIMATE-SMART VILLAGE

**(a) Site Selection:** The selection is based on climate risk profile of the area, choice on alternate land-use, and the enthusiasm of local population basically the farmers, daily laborers and women involved in agriculture activities. After site selection, a steering group of community representatives and researchers together identify appropriate climate-smart options for that village.

**(b) Involvement of local communities:** The success of CSV lies with the involvement of local Community and enhancement of existing local risk management of the group of farmers, researchers, rural agro-advisory service providers and village officials. They are generally made aware of the objectives of CSV and encouraged to formally register with the government (if they have not already) for getting benefit from subsidies on the schemes run by government.

**(c) Conducting the baseline study by researchers:** This is carried out to capture the current socio-economic situation, availability of resources, average income, and risk management approaches of different households. This enables an assessment of the impact of the interventions after a certain period of time.

**(d) Prioritizing interventions of technologies:** The approaches should be best suited to the local conditions. The group discussions involving farmers may indicate their willingness for carrying out the specific work.

**(e) Capacity Building:** This includes a range of tools and approaches offered up-front sometimes. The tools are rain gauges, improved seed varieties, new livestock breeds, tree seedlings, simple machinery such as zero-till machines, subsidies on index-based insurance premiums and discounts on cellphone. Here the group consists of scientists, representatives of private sector, and local government organize regular training sessions for farmers on good agricultural practices. At some sites a small farm is used by the researchers to demonstrate the complete portfolio of interventions.

**(f) Monitoring and evaluation of progress:** The lead partner in the village appoints a site coordinator and assistant to provide technical inputs. Participating farmers maintain a daily diary of their farm activities and work with the site coordinator to monitor and evaluate the progress of their chosen interventions. These results are digitized and analysed by researchers at the end of every crop season.

**(g) Awareness-raising activities:** It can be done by communicating participatory videos on success stories and testimonials from the pilot villages. Success stories can also be publicized widely through mass-media, internet, smart phones, organizing regular 'farmer field days' to motivate farmers, etc.

## 3. KEY INTERVENTIONS IN A CLIMATE-SMART VILLAGE

Agriculture activities must be resilient towards natural disasters and rising temperatures caused by climate change. Villages can be climate smart in a various ways. First, 'weather smart' (Hansen et al, 2011; Glendenning and Ficarelli, 2012; Schubert, 2013) through weather forecasts or information, ICT based crop advisories through radio shows, television, newspapers and mobile phone voice messages, Index based insurance schemes (Mahul et al, 2012) to cover risks associated with changes in rainfall and temperature at the different stages of crop growth and Climate analogue (A climate analogue location is one which has *today* a climate with similar statistical and mathematical characteristics to the climate that is projected in the *future* for the research site of interest, thus allowing the direct testing of adaptation options). CCAFS and partners are developing a software package, CRAFT, to support forecasts of crop production within the growing season (Bhatta and Aggarwal, 2013).

Second, 'water smart' through aquifer recharge, rainwater harvesting, Community management of water, LASER assisted land levelling for reducing irrigation water, on-farm water management, water conservation and drip irrigation. Drainage is important in places that are prone to becoming waterlogged, such as Bihar in India and Bangladesh. Vertical drainage systems are being evaluated in Bihar with the expectation that it will help floodwater seep more quickly back into the natural aquifer, providing the dual benefit of recharge and protecting standing crops.

Third, 'carbon smart' (Schubert, 2013) or conserving carbon content in the soil through conservation tillage, agroforestry, Land use systems and Livestock management, diversified land-use systems and residue management.

Fourth, 'nitrogen smart' through site-specific nutrient management, catch cropping legumes and precise application of fertilisers (here farmers use leaf-colour charts, hand held crop sensors, and nutrient decision-maker tools to decide the most appropriate dosage of nitrogen fertilizers for their crops which may save costs and help in cutting down greenhouse gas (GHG) emissions. Fifth, 'energy smart' through fuel-efficient agro machineries, crop residue management, biofuels, minimizing tillage.

Lastly, 'Knowledge smart' through farmer-farmer learning by making cross-site visits of farmers to analogue sites, farmer networks on adaptation technologies, Seed and fodder banks, market information, crowd sourcing seeds, off farm risk management, etc.

## 4. CLIMATE SMART VILLAGES IN INDIA

The Climate Smart Village model is a unique initiative by Climate Change Agriculture and Food Security (CCAFS) in India. CCAFS is currently testing a scalable model in Haryana and Bihar, in partnership with major CGIAR institutes, civil society and NARS, to promote agriculture practices that will mitigate the effects of climate change on agriculture and help communities to become resilient to extreme weather events such as droughts, floods, and delayed monsoons. The farmers are changing age-old practices to overcome the challenge of increasingly erratic weather patterns.

Haryana lies in India's Indo-Gangetic Plain that is South Asia's food basket, and faces a grim future due to rising temperatures. Its main crops wheat is highly vulnerable to heat stress and paddy cultivation consumes excessive water. Haryana, fed only by a seasonal Ghaggar river, over-exploits its groundwater that has depleted alarmingly in recent decades. Haryana state is now home to 26 "climate smart villages," all of which are part of an initiative led by the research consortium CCAFS in India. The various technique used by the farmer in the CSV Taraori and Anjanthali villages are as follows:

- Using direct seeded rice in which rice seeds are sown directly in a dry seedbed, in contrast to the traditional practice of sprouting rice seedlings in a nursery and transplanting them to intensely tilled fields with standing water.
- Using the new laser-leveling technique that helps the soil for reducing need for irrigation by ensuring uniform distribution of moisture. The soil leveling needs to be done once every 3-4 years. Now 20 of the 100-odd farmers in this village have formed a cooperative group to pool money and buy a laser-assisted land leveler. The CCAGS-CIMMYT study predicts that this technique can save 933 million cubic meters of irrigation water every year. safeguarding the crops (rice and wheat) from new diseases caused by increased temperature variation
- Using crop residue to nourish the fields thereby reducing chemical fertilizer,
- Sensors and leaf colour charts are used to determine optimum fertilizer dosage for the soil.
- Crop diversification from rice-wheat systems to include shorter-duration varieties and switching to maize, pulses and oilseeds particularly in areas having drastically decreased ground-water levels.
- Involvement of women in decision making on farm activities due to mobile SMSes
- Teaching farmers how to become resilient in the face of climate change.
- Use of a monitoring instrument, tensiometer, helps farmers decide when to irrigate their fields. This technique helps in eliminating GHG emissions by an average of 48% compared to the traditional method of continuous flooding of rice fields with alternate wetting and drying.

Bihar: A similar approach is being adopted in India's eastern state of Bihar. Here CCAFS partners with Alternative Futures and Mahila Samakhya-a national programme dedicated to empowering women-trained a core group of elected women who then took the work to more than 1500 additional women across the state. The villages, Rajapakar,

Bali Bathna and Lal Pokhar in Vaishali district were selected in 2011 based on their suitability and willingness of households to adopt climate smart interventions that could be carried out over a period of time to evaluate the results. The key climate-related issues are frequent droughts, water logging and flooding, and decreasing annual rainfall. The district has approximately 90.4 square km of area, which remain permanently waterlogged. Some farmlands have imperfect drainage of the soil, limiting optimum air-water relationship at the root zone affecting the crop growth. Increasing soil salinity is also a matter of concern in some areas of the district. The various techniques used by the farmers in the CSVs are:

i. Use of proper technologies according to farmers' typology, land size, socio-economic status and resource availability.
ii. Additional planting of seeds on raised beds with furrows in between. This offers a dual advantage: the furrows can be drained of water in case of floods and can be watered during drought.
iii. Introduction of high-yielding, stress-tolerant maize varieties and planting pigeon pea on the bunds around the fields and farmers' backyards as pulse crop. This would help in improving protein intake and nutrition security in the area.
iv. (iv)An innovative component of the project is the use of information and communication technology (ICT) tools to disseminate 'climate smart' agro advisories to farmers, by sending voice and text SMSes in local languages to farmers' mobile phones. The messages include weather forecasts and recommended actions, information on pests, seed varieties and techniques for conservation agriculture.
v. Training-the-trainers is another essential element in farmer learning networks.

## 5. DISCUSSION

One of the great strengths of the climate-smart villages approach is its inclusiveness. Climate-smart initiatives are much more likely to achieve their desired outcomes if women are encouraged to take ownership and implement changes at the farm level. This would further enhance if the women have the resources to do so by reforming institutional arrangements and if they work with men. Women, for example, tend to prefer face-to-face interactions for sharing information, as many of them do not have mobile phones, or cannot listen to the radio while out in the field where they spend long hours.

Farmers from different communities, researchers from different disciplines, non-governmental organizations and other partners all come together to test a range of options in an integrated fashion. The Village Resource Centers should become counseling centers to instill confidence in farmers who are at the receiving end of climate change and natural calamities. The agricultural scientists and experts should assure farmers that "we are with you." This approach may help in reducing farmers' suicides. It is clear from this that the food security and resilience can be improved in the face of climate change. At the same time, this also suggests the ways in which small hold farmers can adapt their agriculture.

An important lesson here is the finance to start up such programmes. This is more likely to come from national government revenues, official development assistance and the private sector than from dedicated international climate funds under the UNFCCC which in reality are slow to materialize and insufficiently reliable.

Direct GHG emissions from agriculture are estimated to account for between 10-12% of the global total anthropogenic emissions. In addition, agriculture contributes indirectly to emissions from land use change. However, agriculture also has a substantial potential to mitigate climate change through sequestering soil organic carbon or through reducing emissions of nitrous oxide and methane (Smith, 2008). Recognizing this, national policies are

required to be designed to explicitly encourage reductions in non-GHG emissions and carbon sequestration. For example, Brazil's Low Carbon Fund has an overall goal of reducing more than 160 million tonnes $CO_2$ emissions annually by 2020 (Angelo, 2012). Denmark's Agreement on Green Growth Agriculture has succeeded in combining agricultural growth with an overall 19.4% reduction in nitrous oxide and methane emissions (Rasmussen et al, 2009) and Australia's Carbon Farming Initiative is designed for helping Australia to achieve its GHG (Macintosh and Waugh, 2012).

However, equally important, large-scale initiatives are also underway. These initiatives (Table-1) are designed to improve farmers' social welfare, livelihood resilience and adaptive capacity but those also have potentially substantial co-benefits of climate change mitigation.

**Table 1**

| Initiatives | Objective |
|---|---|
| Integrated Agro-meteorological Advisory Services, India (IMD) | To generate (i) a meteorological component consisting of weather observation and forecasts for the next five days, (ii) an agricultural component identifying 'weather sensitive stresses' and converting weather forecasts into appropriate farm-level advisories, (iii) Two-way communication between farmers and agricultural scientists and (iv) an information dissemination component employing mass media |
| Drought tolerant maize for Africa-2006 (CIMMYT & IITA, 2007) | To develop drought tolerant maize varieties against the risk of climate-induced crop failure. |
| Weather Based Crop Insurance Scheme, India-2007 (Rao, 2011) | To mitigate the hardship of the insured farmers against the possibility of financial loss associated with low crop yields or crop failure resulting from adverse weather conditions |
| Productive Safety Net Programme, Ethiopia (2005) (World Bank, 2011) | To provide transfers to the chronically food insecure population in a way that prevents asset depletion at household level and creates productive assets at community level. |
| Sustainable Intensification in Rice Production in Vietnam (SIR RICE, 2012) | to reduce demand for water through intermittent draining of the paddy fields and methane gas emission |
| Participatory Forest Management in Tanzania (1990) (Pfliegner, 2010) | To reduce deforestation, carbon dioxide emissions and diversification of livelihood strategies of participating agricultural communities, and building adaptive capacity. |
| Grain for Green Programme in China (World Bank, 2007) | To reduce soil erosion by restoring forest and grasslands on low-yielding sloping cropland. |
| Farmer Managed Natural Regeneration in Niger (1980s) | To help in re-greening/ increasing natural tree cover |
| Integrating Climate Change into the Plan Maroc Vert, Morocco-2011 (Saoud, 2011) | To fix Carbon gains from the sequestration of soil carbon due to improved agronomic practices |

**Table 2**

| New Techniques | Remarks |
|---|---|
| CCAFS Climate for downscaled GCM data | It is an open access source for climate change projections |
| Climate analogue locations | It is a field-based approach for testing potential adaptation options |
| Climate Analogue Tool by CCAFS | This is for matching sites with analogous agricultural climates over space and time |
| CCAFS concept on "Farms of the Future" | It is climate analogue tool to connect farmers to their possible climate futures via farm visits. This approach of farmer-to-farmer exchanges between spatial analogues will integrate participatory learning principles in order to promote knowledge sharing between producer communities. |
| *MarkSIM GCM* | It is a stochastic downscaling tool which can provide geographically specific simulations of future rainfall series. This, in turn, can be used in other applications, such as crop models, to simulate the performance of potential adaptation options over future time |

Climate change will be progressive and adaptation strategies are likely to evolve from '*Incremental adaptation*', through '*Systems adaptation*' to '*Transformational adaptation*' depending on the degree of climate change (Richards and Howden, 2012). The ongoing adaptation initiatives are currently focused on managing current climate risk. At the same time, it is also important to start developing and testing of new techniques (Table-2) for adaptation to future climate change scenarios. All these efforts will make the CSVs a huge success in future.

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