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Climate-Smart Agriculture: Farmer's Bane Or Boon?

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CLIMATE-SMART AGRICULTURE: FARMER’S BANE OR BOON?

by

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Abstract

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Climate-Smart Agriculture (CSA) is one of the solutions that simultaneously address the issues of food security, climate change and agricultural productivity. It has been gaining momentum in the last five years among policy circles and development organizations have prioritized CSA interventions in developing countries around the world. In this paper, CSA interventions are examined from the small farmer's perspective and the purpose of this paper is to find out whether Climate-Smart Agriculture truly empowers the farmer in the face of climate change. Such a study emerged from the fact that in the past, agricultural interventions like the Green Revolution promised farmers food security but initiated practices that exacerbated their vulnerabilities and degraded the integrity of the ecosystem. The method involved assessing ongoing and completed projects of development agencies. These projects were examined based on the ease with which a small farmer could adopt such a practice and the ecological sustainability of the project. The results of this examination indicate that there are few interventions that have the potential to truly empower small farmers. Nevertheless, there are those interventions that are designed to be neither ecologically sustainable nor financially viable to the farmer. This implies an inherent flaw in the concept of CSA and sheds light on the vested agribusiness' interest in this area.

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List of Abbreviations

BP: Years Before the Present

CBA: Community-Based Adaptation

CSA: Climate-Smart Agriculture

CIMMYT: International Maize and Wheat Improvement Centre

CIAT: Centro International de Agriculture Tropical

CGIAR: Consultative Group on International Agricultural Research

DDT: Dichloro-Diphenyl-Trichloroethane

DTMA: Drought-Tolerant Maize for Africa Initiative

FAO: Food and Agriculture Organization

FMNR: Farmer-Managed Natural Regeneration

GACSA: Global Alliance for Climate-Smart Agriculture

GEF: Global Environment Facility

GIAHS: Globally Important Agricultural Heritage Systems

GM: Genetically Modified

HABP: Household Asset Building Program

HYV: High-Yield Variety

IARC: International Agricultural Research Center

IITA: International Institute for Tropical Agriculture

ICRISAT: International Crops Research Institute for Semi-Arid Tropics

IRRI: International Rice Research Institute

IFDC: International Fertilizer Development Center

IFAD: International Fund for Agricultural Development

IFPRI: International Food Policy Research Institute

IWMI: International Water Management Institute

IPCC: Inter-governmental Panel on Climate Change

NDU: National Defense University

NGO: Non-Governmental Organization

PSNP: Productive Safety Net Programme

SGP: Small Grants Programme

SRI: System of Rice Intensification

UDP: Urea Deep Placement

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

USAID: United States Agency for International Development

WFP: World Food Program

WVA: World Vision Australia

Introduction

In 2014, the State of Food Insecurity report estimates indicated that 805 million people went to bed hungry or were chronically undernourished in developing and emerging economies of the world. (FAO, IFAD & WFP, 2014). On the other hand, as many as 1.4 billion in the developed countries were overeating and causing food-related health problems. Incidentally, the vast majority of the undernourished are the smallholder farms and pastoralists of the developing countries. (FAO, IFAD & WFP, 2012). Over the past six decades, world agriculture has become more efficient through improved crop production and livestock management systems. But this has somehow not translated into huge differences in the food insecurity of developing nations and yet it has single-handedly contributed to the non-CO2 Greenhouse gas emissions, which is wreaking havoc for earth's climes. (Vermeulen, Campbell & Ingram, 2012) .The changing climate and sea-level rise in turn has disrupted the weather patterns around, leading to erratic rainfalls, increased incidences of extreme weather events, decreased soil fertility thus reducing agricultural productivity and in some cases it has decimated farms and livelihoods. (Stern Review, 2007; Cline, 2007; Fisher, Shah & Van Velthuizen, 2002; IPCC, 2007)

The three challenges of food security, agricultural productivity and climate change are so inter-twined that addressing them separately makes no sense anymore. And Climate-Smart Agriculture (CSA) is the latest buzz-worthy solution to this trinity of problems. CSA, as defined and presented by the Food and Agriculture Organization (FAO) at The Hague Conference in 2010, integrates the three dimensions of sustainable development (economic, social, and environmental). It is an approach to develop the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. The extent and intensity with which climate change affects agriculture and thus lives and livelihoods of people only adds to the immediacy and compelling need of CSA. The goals of Climate-Smart Agriculture are to:

- Sustainably increase agricultural productivity and incomes
- Adapt and build resilience to climate change
- Reduce and/or remove greenhouse gas emissions where possible

Key features of CSA (FAO, 2013):

- Addresses adaptation and builds resilience to shocks
- Considers climate change mitigation as a co-benefit
- Is a location-specific and knowledge-intensive approach
- Identifies integrated options that creates synergies and reduces trade-offs
- Identifies barriers to adoptions and provides appropriate solutions
- Strengthens livelihoods by improving access to services, knowledge and resources
- Integrates climate-financing with traditional sources of agricultural investment

According to FAO (2010), Climate–Smart Agriculture is not a new agricultural system, nor a set of practices. It is a new approach, formulated to guide the needed changes of agricultural systems given the necessity to jointly address food security and climate change. But does Climate-Smart Agriculture offer a viable pro-poor/pro-farmer solution or is CSA a continuation of the Green Revolution era? In the past, Green Revolution brought in efficiency to the agricultural production system and increased productivity but did not make it resilient to climate change, and above all it failed on its promise of making the farmer food secure. It ensured that food would be produced cheaply and distributed such that developed nations would have a year-round supply of cheap fruits and vegetables at the cost of the environment and at the cost of farmer's basic food needs. From its inception, Green Revolution has been a corporate strategy to expand industrial agriculture to developing nations. In such a context, it is vital to assess whether CSA is going to be a proxy for Green Revolution-era practices? Or is there real hope for the farmer? (See Appendix A for definition of farmer in this paper.)

To answer this question, CSA interventions initiated by development organizations (See Appendix A for further information) are identified and examined for the resilience they promise to farmers and their livelihoods. For an intervention to be truly climate-smart, it must be one that provides farmers a pathway to be food secure and such a practice must empower them to lead a sustainable livelihood amidst climate change. Before proceeding to examine CSA interventions, the need for CSA as a concept is established by recognizing the spillover effects of agriculture on climate changes and vice versa. Further, the role and multidimensional character of food security are added to the agriculture and climate change equation so as to emphasize the unpredictability and complexity of these three challenges when they interact. Having established the need for CSA, a review of Green Revolution and its impacts on the environment and on small-scale farmers is also conducted so that there is clarity when juxtaposing CSA practices with Green Revolution practices.

Chapter 1

Literature Review

This chapter begins by reviewing past articles that brought forward the need for Climate-Smart Agriculture as a concept to develop, by establishing the nexus between climate change, agriculture and food security and describing the impacts each has on the other. The second part of this chapter is targeted towards reviewing impact of the Green Revolution on the ecosystem and on small farmers particularly in emerging and developing nations. This part is included in order to bring out the proximity of the two approaches –CSA and Green Revolution, which on the façade may seem like two completely different systems of conducting agriculture but on exploring, the similarities and shades will come into view.

1.1 Deconstructing the Nexus: Need for CSA

Impact of Climate Change on Agriculture

Starting in the late 1970s, studies (NDU, 1980; Waggoner, 1983; Palutikof, Wigley & Farmer, 1984) have employed the use of climate scenarios to assess the impact of climate change on different crops in diverse areas. The focus of these studies tended to be on crop yields alone. Using projected values of different agro-climatic parameters like temperature and rainfall, a projected yield was obtained in each scenario. These studies concluded a definite impact on yield but recorded no consistency in the results, implying cases that recorded positive and negative changes in crop yields. (Lemon, 1983; Strain and Cure, 1985; Warrick and Gifford, 1986). These results were only based on a first-order analysis; other studies conducted during that time employed different impact assessment models but still suggested similar results. For instance, the Marginal-Spatial analyses conducted by William and Oakes (1978), Newman (1980) and Blasing and Solomon (1983) examined effects of changing climate on the margins of production and investigated the spatial shifts in the margins also. Their results suggested that the margins of production were especially sensitive to climate change and could lead to a shift in the geographical location of crop regions. The shifts in crop regions will vary for regions in mid-latitude and higher latitudes and the degree of shift will also vary depending on the temperature rise.

By the late ‘80s and ‘90s, research began to account for the dynamic nature of agriculture. With the establishment of the Inter-governmental Panel on Climate Change (IPCC), results were more mainstreamed, methods and models were more robust, and regional as well as national impacts were studied on different levels. (IPCC 1996; 2001; 2007). In the last two decades, more studies have evidenced the fact that climate change has and will significantly change agricultural productivity on a global and regional scale. (Cline, 2007; Jones & Thornton, 2003; Lobell et al, 2011; Parry et al, 2004). Although most projections estimated small impacts at the global level, they all consistently suggest significant negative regional impacts, especially for the subtropical and tropical regions. (IPCC 2001; 2014).

Studies concentrating on tropical regions showed a spatial and temporal variability in the impacts on agriculture. (Dash & Hunt, 2007; Thornton, Jones, Algarswamy & Andresen, 2009). Jones and Thornton’s (2003) study of Latin American and African agriculture concluded that climate change will adversely impact rain-fed areas that are dependent on subsistence agriculture. In these areas, a slight reduction in yield can mean disruption of rural life. In India, studies at the Agricultural Research Institute of India indicated that for every one degree Celsius increase in temperature during the growing period, there is a possible loss of 4-5 million tons of wheat production. (Ahmad, Alam & Haseen, 2011). And this was done with the assumption that water availability would remain constant.

Other regional studies showed that with increasing global temperatures, sea-levels have been rising, leading to flooding of fertile wetlands in South-east Asia. Changes have been observed in coastal rice yield owing to the unfavorable conditions of sea-level rise in South and South East Asia. (UNDP-SGP CBA factsheet, 2011a). The rise has also led to increased salinity in parts of the Caribbean, reducing productivity of the soils. (Nicholls, Hoozemans & Marchand, 1999; Nicholls, 2004). A one to three meter rise in sea levels will prove to be catastrophic for countries like Vietnam, The Bahamas and Egypt. (World Bank, 2007).

In dry land parts of the world, increased droughts and decreased precipitation have worsened the aridity of the soils. In 2000, the arid and semi-arid regions of the world accounted for 40% of the total land area and these regions were home to approximately 2 billion of the world's population. (Millennium Ecosystem Assessment, 2005). Impacts in these dry regions are related to variations in temperature (excessive heat or frost) and rainfall (droughts or flooding). In some parts of Kazakhstan for example, rapid melting of snow and strong winds dry out the soil and cause erosion resulting in crop damage and poor yields. In other parts of the country, increased summer temperatures, a steady decline in precipitation and frequent droughts lead to a decline in the surface water table and subsequent deterioration of pastureland quality. (UNDP-GEF CBA Portfolio Report, 2012).

From the above review of literatures, it is apparent that climate change has an impact not only on agricultural productivity but on the quality of agricultural land as well. Regional climate impact studies show that climate change does not have a uniform pattern. Each region has a climate impact specific to its location and ambient environmental conditions. Sometimes even within a particular region, a spatial and temporal variation of climate's impact on agriculture is seen. In addition to unequal regional pattern of climatic impact on agriculture, there are important inequalities (IPCC, 2001) and other non-climatic stressors (Morton, 2007; Thomas & Twyman, 2005) that increase the vulnerability of developing countries. These include population increase, environmental degradation (caused by poverty, deforestation and soil degradation), HIV/Aids pandemic, state fragility and armed conflict. Researchers have called for a conceptual framework, which would recognize the complexity, and high-specificity of these production systems and one which would incorporate the impact of non-climatic stressors on rural livelihoods (Morton, 2007; Thornton et al, 2009) so as to ensure agriculture and livelihoods remain sustainable and resilient to climate change.

Agriculture's Contribution Towards Climate Change

Before the development of agriculture, hunter-gatherers collected and harvested all edibles needed from nature. In this situation there was minimum exploitation of resources, as they would only take what was needed for subsistence. (Lee, 1997). As these societies evolved into more permanent settlements, the need to till and cultivate became a requirement. Also, evolution of soil tilling, from hand-till to plough, ensured intense food production enough for sustenance and surplus for trade. Ruddiman (2003) calculated the total carbon emissions from 8000 B.P. until the beginning of the industrial era to be twice as much as released during the industrialization period, which indicates the collective impact of small activities by millions of individual farmers over time on GHG imbalances in the atmosphere.

With increases in population, cultivable land had to increase and humans started to clear forests. Since 1945, humans have cleared and converted more land to cropland compared to eighteenth and nineteenth centuries combined. (Cerri et al, 2007). Currently, the major impacts of land use change are occurring in the tropical rainforests of Brazil, Congo and Indonesia. The World Resources Institute in 2000 reported that clearing of forests between 1980 and 1985 alone led to an annual emission of 1.9 PgC (pentagrams of carbon) and since 1980, forest land has declined by 10% in developing countries. If the gases released from deforestation in Brazil were considered, it would rank 5th instead of 17th in the list of highest emitters. (Fearnside, 2006). Illegal deforestation is a major problem in developing countries and though policy makers tighten the regulations deforestation continues. Although land is being cleared for agriculture and increased food production, in the absence of forests the level of precipitation in a region is altered leaving climate change exacerbated, which in turn negatively affects agricultural productivity and food production. (Knorr et al, 2005). With forests decline, other ecosystem services of cross-pollination of species, clean air and water (Foley et al, 2005), soil stability and erosion control (Bertol et al, 2005) are lost with it.

Besides deforestation and land clearing, agriculture's contribution to climate change varies depending on the following factors as well:

- Vegetation cultivated: Recent studies have shown that most land surface-atmosphere interaction takes place through vegetation (Raddatz, 2007) and that changes in land cover (vegetation type) could affect the local and regional climate owing to variations in albedo, soil water, surface roughness. (Bonan, 2002).
- Irrigation creates "soil moisture hotspots" that affect convective rainfall in an area. (Desjardins et al, 2007). Further studies on different irrigated sites have concluded increasing trends in dew point temperatures and decreasing trend between the monthly maximum and mean temperature as well as modifications in the growing season. (Adegoke et al, 2003 Mahmood et al, 2004).
- Soil temperature affects the heat in the ground and soil constitutes the largest surface carbon pool approximately 1500 Gt. (IPCC, 2003). Any land use or land use

change can modify the soil carbon stocks even if some agricultural carbon systems are perceived to be in a steady state. (Six et al, 2002; Lal, 2006).

- Increased use of fertilizers during the Green Revolution have transformed large areas of land and injected the huge amounts of human-induced nitrous oxides and nitrogen gases into the atmosphere. (Hopper, 1995; IPCC, 2001).
- Livestock production is another big emitter of greenhouse gases. These include methane release from enteric fermentation and manure management activities, nitrous oxide from manure and carbon dioxide from degradation of pasture. (Steinfeld et al, 2006).

The impact and contribution of these activities is not similar and the impact of each factor is interdependent on the type of land being worked on, type of vegetation cover, ambient weather conditions etc. Within each region agriculture may have a different influence on the persistence of wet or dry conditions and this may again vary for seasons. (Shukla & Mintz, 1982; Timbal et al, 2002; Koster and Suarez, 2004).

The contribution of agriculture to GHG emissions is difficult to estimate because of the diffusion of sources and complexity of the systems. (Gregory et al, 2005). Therein lies the need to better understand the causes and mechanisms of elevated GHG emissions for different soil types and different vegetation. This information is needed to better inform sustainable agriculture practices that will balance productivity and GHG emissions. Agriculture has an undeniable influence on the way climate has been changing and will greatly influence future climate change. And moving forward a need for a Climate-Smart Agriculture does exist.

Food Security – Its Interactions with Climate Change and Agriculture

The eradication of hunger is one of the topmost priorities in the Millennium Development Goals and by the middle of the century there will be about 9 billion people to feed. (Godfray et al, 2010). The ability of agriculture to cater to growing demand has been a cause of concern since generations and continues to be high on the global policy agenda (Rosegrant & Cline, 2003) especially with 805 million people still starving. (FAO, IFAD & WFP, 2014). There is immense pressure on the global food system and climate change is one of the leading factors that make the task more daunting. In this section, different aspects of food security are looked at to be able to appreciate the multidimensional character of food security in its interactions with climate change and agriculture.

The FAO defines food security as a "situation that exists when all people, at all times have the physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." (FAO, 2001). The definition has four key aspects: availability, stability, access and utilization. Most studies on food security have mostly concentrated on the impact of climate change on food production or crop yields. (Rosenzweig & Parry, 1994; Parry et al, 2005; Lobell & Field, 2007).These studies reported the negative impacts of climate trends on crop yield especially in sub-tropic and tropic regions. But to get a complete "food security-climate change-agriculture" nexus all the four aspects of food security have to be considered. With increased incidences of extreme weather events such as flooding, droughts, hurricanes (IPCC, 2001; 2007) and a decreasing growing season climate change not only affects the crop yield (availability) but stability of such a produce is affected too. For example in semi-arid regions, droughts can dramatically reduce crop yield, livestock numbers and productivity. Most of these regions are located in Africa, parts of South-east Asia and the Latin and Caribbean region meaning that the poorest regions with the highest level of under-nourishment will be exposed to high degrees of instability in their food and food production. (Bruinsma, 2003).

Another dimension of food security is “access”: access to adequate resources for acquiring appropriate food for a nutritious diet. Access implies both the physical and economic accessibility of healthy food. Climate change affects both to a certain extent. Reduced predictability of weather patterns and increased occurrences of extreme weather events have led to decreased physical access to food. In developing countries, the infrastructural constraints worsen the situation and leave rural population helpless. Further, climate change reduces economic access to food by affecting food prices. With climate change, the cost of producing food and prices of imports have steeply increased, reducing the buying capacity of small-scale or resource poor farmers. But economic access to food is an issue in both developed and developing countries and to think climate change is the main stressor in this situation would be myopic of research. Economic access to food is reduced because of policies in place and among other factors, the politics on which these policies are based.

In developed countries for example, it costs more to eat a vegetable or fruit than to buy a can of soda and chips. It is an established fact that the cost of healthy food like fresh fruits and vegetables is high (and rising) compared to processed food. (Drewnowski & Darmon, 2005). Areas with limited access to healthy foods but plenty of fast food restaurants and convenience stores are so common in America that they have been christened "food deserts". In communities without supermarkets, many families buy their food from corner stores. These stores often only carry packaged food and do not offer much fresh fruit or vegetables. Studies have been conducted which indicate that locations of food deserts or unhealthy food environments correspond to areas with highest number of African-Americans/Black residents. (Gordon et al, 2011). From this it is evident that the poor in developed countries have little economic access to healthy food. Similarly, economic access of food for the poor in developing countries is greatly reduced by rising food prices. For example, between 2006 and 2008 the price of rice tripled, price of wheat doubled, price of soy and corn increased by 150%. (Ziegler, 2011). During the food price crisis of 2008, 37 countries were affected worldwide: among them Yemen in the Middle East; Haiti in the Caribbean; Peru and Mexico in Latin America ; and Bangladesh, Pakistan in Asia.(Kitissou, 2014). Many of these countries are dependent on imports and shocks in the world economy affect imports everywhere. Food riots broke out in 15 of these nations as well. Many reasons were given to account for the spike in food prices from natural to man-made disasters such as diversion of crops for bio-fuels. However, Kitissou noted that to simplify the cause as a "Cash crop Vs Staple" conundrum faced by policy makers would mean to overlook the complex but powerful structure within the agriculture and food system that drives food production and the policies that really affect access to food as well. Thus, the purchasing power of consumers, their real incomes and food prices are key elements that affect accessibility to food. And these elements in turn are greatly affected by climate change, shocks in the agricultural economy and government policies.

"Utilization" is the fourth aspect of food security that encompasses all food safety and quality aspects of nutrition. It is the utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional wellbeing where all physiological needs are met. (FAO Policy Brief, 2006). The utilization of food based on this definition varies depending on the household level knowledge of food storage and cooking techniques and differs for different cultures. Climate change affects the way individuals use food effectively, by altering the conditions for food safety and changing the disease pressure from vector-, water- and food-borne diseases. (Schmidhuber &Tubeillo, 2007). Studies have shown that with rising temperatures there will be increased incidences of food poisoning. (Kovats et al, 2004; Fleury et al, 2006). Extreme rainfall events can increase the risk of outbreaks of water-borne diseases especially where traditional water-management techniques are still used. (IPCC, 2007). Flooding in countries with poor infrastructural facilities can expose scores of population to water-borne diseases like cholera and jaundice that reduce their capacity to utilize food effectively. The purpose of food security is futile and incomplete if food is made available and accessible but people cannot utilize it effectively.

The different aspects of food security and its dynamic interactions with climate change and agriculture sheds light on the complexity of CSA's task and also brings out the vital need for such a concept. The preceding sections deconstructed the nexus and established the links between climate change, agriculture and food security. These links prove that business as usual will not be able to address the inter-connected problems of food security and climate change. Food and agricultural systems must be made more efficient and resilient at every scale from the farm-level to the global level. It is precisely to cater to this issue that the FAO forged the concept of CSA as a way forward for food security and agricultural productivity in a changing climate. CSA aims to improve food security, help communities adapt to climate change and contribute to climate change mitigation by adopting appropriate practices and developing enabling policies and institutions.

1.2 Green Revolution

Green Revolution, Metress (1976) noted had become the patron saints of the "technology is God" cult in the '60s. With its package of high-yielding variety of seeds, fertilizers, pesticides and promise to end hunger it was supposed to be a scientific transformation that would radically change third–world agriculture and thus bring about self-sufficiency in these countries. This section briefly draws attention to the genesis of the revolution and its impact on small farmers around the world. Firstly, the genesis of the Green Revolution highlights the institutions and governments that spearheaded research into agriculture and the "Green Revolution" so as to draw a parallel with the institutions that are leading in research in the field of Climate-Smart Agriculture. The second section concentrates on the impact of Green Revolution on the small farmer. This is intended to get a better understanding of the famer's point of view. Gauging the farmer's viewpoint is important to be able to analyze and critique climate-smart practices which are on the field and in the making.

Brief Genesis of the Green Revolution

In the 1940s, scientific missions were sent to Mexico to assist in agricultural development at the behest of the American government and US foundations. (ActionBioscience website, 2002). Norman Borlaug was the scientist associated with the Rockefeller foundation that bred the "miracle seeds" of wheat in the plant-breeding program in Mexico. These miracle seeds promised high yields if supported by prescribed fertilizers and controlled irrigation practices. Such a combination of high–yielding grain seeds and intensive inputs based on modern agricultural technology promised multiple harvests for the farmer (Metress, 1976) and saw to the advent of the Green Revolution. This assumed link between the new seeds and abundance was sought to be replicated rapidly especially in food-starved Asia. The diffusion of these "miracle seeds" of wheat was successfully overseen by the International Maize and Wheat Improvement Centre (CIMMYT) which had been set up in 1956 as a result of venture between the Rockefeller Foundation and the Mexican government programme. (Shiva, 1991). In 1960, the Rockefeller and Ford Foundations set up IRRI or the International Rice Research Institute in Philippines to produce and launch the "miracle" rice in Asia to transform their agriculture. (IRRI website, n.d.). By the 1970s, a string of similar specialized agricultural centers emerged in different parts of the world like the Centro International de Agriculture Tropical (CIAT) in Colombia, the International Institute for Tropical Agriculture (IITA) in Nigeria, the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) in India etc. In 1971, at the initiative of Robert McNamara, the president of the World Bank, a Consultative Group on International Agricultural Research (CGIAR) was formed to finance the network of International Agricultural Research Centers (IARC). (Shiva,1991). Since then this group has enlarged to a consortium of 15 IARCs. This network of institutes ensured the propagation of Green Revolution in Asia, Africa and Latin America.

Though CGIAR was formed to support this large network of IARCs, in reality it ensured centralized control of knowledge which was built into the chain of CGIAR from which technical know-how of seed varieties and other technology were transferred to second-order national research centers by bypassing farmers' rights to seeds and ignoring traditional knowledge that came with the farmer. (Shiva, 1991). At one level, this ensured farmer's dependence on capital-intensive agricultural techniques and at the country level, third world nations had to open their markets to U.S. Agro-chemical giants to provide these inputs. Though Green Revolution held the promise of self-sufficiency, in actuality it brought with it a dependence on foreign capital and inputs. Hence as Shiva (1991) noted, the science of the Green Revolution was essentially a political choice.

Impact on Small Farmers and Their Farming Techniques

- **Loss of the "seed" and loss of crop diversity:** For 10,000 years, farmers and peasants had been producing their own seeds, on their own land, selecting the best seeds, storing them, replanting them and letting nature take its course in the renewal and enrichment of life. (Dasgupta, 1977; Shiva, 1991). With the introduction of the "miracle seeds" it became private property protected by patents and intellectual property rights. The farmer had to purchase the seeds, which was once a common genetic heritage. In some cases they were allowed to reuse them without further payment but the reused hybrid seeds reduced the yield of the crop. (Mallick, Ejnavarzala & Reddy, 2011). This changed the fundamental nature and meaning of 'seeds'. (Shiva, 1991). Agriculture for centuries was based on the strategy of conserving and enhancing genetic diversity but institutions now controlled the genetic expression of seeds .This control enabled them to substitute genetic diversity and self-renewability of crops with uniformity and non-renewability which ensured multi-national profits. The farmer thus lost his privileges to the seed and nature lost its innate ability to be bio–diverse.

- **Increased use of fertilizers and pesticides adversely affected income and health:** The miracle seeds were produced to be high consumers of fertilizers and pesticides. Traditionally, agriculture was based on organic farming techniques, including organic manure and locally available inputs (Mallick, Ejnavarzala & Reddy, 2011) but with these seeds, farmers had to invest in chemical fertilizers which added to the burden of the small farmer. In India for example, many farmers in agriculturally backward areas could not afford to purchase chemical fertilizers, and distribution centers and credit facilities were also inadequate in these areas.(Chakravarti, 1973). The demand for pesticides increased not just as a complementary demand along with the "miracle seed" but also had an unfortunate effect on crop diversity. Mono-cultural practices eroded the genetic base of third-world agriculture. Such a decrease in crop species diversity led to greater incidences of diseases and insect-pests. (Sidhu, Vatta & Dhaliwal, 2010). An example worth noting here is the one cited by both Shiva (1991) and Pimentel (1996). They noted the case of brown planthoppers in Indonesia. Before the Green Revolution, the brown planthopper was a minor pest in the rice crops of Java and north Sumatra. By the late 1970s however, the planthopper grew resistant to the pesticides that were wiping out its predators and it devastated over 1.2 million acres, destroying 350,000 tons of rice, which was enough to feed 3 million people for a year. Efforts to eradicate this remarkably resistant insect with higher doses of pesticide proved to be a costly affair and a failure. So when another brown planthopper plague appeared imminent in 1986, the Indonesian government reverted to prerevolutionary techniques: it cut pesticide subsidies and banned many pesticides from rice fields. Within a year, pesticide use fell by more than half, natural predators thrived, and the planthopper population in pesticide-free fields declined by 75 percent. Crop yields soared, and the government saved a small fortune in agrochemical subsidies.

Extensive use of pesticides has caused serious public health and environmental problems as well. (Bull, 1982; WHO, 1990). Singh (1993) reported that infants in Ludhiana and Mukteshwar (regions of Punjab) were receiving pesticide dosages, which were 13 to 24 times the levels prescribed by the World Health Organization. This was attributed to the heavy contamination of staple food grains (in the mother's diet) with DDT and other harmful pesticides. Thakur et al (2008) concluded that there were significantly higher levels of cancer in villages where pesticide use was heavy. Other reports (Zwerdling,2009; Kuruganti, 2005) among children in Mexico and India found that children living in villages that had high pesticide use performed significantly worse, as a group, on memory and coordination tests than children in villages that used less pesticides. This intensive use of fertilizers and pesticides has not only affected the health of the farmer and his family but it has taken a heavy toll on livestock and the ecosystem as well. With reduced plant diversity, loss of fauna has been widely reported. To the extent that today, peacocks — India's national bird — have become a rare sighting. (State of Environment: Punjab, 2005; 2007; Kaur Sangha, 2014). Shiploads of beef and poultry have also had to be destroyed because of excessive pesticide contamination. Frequently Central American governments have had to take back shipments of beef because they have not cleared the importing nations' pesticide residue limits. (ICIATI, 1977). Thus farmers lose significant number of livestock and animal products due to pesticide–induced issues.

- **Unsustainable water demands by "miracle seeds":** High-yield wheat, for example, required three times the irrigation of traditional varieties. The availability and timely supply of adequate irrigation is a main factor in the adoption and success of HYV seeds. (Chakravarti, 1973). For small farmers in India who depend on seasonal monsoons as their source of irrigation, the "miracle seeds" placed immense pressure on them. Water is a scarce and a precious commodity that is too expensive for a subsistence farmer. In India, canal irrigation is expensive and is not practical if a large plot of land is unavailable. Further this heavy demand for water by one crop proves to be fatal for other dry-land crops such as millet and oil seeds, and the land itself. There is also the issue of irrigation exceeding the land's drainage potential, causing waterlogging and salinization on an unprecedented scale. In India, Shiva (1991) notes that 25 million acres of canal-irrigated land are waterlogged and another 60 million acres are threatened with salinity. And cites an example from the state of Uttar Pradesh, where one massive irrigation project waterlogged 20 percent more land than it irrigated, reducing overall food production.

- **Reaping debt and disparity:** The techniques brought with Green Revolution sparked a vicious cycle in which farmers were forced to spend more on fertilizers and pesticides to not only start a monoculture–based farming but to counteract what monoculture and heavy fertilizers had done to their land. (Laidlaw, 2008; Zwerdling, 2009). Fertilizers and pesticides were the least of the inputs; the farmer had to invest in capital-intensive indivisibles like tractors and finance, which was not easily accessible to all farmers. The poor farmers and landless tenants in India had to seek institutional credit with local village cooperatives and more often than not, bureaucratic formalities would make it impossible for small farmers to procure credit. (Dasgupta, 1977). This increased debt among the poor farmers and disparity between farmers within one village since the poor and rich farmer did not have equal access to agricultural technology and finance to enable production. Further, Dasgupta (1977) observed that the adoption and success of the Green Revolution in India took place in selected areas, which were known for developed infrastructural facilities like irrigation canals, credit facilities, a good network of transport and communication. These areas were also the places that had a group of rich famers that were willing to experiment with new capital-intensive technology. This elevated the regional disparity in India.

Thus, in essence the Green Revolution dispossessed small farmers of their land, their seed and skewed their choices. The science and technology of the revolution excluded poor regions, poor people and sustainable options. (Shiva, 1991). Though it promised countries like India self-sufficiency in food in the 60s, four decades later the nation is still food insecure. The country is home to a quarter of all undernourished people worldwide. (WFP country statistics, 2014). The combination of science and politics that first generated research in the Green Revolution promised Mexico and other Latin American nations an export-oriented agriculture and in the process distorted the environment and threatened small farmholder livelihoods and the country's food security. Giving developing countries an agro-technology solution that is already stacked against the poor of the state is tantamount to giving no solution at all.

Lappe, Collins and Fowler (1984) summarized it as follows:

Historically, the Green Revolution represented a choice to breed seed varieties that produce high yields under optimum conditions. It was a choice NOT to first concentrate on improving traditional methods of increasing yields, such as mixed cropping. It was a choice NOT to develop technology that was productive, labor-intensive and independent of foreign input supply. It was a choice NOT to concentrate on reinforcing the balanced, traditional diets of grain plus legumes. (p. 153)

This chapter established the inter-connected nature of food security, climate change and agriculture. Based on past approaches, it is clear that our systems of food production and agriculture have indisputably contributed to climate change. A Climate-Smart approach to growing food and feeding ourselves is called for so as to reduce the impact of climate change on the ecosystem and us. But such an approach should ensure that it does not tread the path pioneered by Green Revolution and become a façade for commercial agribusinesses to present skewed choices to the small farmer and leave climate systems no better than they are today.

Chapter 2

Research Method and Analysis

2.1 Data collection and method

In order to identify climate-smart interventions, the “Climate-Smart Agriculture” definition (see Appendix A) as stated by the FAO (2010) and as stated by Neufeldt et al (2013) are used. These are the two definitions that are widely cited and used by development organizations as the working definition to initiate CSA in different countries. These interventions include agricultural practices for climate change adaptation and delivery systems/institutions in place to manage climate risks. Each of these interventions may or may not have farmers as the ultimate decision-maker but they are primary stakeholders and their perspective is important and must be explored. The interventions chosen to be examined are not an exhaustive list of climate-smart interventions but they are representative of the direction in which climate-smart agricultural activities are headed. The interventions examined are:

- Agroforestry
- Integrated farming and fishing systems
- Preserving genetic diversity
- Agricultural and livestock waste management
- Urea Deep Placement technique
- System of rice intensification
- Water management techniques
- Renewable energy options
- Genetically modified crops
- Climate risk management systems

These interventions were identified by going through online databases of development organizations and agriculture consortiums. In addition to identifying interventions, specific projects for each intervention have been chosen to clearly understand the impact of each intervention on small farmers and their livelihood.

The projects chosen under each intervention are successful and ongoing sustainable initiatives in action in the field. In this paper, they will be treated as case studies. These projects belong to leading development organizations like the UNDP, World Bank, FAO etc. Some projects cited were initiated in partnership with USAID, CGIAR consortium of institutions and GEF as well. The project reports were all procured through the open access repositories of individual organizations. The reports give facts, figures and information about the background of the community, the decision-makers involved in the project, funds available, the beneficiaries and co-benefits of that particular project. The information that is present and absent in these reports will give insights into the effectiveness of CSA interventions from the small farmer's point of view. The reports have pertinent information that will help answer the research question, "Does Climate-Smart Agriculture truly empower the farmer?"

The effect Green Revolution practices had on farmers in developing countries has already been established. Similarly, development organizations often initiate ambitious projects with promises to change landscapes and people's lives but by the time the project is completed the real victims of climate change and food security are not left empowered. Therefore, in this study CSA interventions are examined and only those that meet the below mentioned conditions will be considered as truly empowering from the farmer's perspective. The necessary conditions are:

1. It needs to be **financially sensible** (see Appendix A for further information) for a small farmer to initiate and continue practicing in the long run.

2. It needs to be **ecologically sound** (see Appendix A for further information) and aid in mitigating climate change or adapt to it.

In other words, this study attempts to discover how far "Climate-Smart" interventions empower a farmer to engage in activities that mitigate climate change without compromising on basic needs like food and livelihood.

2.2 Research analysis

The analysis begins by highlighting the origins and main players involved in the "Climate-Smart Agriculture" movement. This is done to draw a parallel between the origins and main actors of Green Revolution and find out if patterns emerge. The second part of the analysis moves to examine individual CSA interventions based on the conditions mentioned above.

Origins of CSA and the Main Players

The term CSA was first used in a FAO conference (2009a) to describe the tensions between maximizing agricultural productivity, increasing resilience of agricultural systems in the face of climate change and mitigating Greenhouse Gas (GHG) emissions from agriculture. (FAO, 2009b). CSA was defined and presented in the technical document prepared by FAO as an input for the 2010 Hague Conference on Food Security, Agriculture and Climate Change. One of the key messages of the paper was the need to develop climate-smart agricultural systems and the need to transform agriculture in developing countries in order to achieve future food security and climate change goals. (FAO, 2010). The efforts of this conference led to a global agenda to realign investments in agriculture towards climate-smart interventions. Based on the conference's CSA definition and features, different organizations have introduced a variety of CSA interventions including innovative agricultural practices, shift in policies and delivery mechanisms. In 2012, the second Global Conference on Agriculture, Food Security and Climate

Change in Hanoi led to the publishing of the Climate-Smart Agriculture Sourcebook which further advanced the concept. (FAO, 2013). The CSA Sourcebook was written for policy makers and planners giving them a brief analysis about all the issues that need to be addressed in different sectors like water, livestock, soil, energy, genetic resources, fisheries etc. The major part of this sourcebook concentrates on changes that need to take place in the productive or supply side of agriculture to make it climate-smart. Only one module in the sourcebook contributed to the consumptive/demand aspect of food - namely the unsustainable food choices people make and food waste occurring, especially in developed countries and in the burgeoning middle class of developing nations. If CSA exists to address the food security of farmers on one side of the globe, then it needs to address the food waste occurring on the opposite side of the globe. For CSA to be effective for the environment, there needs to be systemic changes on the demand and supply side.

On 23rd September 2014, the Global Alliance for Climate-Smart Agriculture (GACSA) was launched at the UN Climate Summit. With the launch of this alliance, CGIAR committed more than half of their operating budget (500 million dollars) towards CSA interventions. CGIAR press release dated 23rd September 2014 had the headline: "Leading agricultural research partnership pledges to bring "climate-smart" agricultural innovations to half a billion vulnerable farmers over 15 years."

GACSA sought to improve people's food security and nutrition in the face of climate change and streamline research in this endeavor. The action plan of the alliance read that it considers itself a voluntary, farmer-led, multi-stakeholder, action-oriented coalition committed to CSA. But a look at the member list provides insights into this self-proclaimed "farmer–led" coalition. At the launch, the members included individual member countries and other strategic partners like CGIAR, IARCs, CIAT and World Bank who will spearhead the intervention in different countries. By January 2015, the membership of this alliance grew to 74 members. Barring the 18 individual country members, more than a half of the remaining 52 members belonged to the consortium of CGIAR-linked organizations, World Bank and similar agencies.

CSA as a concept is relatively young but on tracking the development of this concept, its definition and the major agencies that are funding research in this field, it is interesting to note that almost all the organizations that promoted Green Revolution in the 1960s are promoting the climate-smart agricultural revolution as well, namely CGIAR, their IARCs and World Bank.

If climate-smart research is mainly being promoted by the strategic partners of Green Revolution, then a further examination of existing climate-smart interventions will give a much–needed reality check to these practices.

Critical examination of CSA Interventions

<u>Intervention 1: Agroforestry</u>

Agroforestry is a set of land-use practices that involve a deliberate combination of trees, agricultural crops and/or animals on the same land management unit in some form of spatial arrangement or temporal sequence. (Lundgren and Raintree, 1982). Retaining or deliberately mixing of woody perennials with herbaceous crops and/or animals plays both the productive function of providing food, fodder, fuel and wood and a protective role through soil conservation, wind breaks and shelter belts. Agroforestry practices initiated will vary depending on the ecological and geographical zone. As mentioned earlier, interventions of CSA are not all new. For instance, agroforestry involves reviving traditional practices like combining trees and crops which were an inherent part of traditional farming methods. Traditional farmers practiced agroforestry to divide their risk, conserve land and maximize output.

Case study: Securing livelihoods and environment through agroforestry, Tanzania (Information sourced from FAO-GIAHS, 2008a)

In Tanzania on the southern slopes of Mount Kilimanjaro, the “Kihamba” agroforestry system covers 120,000 hectares. Under FAO’s Globally Important Agricultural Heritage Systems (GIAHS) initiative, preserving the 800-year old Kihamba system was prioritized. The FAO project report noted that activities were piloted in 660 households to enhance farmer’s cash income while preserving the ecological and social integrity of the system. This project was aimed at ensuring that the agro-forestry practices in place would continue to provide food security and livelihood for the nature-dependent population residing in the area. The report indicates that farmers were introduced to certified organic coffee farming and vanilla as a high value additional cash crop. With the conversion to organic coffee, the farms not only indulge in a healthier way of growing coffee but will be able to increase the cash value of their coffee. This project enabled farmers to rethink sources of cash income by not compromising on the environment. This initiative rehabilitated an already intricate system of irrigation canals and ponds, “Nduwa,” which helped farmers produce a diversity of crops. In addition, the report notes the introduction of trout aquaculture along the canals to supplement the farmer’s food needs. The high biomass production and sustained cultivation of the multi-tier agroforestry system are critical for the ecological resilience of the Kilimanjaro District. (FAO-GIAHS, 2008a).

Case Study: Agroforestry in drought-stricken Sahel region, Africa (World Vision Australia, WVA, 2005)

Agroforestry has been practiced in the drought-stricken Sahel region of Africa for two decades. In Sahel, the Maradi Integrated Development Program introduced Farmer-Managed Natural Regeneration (FMNR) 20 years ago, under which farmers allowed stumps to regenerate.

(Taylor and Rounds, 1991; Rinuado, 2005). FMNR is a systematic regeneration and sustainable management of trees and shrubs growing from living tree stumps, roots or seeds. (Rinuado, 2005). It involves selection and pruning of regrowth coming from tree stems and roots. During the 1980s, the FMNR initiative began as part of a UN food-for-work program targeting 95 villages in Maradi region of Niger. (WVA, 2005). World Vision reported in its website that the initiative did not sustain beyond the food-for-work program because of stringent laws regarding ownership of trees in Niger. It was only after the ownership of trees was transferred from the government to the farmer that the farmer began to consider growing trees as an alternative approach to obtain cash, food and firewood. In time, farmers who retained their trees got more firewood, fewer pests and diseases, less soil erosion, rising water tables and higher crop yields. Over a 20-year period, the report indicates an increase in grain production to the tune of 500,000 tons per year, an improved food security situation for 2.5 million people, restoration of 5 million hectares (ha) of land with over 200 million trees reestablished or planted. (WVA, 2005).

The above-mentioned Tanzanian and Sahelian agroforestry case studies are proof that it is possible for agroforestry to create a more integrated, diverse, productive, profitable, and sustainable land-use system that is also beneficial to a small scale farmer. In both case studies, farmers were encouraged to grow a combination of trees and crops that are naturally occurring and indigenous to their areas. Such an intervention allows even a resource-poor farmer to adopt and practice FMNR and/or agroforestry. Further, it gives individuals and community members the opportunity and responsibility to nurture naturally occurring woody vegetation, thereby restoring degraded land and rewards them with alternative sources of cash income by sustainable harvesting of wood and non-timber forest products. Here the only obstacle for initiating or continuing such a practice would be lack of awareness and the prevalence of restrictive laws, which reduce the farmer's incentive to keep practicing agroforestry. Thus, agroforestry as a climate-smart intervention is truly an intervention that mitigates climate change while being pro-poor, locally-led and empowering for a farmer.

Another feature that needs to be highlighted is that polyculture plantations are an important and distinguishing characteristic of agroforestry, as compared to monoculture plantations or industrial forestry. The former is based on a multi-tree/multi-crop system that does not result in degradation of that soil or ecosystem but the latter is based on a western model that includes mass planting of exotic species like eucalyptus or species that generate maximum income like rubber trees but drains the soil of vital nutrients. Only an agroforestry practice that encourages farmers to grow a combination of trees and crops that are suitable for their geographic zone or indigenous to their area must be considered as an acceptable climate-smart practice by development organizations. This is an intervention that has the potential to change not only the landscape but also has the potential to empower the small farmer if practiced in the real spirit of the intervention.

Intervention 2: Integrated Farming/Planting and Fishing Systems

Fisheries and aquaculture are important contributors to food supply, food security and livelihoods of people at the local and global scale. But rising sea levels and increased salinity have proven to be destructive to coastal zones and mangrove forests, which provide a haven for different species of seafood. Overfishing has also depleted the stocks of fish and unpredictable weather owing to climate change has greatly affected the lives of many fishermen. In such a scenario, the only sustainable and local solution for these people would be to practice integrated fish-farm-livestock systems. Such systems are formed by taking into account the knowledge and uncertainties about biotic, abiotic and human components of an ecosystem and their interactions.

A primary implication is the need to cater both for human as well as ecosystem well-being. This implies conservation of ecosystem structures, processes and interactions through sustainable and innovative use of resources.

Case Study: Aquaponics and Mangrove planting, Barbuda (UNDP-SGP Project database,2013)

Barbuda, the sister island of Antigua (West Indies) is home to a fishing community deeply and directly affected by both rising sea levels and the harsh reality of food insecurity. Here, UNDP reported an initiative under its Small Grants Programme (SGP), which was started in conjunction with the NGO Barbuda Research Complex. The project piloted an aquaponics project in which small fish like tilapia are grown in a tank and the aquaculture effluents are not wasted but diverted to an herb/vegetable garden. In an island where water and food are precious commodities, this intervention is not only climate-smart but empowers the farmer with an alternative food source and livelihood. The project report further noted the planting of four different varieties of mangroves along the Codrington lagoon in Barbuda, which had been devastated by recent hurricanes. (UNDP-SGP, 2013). These mangrove forests stabilize the coastline, reducing erosion from storm surges, currents, waves, and tides. The intricate root system acts as an important nursing habitat of juvenile marine species and also provides direct economic benefit to the fisheries sector in Antigua and Barbuda. In addition, they provide food and shelter for many species of sea birds and marine invertebrates such as crabs, sponges, tunicates, molluscs and crustaceans. These animals make their homes within mudflat areas of wetlands and among the prop roots of red mangroves. This system not only makes optimal use of existing resources but is a climate–smart adaptive intervention. Further, it allows community members to contribute to other activities that will mitigate climate change and venture into a sustainable and alternative livelihood option like aquaponics.

Case Study: Rice-Fish Farming, Bangladesh (Project obtained from World Bank database, 2009a)

This traditional farming system involves raising fish (and sometimes ducks) in rice paddies. They provide pest control and fertilization, reducing the need for external inputs (and costs), increasing profitability and sinking environmental impacts. It also reduces competition for water and other resources and provides additional income and food sources, which provide a small buffer against climate variability. This practice was initiated in rural Bangladesh where poverty and climate change have rendered malnutrition the norm for children. In 2009, World Bank through their Development Marketplace program selected 100 farmers in Gauripur and Phulpur sub districts under Mymensingh district of north-central Bangladesh, which is one of the rice bowls of the country to develop a fish culture in rice fields. The fish raised in these rice paddies are Small Indigenous Species (SIS) of fish from Bangladesh, which are particularly high in protein and micronutrients. Such a community-based small indigenous fish culture development in rice fields of rural Bangladesh has the potential to not only provide much-needed nutrients to infants and young children but also provide farmers with an added source of food and income without any environmental consequences.

By integrating different systems of fish and rice together, the small farmer reduces his vulnerability to not only climate change but food insecurity. It also gives the farmer/fishermen an opportunity to take up an alternative sustainable livelihood of raising fish in an aquaponics farm, at a time when fish stocks in the sea have depleted and climate change has made fishing more risky and treacherous for fishing communities. Further, such an integrated approach reduces waste in the system, optimizes the use of natural resources and allows the farmers to not only practice climate-smart agriculture but also be part of producing energy-smart food as well.

Hence, an integrated fishing/farming system is one of the ways to move ahead, especially for small farmers because it is an ecologically sustainable option that enables the farmer to be self-dependent as well. Aquaponics does involve a certain degree of financial commitment but it is more of a fixed investment than a recurring cost that the farmer will incur. The rice-fish farming system is relatively easier for a small farmer to adopt. These are actions that will sustainably make the farmer resilient in the face of climate change. It needs to be mentioned here that institutional support can go a long way for such practices that attempt to create alternative and sustainable livelihood/food options.

Thus, the integrated farming and fishing system is truly climate-smart and provides the farmer with sustainably resilient options of farming, fishing and living.

Intervention 3: Preserving Genetic Diversity

As mentioned in the first intervention, polycultures and multicropping rather than monocultures must be the mainstay of Climate-smart agriculture. Preserving and maintaining the rich genetic diversity of different crops and domestication of wild relatives revitalizes soil and ecosystem health. Such genetic diversity results in better yield and lesser pests. In such a situation, farmers have the freedom of practicing the age-old tradition of retaining different seeds of the same crop for further cross-breeding and to maintain the genetic diversity among their crop. Traditional seed management systems like seed saving to preserve genetic diversity provides for a biodiverse and more importantly resilient ecosystem.

Case Study: Preserving Andean traditional genetic diversity, Peru (FAO-GIAHS, 2011)

The FAO Commission on Genetic Resources for Food and Agriculture adopted a “Program of Work on Climate Change and Genetic Resources for Food and Agriculture” to promote the understanding of the roles and importance of genetic resources for food and agriculture in food security and nutrition and in ecosystem resilience in light of climate change. (FAO-GIAHS, 2011). The project reported that farmers still cultivate colorful traditional potatoes and quinoa varieties, each for a special climate and altitude condition. Terraces allow cultivation in steep slopes and different altitudes in the high plateau, around Lake Titicaca (Central Andes). In the canals, silt, sediment, algae, and plant and animal residues decay into a nutrient-rich muck. This can be dug out seasonally and added to the raised beds. These heritage systems are characterized by ingenious microclimate regulation, soil and water management schemes, and the adaptive use of crops to deal with climate variability. These practices are heavily dependent on local rich resources of indigenous knowledge and associated cultural heritage. It helps maintain soil fertility, biodiversity and control land degradation. The FAO-GIAHS project, in coordination with the Peruvian Ministerio del Ambiente (MINAM) and the participation of local institutions, helped value these ingenious agricultural systems and traditional products that have maintained this unique, culturally and biologically rich environment since centuries. Such projects leverage global and national recognition of the importance of agricultural heritage systems and institutional support for their safeguard.

Case Study: Trinidad-Identify and distinguish ancient cocoa varieties (World Bank, 2009b and the University of West Indies website)

The World Bank initiated this project in 2009 under the “Sustainable Agriculture for Development” program. This project relied on the willing cooperation and assistance of 69 small cacao farmers, who have steadfastly conserved these relic (traditional) trees. The scientists from Trinidad and Tobago visited the farms, collected leaves, flowers and fruits, accompanied by precise GPS coordinates at each location, and characterized the trees to reveal a very diverse population. Pods were harvested and the beans fermented and dried under Trinidad and Tobago’s traditional cocoa processing conditions and then sent to the chocolate making laboratories of MARS, Inc. and Cocoa Research Center of The University of West Indies, St. Augustine, for further processing and sensory evaluation that identified an array of fruity and floral flavors, typically inherent in the twin island's famous cocoa flavor reputation. The project reported that a group of molecular genetics researchers from the University of British Columbia, in close collaboration with researchers from the US Department of Agriculture at Beltsville analyzed the DNA extracted at the research center from the leaves of these selected cacao trees and created a novel molecular tool, which enabled them to distinguish many different types of these ancient cacao trees. Data on their origin as well as their flavor and agronomic characteristics were included on a newly designed website that aims to provide chocolatiers and other interested persons with a sophisticated source of information on Trinidad and Tobago's incredible wealth of cacao diversity and its allied flavors. (University of West Indies website, n.d.).

This project aimed at identifying the different and distinct varieties of cocoa available in regions of Trinidad so as to preserve them and also let the farmers know of the presence of such varieties in their backyard. The 104 relic cacao trees identified were cloned and conserved in local gene banks as very valuable Trinitario germplasm for distribution to farmers, and was utilized for breeding new varieties with enhanced flavor and yield attributes to augment the already outstanding Trinidad Selected Hybrids. Farmers were also given training and workshops on branding and how to market the uniqueness of their cocoa seeds so that they get a fair deal for their higher quality product. But the report did not specify details about the way in which small-scale farmers will have access to a market to get this premium or no other fair-trade model was initiated so as to guarantee the best price to these small-scale farmers. The attempt to preserve and identify genetic diversity is climate-smart but for it to be truly empowering, it needs to ensure farmers a channel to get the direct benefits of this varied and unique gene pool.

Preserving traditional varieties of crops for food and agriculture is climate-smart and will continue to represent key resources for building the resilience of an ecosystem. Domesticating wild relatives will combat the genetic erosion that has taken place over the years through mono-cropping and also build up stocks needed to adapt to changing climes. Both the Andean and Trinidadian case studies aimed to preserve and maintain rich diversity of crops and traditional agricultural systems. However, these practices are very often victims to modernization, unsustainable technological and economic changes. Beyond the project phase of development organizations, challenges and issues such as the lack of promotion of diversified and organic products, competition from globalized and subsidized substitutes (imports of exotic cultivars) produced on industrial and unsustainable farms threaten the foundation of traditional agriculture and associated biodiversity in these agriculture heritage sites. In addition, increasing poverty and food insecurity on these productive landscapes encourage youth to migrate to other regions/occupations or indulge in unsustainable but profitable monoculture plantations. In this age of seed companies, reviving traditional seed-saving techniques through such CSA practices is important. However, for it to be beneficial to the farmer this system has to be incentivized, and training tools must be given to farmers to farm sustainably and certification procedures must be in place for the organic and unique products guaranteeing the farmer a financially sustainable price. It is only then that farmers will feel that sustainable farming by preserving genetic diversity has the prospects to make them resilient in the face of poverty, climate change and food insecurity.

Intervention 4: Agriculture and Livestock Waste Management

Agricultural waste includes field wastes like straw, weeds and livestock waste.

Understanding the type and constituency of the waste is useful to its management. A mountainous community will not have the same quantity and type of waste as an island-based/tropical community. The type of waste management technology adapted for a region must be primarily specific to the community's need and it also must depend on the intensity of wastage or environmental degradation occurring due to presence of agricultural/livestock waste.

Case Study: East Asia, Livestock waste management (FAO-GEF Experience Notes, 2008b)

An FAO-led Livestock Waste Management project in East Asia supported by GEF/United Nations Environment Programme (UNEP) was designed to reduce the major negative environmental and health impacts of rapidly increasing concentrated livestock production on water bodies and thus on the people in three countries of the East Asia region: China, Thailand and Vietnam. This project achieved the introduction of a regional approach that permitted comparison of results and experiences on waste management and policy elements, exchange and transfer of technology and approaches. Even though the three countries had similar issues, since the scale of agricultural operation differed in each country the approach established in each region was different. The project reported that new technologies (biodigestors, manure storage and recycling facility) were introduced in large and mid-sized farms. And small farms were encouraged to begin composting so as to maximize their output through organic farming practices. This initiative noted that its massive effort in this region reached half a million farms. With the collaboration of the government, private sector, financial institutions, academia, research institutes and farmers the greenhouse gas emission mitigation objective was incorporated. Farmers were given training, and workshops were held to make them aware of the impacts of adopting more sustainable practices. (FAO-GEF Experience Notes, 2008b). And it has led to a positive effect on beneficiary incomes and enhanced public participation.

Such practices improve long-term sustainability of the livestock sector for farmers by transferring techniques that convert animal/farm waste into by-products which can be used further or sold (biofertilizers). The additional income and increased efficiency gives farmers the incentive to invest in climate-smart innovative waste technology. Moreover, efficient waste management techniques reduce effluent waste into surrounding water bodies which protects the environment and the population residing in the region. As a climate-smart intervention, agricultural/livestock waste management techniques decrease the farmer's vulnerability by increasing farm efficiency while taking steps to reduce GHG emissions and other pollutants. It is these single-farmer commitments replicated on a regional scale that bring in the global benefits of adaptation and mitigation.

Intervention 5: Urea Deep Placement Technique

Case study: Urea Deep Placement technique in Bangladesh and Nigeria (IFDC Report, 2013)

The Urea Deep Placement (UDP) technique, developed by the International Rice Research Institute (IRRI) and International Fertilizer Development Center (IFDC), is one of the examples cited as a climate-smart solution for rice systems. IFDC is not part of the CGIAR consortium but works closely with them. Since its inception, IFDC has been funded by USAID and World Bank. To put things in perspective it must be mentioned that in 1994, Norman Borlaug became an IFDC directorial board member.

Before UDP, the usual technique for applying urea, the main nitrogen fertilizer for rice, was through a broad-cast application that was considered inefficient, wasteful and polluting to the environment. In the UDP technique, urea is made into "briquettes" of 1 to 3 grams that are placed at 7 to 10 cm soil depth after the paddy is transplanted. The case study reported that this technique decreases nitrogen losses by 40 percent and increases urea efficiency to 50 percent. It increases yield by 25 percent with an average 25 percent decrease in urea use. (IFDC Report, 2013). UDP has been actively promoted by the Bangladesh Department of Agricultural Extension with IFDC's assistance. In 2009, UDP was used on half a million hectares by a million farmers. The widespread adoption of the UDP technique in Bangladesh was reported to have had important impacts: farmers' incomes increased owing to increased yields and reduced fertilizer costs. There are now 2,500 briquette making machines in Bangladesh. On-farm jobs have also been created as the briquettes are placed by hand, which requires six to eight days labor per hectare. With FAO-led support, UDP is being up scaled to African countries as well.

Now, as a climate-smart practice Urea Deep Placement is not a good example of an intervention that actually empowers a small farmer. Firstly, UDP requires the farmer to incur frequent input cost of buying these urea super granules. Secondly, there is the labor cost of applying these urea super granules into the soil and if it is not done manually then a farmer incurs the cost of the applicator. Thirdly, the IFDC report fails to mention that UDP has been in place in Bangladesh since 1980s but farmers are still suffering from severe poverty and food insecurity in this region. Further, there is no conclusive evidence that at a global level UDP has reduced GHG emissions caused by the production and management of fertilizers especially with interaction between various irrigation techniques. Finally, as fertilizer prices are linked to energy prices and consequently very volatile, increasing dependence on an imported inorganic fertilizer only increases the vulnerability of the country and farmers to economic shocks. UDP cannot be considered a climate-smart intervention because it is catered towards a farmer that is financially established with a large farm and is merely an extension of chemical fertilizers of the Green Revolution era. Also, such a system does not aid in revitalizing soil quality. Rather, it makes soil completely dependent on costly inputs.

Intervention 6: System of Rice Intensification (SRI)

SRI is not a usual agricultural technology. It is an agricultural innovation, which is more a menu of options rather than a recipe. It is a set of rice production practices that boost yields, reduce water demand, enhance the environment and mitigate climate change. (Uphoff, 2008). It aims to improve the productive efficiency of land, labor, water, nutrients and capital by being least dependent on agro-chemical inputs and by changing the way soil, land, water are being managed for paddy cultivation. The system of rice intensification is dynamic but the core set of ideas and practices include (Uphoff, 2008):

- Using young seedlings to preserve mature plants growth potential -- although direct seeding is becoming an option with SRI, a major change in the original concept, thanks to farmer innovation.

- Avoid trauma to the roots – transplant quickly without inversion of the seedling-roots tip to avoid the delay associated with resumption of growth after transplanting. Give plants optimally wider spacing – one plant per hill and in square pattern so as to achieve the “border effect” for the whole field.

- Keep paddy soil sufficiently moist but not continuously flooded, mostly aerobic and not saturated. This concept has been adapted for rice growing in rainfed, un-irrigated areas with considerable success. Actively aerate the soil as much as possible to control weeds.

- Enhance soil organic matter as much as possible applying compost, mulch, manure, etc. Chemical fertilizers can be used with SRI, but the best results have come with organic soil.

Results are not uniform across countries or even sometimes in neighboring fields. They will vary according to soil, climate, local constraints, the steps a farmer applies and the quality of management. This is why some farmers triple their usual yields and others achieve only a slight increase initially. Below is a case study of a successful SRI intervention.

Case Study: Vietnam (International Food Policy Research Institute, 2012)

In Dai Nghia commune, 2006 marked the launch of the System of Rice Intensification extension partnership for Oxfam and Vietnam government's Plant Protection Department. Key agro-practices initiated in Vietnam were alternate wetting and drying of soil during grain filling and application of organic fertilizers such as manure. Such an alternate wet and dry approach allows the prevention of anaerobic bacteria, which is a major emitter of methane (a greenhouse gas). The report noted that farmers were allowed to choose which seeds they wanted to plant but were taught a better crop planting technique with seedlings being widely spaced in a grid pattern. On average, SRI farmers increased their yields by 9 to 15 percent while reducing use of inputs compared to conventional practice: 70–75 percent less seed, 20–25 percent less nitrogen fertilizer, and 33 percent less water. (IFPRI, 2012). The report cited farmers' positive remarks about the changes to the environment and their health as a result of less use of pesticides, herbicides and chemical fertilizers. Farmer participation in design and delivery of the program fostered buy-in, helped to garner support for horizontal scaling and facilitated functional expansion and longer-term systemic changes.

SRI is clearly an agricultural intervention that is climate-smart and from the report, it is apparent that such an evidence-based, open-ended learning approach is being well received by farmers and the local technicians alike. The fact that it isn't a one size fits all intervention and the fact that poor farmers are not expected to make continuous heavy investments for their seed or other inputs make this a pro-poor climate–smart strategy. SRI brings benefits to smallholder farmers in terms of increased yields, while building long-term resilience by reducing the amount of water they use and helps mitigate climate change by reducing emissions of greenhouse gases and sequestering carbon in the soil.

Intervention 7: Water Management Techniques

Water is the most crucial resource for sustainable agricultural production in the dry land/rain fed areas. However, the major part of the rainwater falling in the farmer's field in these areas goes away unused as runoff. The runoff does not only cause loss of water but it also washes away precious top soil. Hence, the need to use water wisely through improved irrigation systems and the need to harvest water in rain-fed regions is imperative. Water can be harvested through dams, percolation tanks and by practices like contour bunding and gully plugging. Irrigation can also be made more efficient and effective through technologies like drip irrigation and practices like recycling grey water.

Case Study: Contour Bunding in Sahel (Project from IFAD, 2011)

Rainfall is sparse and intermittent, and droughts are frequent in Sahel region of Africa. When rain does fall, it is usually in short, intense downpours. After the long dry season, the hard-baked surface of the soil is largely impervious, and the rain runs off to be carried away in streams and rivers, along with valuable topsoil. As a result, both people and plants are deprived of the water they need. IFAD's initiative of constructing stone bunds along contours has proved to be an effective way of reducing runoff. These loose 'walls', 20–30 cm tall and spaced 20–50 meters apart, slow the runoff, allowing more of the water to soak into the soil and trapping silt and organic matter that would otherwise have washed away. (IWMI Working Paper, 2008). Combined with other changes in land management, such as digging *zai* pits — shallow bowls filled with compost or manure in which crops are planted — the bunds markedly increase cereal yields. Sorghum and millet yields of more than one ton per hectare have been reported in this project, double the yield achieved on unimproved land. (IFAD, 2011). Further contour bunds are climate-proof, that is if the climate becomes wetter, the bunds will alleviate runoff erosion, and if it becomes drier they will contribute to water harvesting. The report states establishment of contour bunds on 200,000 to 300,000 ha of land across the Sahel. Also, groundwater levels are rising, and farmers have started growing vegetables on small plots near wells, thereby increasing both their incomes and the diversity of their diets.

Case Study: Drip Irrigation for Sugarbeets in Turkey (UNDP-SGP Project database, 2005)

Turkey's 1.3 million hectares of wetlands has been degraded in the 20th century due to unsustainable water use and management practices specifically for irrigation. Traditional irrigation methods are wasteful, in addition, thirsty crops particularly sugarbeet consume much water than the other crops. Besides anthropogenic causes, these degraded lands are also subject to desertification which makes agriculture difficult to sustain. The UNDP-SGP project was initiated to reduce the inefficiency in traditional irrigation system and introduce drip irrigation system in the sugarbeet production. The project aimed to demonstrate and disseminate the experiences of the Kayseri Sugar Beet Cooperative in using drip irrigation for sugar beet production. This technique of irrigation involves irrigating crops by allowing water to drip through an intricate system of valves and pumps which control the amount of water being expended. It not only uses less water and thereby protects the land, but also significantly improves the efficiency of production. Through this technique the objective was to conserve soil, water and wetlands of Central Anatolia. The NGO has been actively involved in the demonstration of the activity since 2005 in this region, which is a regular land for cultivation of sugar beet. The project was able to improve existing drip irrigation systems and install new ones which have helped these semi-arid lands manage scarce water in a better manner. Better water management techniques not only improve soil and agricultural productivity but have the potential to rehabilitate degraded land in semi-arid regions.

Case study: Grey-water initiative in home gardens of Jordan (UNDP-SGP, 2008)

Jordan similar to Middle-Eastern countries consists of semi-arid and arid zones which are quickly being degraded by prolonged drought conditions. This project aimed at enhancing, sustaining and expanding a grey-water initiative implemented by the Inter-Islamic Network on Water Resources Development and Management. The initiative involved the introduction of grey-water treatment and use at the household level for irrigation of restricted agriculture, in order to contribute to saving scarce drinking water and sustainable management of lands in the project area. The project reported working with a hundred households, supporting 50 of these households to install grey-water treatment units and plant home gardens with suitable plants, and another 50 households to implement income generation projects based on the sustainable use of natural resources in the area. It also included an awareness component that aimed at transferring the idea of grey-water use in restricted agriculture to other areas in the country. With such an initiative the project reduced the total area affected and the number of locals being affected by desertification. In addition, it also increased the number of people being associated with additional income-generating activities.

All the above water management techniques are climate-smart techniques that have the potential to alleviate hunger for the farmer by improving productivity and reducing costs. They also give farmers an opportunity to be sustainable by changing the way they use a scarce resource. From the perspective of climate change adaptation, contour stone bunds protect the land from heavy rain in years with high rainfall. In drought years, they improve rainwater harvesting, retention and infiltration into the soil, increasing the amount of water available to plants and guaranteeing the harvest. If a good vegetation cover is developed on the stone bunds, they also lower soil temperature, provide protection against wind erosion and help to conserve biodiversity. The other techniques of drip irrigation and the grey water initiatives are excellent technologies to reduce wastage and make maximum use of resources. The primary constraint to widespread adoption of these techniques (stone bunds, drip irrigation system) is the high initial cost and lack of land security among farmers. These techniques don't require incurring a frequent high cost but the initial cost can be a burden. Farmers therefore require external support from government, extension services from NGOs to adopt such practices. Once these initial costs are met, farmers not only engage in an action that improves soil productivity but are also actively involved in adaptive climate actions as well. Lack of land security due to bureaucracy or conflicts is another issue that impedes adoption. In Africa, many farmers are not willing to invest in such practices because they are working up leased land and not their own. Therefore in such zones interventions need to tackle bureaucratic machinery and local policies to establish a system of providing ownership of land to small farmers.

Intervention 8: Renewable Energy Options

Agricultural activities need energy and with human population growing at an enormous rate climate-smart agriculture interventions must include energy-smart practices or initiate the use of alternative energy options. The following case studies are indicative of them.

Case Study: Introduction of fuel-efficient stoves in Nepal (UNDP-SGP, 2011b)

In this project, mountain and lowland communities in Nepal were trained and taught renewable energy technologies like rice husk stoves and bio-briquettes. The metal rice husk stove is ideal for lowland communities where rice husks are plentiful. It is easy to operate and economical. The report also notes that making bio-briquettes is not new in Nepal, but the approach to it is. The change is the use of an invasive exotic species, Eupatorium adenophorum or 'banmara' in Nepali, as the raw material. (UNDP-SGP, 2011b) This intervention not only improves forest wealth by getting rid of weeds but reduces GHG emission by being less dependent on fuelwood. These communities were also encouraged to have an integrated livestock-agro-forestry system in their farm so that waste is minimized; productivity of their land is climate-proofed and increased. Engaging in multiple crops and fruit trees reduced the vulnerability of farmers and use of alternative energy options reduced their carbon footprint too.

Case Study: Electrifying Africa by solar power (UNDP-SGP Factsheet, 2014)

In 2008, the UNDP Small Grants Program started a joint initiative with Barefoot College (India) to support "Women Solar Engineer" pilot projects across Africa and Asia. In this collaborative effort, the UNDP-SPG provides communities with technical support and funding for the solar panel kits. The Barefoot College, a pioneer in demystifying complex technological processes for illiterate students, offers a six-month training program to the women beneficiaries on their campus in Tilonia, India. The goal of this "Women Solar Engineer" initiative is to build local capacity and electrify poor, "off-the-grid" communities with clean, low-cost solar energy simultaneously bridging the gender gap and empowering women. This partnership has been implemented in 18 countries within Asia and Africa. UNDP-SGP Country statistics reported the following: Mozambique country estimates for annual kerosene consumption fell by 27,375 liters and annual fire wood consumption fell by 91,250 metric tons. In Ghana, the rising price of kerosene has led to large-scale deforestation and soil erosion as communities resort to firewood to meet their energy needs. With solar electrification, communities in Ghana managed to replace

95% of kerosene lamps with solar powered lighting; while those in Niger succeeded in eliminating kerosene lamps completely. In Ethiopia, Cameroon, and Chad, solar electrification had a substantial impact on easing pressure on deforestation, as they were able to reduce consumption of both firewood and kerosene. (UNDP-SGP Factsheet, 2014)

The objectives of climate-smart agricultural practice will not be met if alternative energy options are not looked at. Making small-farmers aware about their farm's carbon footprint and helping them understand the consequences of their actions is of utmost importance. Being an energy starved planet, agriculture cannot move forward by being dependent on polluting fuels alone, alternative clean solutions must be initiated on the farm and replicated at different levels. Thus the use of renewable energy interventions like rice-husk stoves, biogas and solar cookers are empowering and sustainable options for the small farmer. They ensure climate change mitigation while giving communities alternative tools to meet their energy needs for food and shelter.

Having established that small-scale, low-input and long-lasting alternative energy options are indeed climate-smart and pro-poor, it is imperative to note here that production of biofuels based on food/feed crops must not be treated as a climate-smart agriculture intervention. The rationale being that in the past the expansion in production and consumption of biofuels triggered a decrease in exports of food (or increase in imports) which drove up international food prices, and in turn negatively affected food security in poor countries. Further, in poorer and less regulated nations biofuels compete for available land and water, finally leaving the poor farmer hungry. So if climate-smart agriculture is an intervention for the farmer to be food-secure and sustainable, then biofuels based on food/feed crops cannot and should not be considered a CSA intervention.

Intervention 9: Genetically Modified Crops

GM crops have been at the heart of the Green Revolution with high-yield varieties of corn, wheat and rice available and advocated in most countries. With climate-change, GM-crops have newer varieties of staple and vegetable crops that are adapted to local weather requirements like droughts and changing soil conditions like increased salinity. They also include modifications as per cooking/milling properties and pest and disease resistance needs.

Case study: Drought-tolerant maize varieties, Africa (DTMA Report, 2014)

Maize is a staple food for more than 300 million people in Africa but, by the 2030s, drought and rising temperatures could render 40% of the continent's current maize-growing area unsuitable for maize varieties available today. Maize production in southern Africa, for example, may fall by 30% or more. Since 2006, more than 100 new, drought-tolerant maize varieties and hybrids have been developed and released across 13 countries by the Drought Tolerant Maize for Africa Initiative (DTMA), funded by the Bill & Melinda Gates Foundation, the Howard G. Buffett Foundation, USAID and the UK Department for International Development. This initiative was mainly coordinated by the International Maize and Wheat Improvement Center (CIMMYT) and the International Institute of Tropical Agriculture (IITA) and they brought together a wide range of partners, including publicly-funded research organizations, public and private seed producers, varietal certification agencies and farmer groups. Over the years this initiative of new maize varieties has yielded up to 35% more grain in farm trials than those grown previously by farmers'; the best hybrid out-yielded even the most popular commercial variety by 26%. More than 2 million smallholder farmers in sub-Saharan Africa are now growing these new varieties and hybrids. The project report cited farmer's yields being 20–30% above what they would have got with their traditional varieties, even under moderate drought conditions. Farmers themselves guide the breeding efforts, making sure the varieties developed meet their requirements. Certification agencies have been engaged in the process from the beginning, so their staff is up to speed on what the initiative is trying to achieve and the new varieties can move efficiently through the certification process. Post the farm trials, it was reported that seed companies are geared up and ready to produce seed as soon as it is ready for release.

The above case study is just one among the many genetically-modified climate-change centered crop varieties available in the market. Examples from other countries include salinity-resistant rice variety, herbicide and pest-tolerant varieties of canola – all of which fall under "climate-smart" interventions for development organizations. Genetically-modified crops may boost productivity and may also enable farmers to produce under harsh drought/salinity conditions but the report on the drought-tolerant African maize case study fails to explain whether farmers own their seeds. It also fails to give any information about the dependency of these varieties on other agricultural inputs like chemical fertilizers. The report does not mention whether using these GM-crops allows the farmer to continue indulging in intercropping and other agro-ecological activities. Under the current circumstances of abrupt weather patterns and extreme weather events, breeding diversity is the only way farmers can continue to farm, eat and thrive. Promoting GM-crops implies taking away the seed from the farmers. It takes advantage of the vulnerability of the farmer who unknowingly is dragged into a globalized, centralized agricultural system that renders them exposed to not just natural shocks from the environment but financial shocks from the economy. GM-crops, as the above case study mentions, may report increased yields but the fact is that farmers earn this high yield at immense input cost and an even larger environmental cost. By decreasing diversity, GM-crops reduce the built-in resilience of the ecosystem. By genetically-modifying crops, seeds may become climate-smart (by way of defeating the current drought or salinity situation) but they don't empower the farmer in any way. Also, seed companies and research organizations don't broadcast the fact that these varieties are sure to fail in case the region has a good season and if that were to happen farmers lose a full yield because of the seed used. The report mentions the fact that engaging the private sector has helped to ensure farmers access to both inputs and markets for their produce. But the truth is that once the funding stops farmers are left with nothing. Without the freedom to use their seed, they are disabled. Without the seed, what use are inputs and markets? Having free access to the seed and building on trial-and-error based traditional methods of farming is the only way farms can practice healthy and sustainable farming. When development organizations promote GMOs as "Climate-Smart", in effect they blatantly ignore farmer's rights and license exploitative approaches of agro-biotech corporations under the "climate-smart" umbrella. GMOs of any kind, whether climate-resilient or not, must neither be considered climate-smart nor empowering to the farmer.

Intervention 10: Climate Risk Management Systems

Agriculture is inevitably at the mercy of climate. Faced with these seemingly endless risks posed by the weather, resource-poor farmers are reluctant to gamble on investing in inputs. In a good season, these could boost their yields and bring them extra food and income. With abrupt changes in weather and increased incidences of severe weather events, the risk of crops and livestock being wiped out is riskier. Innovative approaches are being tested throughout the developing world. Examples include a program in Ethiopia that is helping resource-poor farmers to rebuild their resources and boost their food security, and a weather-based insurance scheme in India that is encouraging smallholder farmers to take judicious risks to raise their production.

Case study: Weather-based insurance for farmers in India (Report obtained from World Bank, 2010)

Introduced as a pilot in 2003, the Weather-Based Crop Insurance Scheme was adopted by the government of India in 2007 under the guidance of World Bank as an alternative to the existing 'yield index' insurance. The weather index includes rainfall (high or low, length of wet or dry periods etc.), temperature, humidity, wind speed, and a combination of these as a proxy for disease risk, and is based on measurements taken at official weather stations around the country. Payouts are triggered automatically without the need for farmers to formally file a claim, reducing transaction costs and resulting in rapid payouts, usually within 30 days of the index trigger. (World Bank, 2010). The system also has the advantage of avoiding fraudulent claims by those insured. Insurance prices are subsidized by the government and these services are offered by private and public agencies.

The project reported that 12 million farmers were insured under this scheme and with more memberships, premium prices have been falling. This is a sustainable, climate-smart way of managing the farmer's climate risk. The only downside is that weather-index-based insurance requires a dense network of weather stations to gather data; India needs to double the number of weather stations if it is to support reliable weather index-based insurance. More research is also needed to improve the indexes used, to ensure that they accurately gauge the impacts of weather on crop yields. Also, national institutional support is needed to ensure premium prices are regulated, open access to weather data is maintained and farmers who are resource-poor have access to protective schemes like these.

Case study: Safety-net program for Ethiopian farmers (World Bank, 2009c)

In 2005, the Ethiopian government introduced the Productive Safety Net Programme

(PSNP) to improve the food security of people who suffer from chronic food shortages and live in areas that are prone to drought. The programme was fully funded by a number of external donors. In this program, households that have experienced food shortages for at least three months each year in the previous three years and have no external social support (like relatives working in towns and cities that send remittances) will receive payments in cash, food or a mix of the two in exchange for six months' work on public works projects. Households that cannot provide labor, such as those headed by disabled or elderly people, receive the payments as grants. These are chosen through a participatory approach based on local authority development plans and include such things as enclosing protected areas, establishing woodlots, constructing hillside terraces, shallow wells and ponds, and diverting streams for irrigation. The project also reported of a complementary program, the Household Asset Building Program (HABP) that has provided access to agricultural credit and similar services to help people build up their productive assets and increase their agricultural production. Household food situation is monitored regularly. Once they are deemed to have achieved an acceptable level of food security and no longer need external support, they 'graduate' from the PSNP. The Productive Safety Net Program improves the food security of people who suffer from chronic food shortages and live in areas that are prone to drought. It has improved child nutrition situation as well as allowed small farmers to diversify activities and secure livelihoods through alternative work opportunities.

Both the above case studies are climate-smart interventions that manage the climate risk imposed on farmers. Such schemes are needed and support farmers when climate-related abrupt changes make farming impossible. Only such schemes will provide a fail-safe instant alternative to the farmer and in the long run, will prevent out–migration of large number of farmers to urban towns in search of better prospects. Finally, such systems are helping farmers retain their farm work and yet have a viable alternative livelihood option that is less vulnerable and one that can meet the demands imposed by future climate scenarios.

Chapter 3

Results and Discussion

3.1 Juxtaposing CSA and Green Revolution

On comparing the origins and the main players associated with Green Revolution and Climate-Smart Agriculture there emerges a pattern. Firstly, both the Green revolution and CSA are being funded and aggressively promoted by the same organizations, namely CGIAR, their various IARCs and the World Bank. The only difference in this respect is that during the inception of the Green Revolution, the direct involvement of American foundations like Rockefeller and Ford were explicitly stated but, with CSA, private foundations with conflicting interests can funnel investments through the CGIAR-network of institutions or by partnering with the Global Alliance for Climate-Smart Agriculture. In this matter, there is a distinct lack of clarity.

Secondly, Green Revolution and CSA have similar and skewed key messages or promises to farmers. Green Revolution promised the poor farmer self-sufficiency in developing countries through the diffusion of "miracle seeds". In other words, Green Revolution promised farmers a transformation in farming outputs but small farmers continued to suffer. Similarly, since CSA's introduction in 2009, one of its key messages was to "transform agriculture in developing countries to achieve food security amidst climate change" and as part of this approach, the World Bank and FAO – among other agencies and corporations – are pushing 'climate-smart' initiatives that could turn farms into carbon offset projects. These offset projects do not have the small farmers' livelihoods and food security in mind, but rather, they continue to finance greenhouse gas emissions in rich industrialized countries and these projects pose serious risks to developing country agriculture.

3.2 Does CSA truly empower the small farmer?

Of the 10 interventions examined in this paper, only two interventions did not meet the necessary conditions to be considered a truly empowering intervention from the farmer's point of view. The other eight interventions had varying degrees of success in genuinely empowering the farmer.

Urea Deep Placement technique and genetically modified crops were the two interventions that did not make financial or ecological sense for the farmer to adopt. Both of these interventions are climate-spruced versions of industrial agriculture. Like the "miracle seeds" of the Green Revolution, these practices only increase the soil's dependence on toxic chemicals and other agrochemical inputs. In India, Shiva (2014) noted that corporations like Monsanto are claiming patent monopolies on not only climate-resilient seeds, but they are also claiming a monopoly on climate and weather data. Her article cites Monsanto as having bought, for $1 billion, the US-based Climate Corporation, which controls vast data on climate. These corporations want to sell their fertilizers and seeds (adapted to their fertilizers) to farmers. Furthermore, they want to monopolize climate data that is crucial to agriculture. This is a strategy for total control of agriculture in times of climate change. (Shiva, 2014). And for small farmers, once the initial project funding ceases, they have to incur high input costs to maintain agricultural productivity and sustain their food and livelihood needs.

Among the other eight interventions, integrated farming and fishing culture, preserving genetic diversity, agriculture and livestock waste management, water management techniques and climate risk management were pro-poor/pro-farmer solutions that had the potential to empower the farmer. These solutions did involve a considerable financial investment on the farmer's part but this cost was not recurring and did not lead to the farmer's dependence on external agencies in the long run. Moreover, by adopting these practices the farmer could engage in adaptive or mitigative functions while being employed in alternative livelihoods. The remaining three interventions were also viable solutions that held promise for the farmer. But they need to refine their scope to restrict any forms of unsustainable industrial agriculture. Limitations need to be placed:

- on renewable energy options to exclude biofuels that compete with food/feed crops for land
- on agroforestry to include only polycultural plantations and vegetation
- on SRI to include only practices that are small-scale, low input and sustainable

3.3 Discussion

The juxtaposition of CSA's origins and promoters with those of Green Revolution and the examination of CSA interventions through actual field case studies/projects gives this paper a two-dimensional analysis of CSA as a concept. With respect to the interventions, the fact that CSA allows for genetically-modified crops and input-intensive interventions like UDP are indicative of loopholes in the definitions and scope of CSA. The definition of CSA as stated by FAO is so broad that any intervention that includes agriculture and climate will be deemed "climate-smart". In such a case, organizations whose ulterior motive is to increase profits will partner with development organizations and initiate monoculture plantations in developing countries under the umbrella of a CSA intervention like agroforestry. And if the definition of agroforestry does not explicitly exclude monocropping and monoculture plantations, then the environment and the farmer is left worse off. As mentioned in the earlier section, there are many limitations that need to be put on various CSA interventions in order for them to be truly effective for the environment and empowering for the farmer.

In the light of these loopholes that have emerged within the CSA concept and its various interventions, it is right to assume here that these loopholes exist intentionally. The fact that actions and major funding to Climate-Smart Agriculture is being primarily initiated by the same network of players that promoted Green Revolution in developing countries in the '60s explains why CSA as a concept is open to interpretation and exploitation. From the inception of the "Green Revolution", the corporate strategy of the Rockefeller, Ford foundations and the CGIAR departed from indigenous knowledge and traditional practices of agriculture. The diverse knowledge of local cultivators and plant breeders in India, Mexico, Philippines etc. were displaced and replaced with an exogenous, top-down chemically intensive American-style agriculture. Similarly, CSA interventions can and will become a top-down, chemically intensive, green-washed version of the Green Revolution if so-called climate-smart innovations and their research continue to be spearheaded by large agricultural consortiums that work hand-in-hand with agrochemical giants.

Climate-Smart Agriculture is needed and it is the way to go moving forward. But there should be a change in approach and a change in the organizational structuring of climate-smart endeavors. Centralizing knowledge into an alliance like the Global Alliance for Climate-Smart Agriculture will not feed farmers. It will not decrease the vulnerability or their carbon footprint. Agencies promoting CSA need to move away from the belief/objective that "transforming agriculture in developing countries" is the solution to food security and climate change. They need to initiate a change in consumptive patterns in the developed countries as well. Developing countries may be the ones suffering extreme climate change and food insecurity but they are not the only ones contributing to the anthropogenic changes in climate. Unsustainable production patterns cannot successfully be addressed without acknowledging the consumptive drivers that shape and largely dictate the design of these production systems. Agencies at the helm of climate-smart research need to initiate a dialogue on food, its availability and people's carbon footprint based on their daily diet in developed countries and make them more aware about the impact of their choices. In most developed countries, supermarkets and restaurants don't work on the principle of seasonality in the choice of fresh fruits and vegetables available/demanded. Food prices in grocery stores (barring the farmer's market) do not represent the true cost of growing it. If CSA has to be effective, food has to be produced in a sustainable manner and it has to be sold at a fair price that represents the real cost of producing it. This will make a great difference to the producing farmer and the entire value chain. Further, in the developing countries, CSA should not mean a continuation of the Green Revolution-era practices. It must be a revival of seed-saving culture. It must be the restoration of soil by feeding it organic matter and making it resilient through climate change. It must also be a revitalization of farming as an economically viable and ecologically sustainable option for farmers in developing countries in the face of climate change. CSA practices like preserving genetic diversity will become truly beneficial to farmers only if this system is incentivized and countries place sanctions against cheap imported substitutes and make movements to protect local farmers and indigenous varieties.

3.4 Recommendations for CSA to be empowering for the farmer

- CSA needs to systematically address the consumptive demand and productive supply elements of food and agricultural systems. At the global and national level, CSA could help structure and develop a coherent and sustainable set of policy tools to support nutritional health, food security and agro-ecological systems. For example: Developed and some developing countries (owing to increasing middle class) should adopt "sustainable diets"(See Appendix A for definition). Such diets can be initiated by reducing or eliminating subsidies that encourage unsustainable consumption and waste, and consider tax options to shift consumption patterns. At the local level, CSA must initiate a combination of traditional techniques and sustainable agricultural innovations that reduce input-dependency and vulnerability of the farmer to climate change and food insecurity.

- Redefine Climate-Smart Agriculture to clearly exclude any forms of industrial agriculture which may proxy under CSA activities. CSA's definition must also be expanded to recognize farmer's rights to seed and techniques, and their rights to food and livelihood in the context of climate change.
- Regardless of the region, development and research organizations must adhere to standardized technical definitions for CSA practices when they initiate projects. There cannot be a "pick and choose" feature for CSA interventions. This does not mean a one size fits all solution for every community. Solutions can be varied and highly local but they need to fall within the purview of a standardized definition.
- Reorient agricultural research and extension services: Promote on-farm research by small scale farmers' agroecological practices; develop publicly-bred and managed seed varieties that are resistant to droughts, floods, and pests. CSA must build bridges between local and scientific knowledge, so as to encourage local innovation and to reduce the dependency on external inputs.

3.5 Limitations of This Study

One of the major limitations of this paper is that the examination of CSA has been done through projects by way of project reports. These project reports were written by the funding agencies and the project coordinators. A better method would have been an actual field study of

CSA project sites post the funding cycle to better examine the effectiveness of these interventions in empowering the farmer. Further, the examination of CSA interventions is also restricted by the number of interventions chosen. This paper would be more informative if more interventions were examined.

Conclusion

CSA is the buzz-word among climate and agriculture scholars and among global policy makers. In a broad sense, the concept of "Climate-Smart Agriculture" makes sense owing to increasing disturbances in climate phenomena and the corresponding effects on agriculture and food security. But on close examination of individual practices and interventions, this study reveals the vagueness and the inherent dichotomy of the concept. The findings of this study indicate that there are practices like integrated farming/planting techniques, preserving genetic diversity and water management technologies that are climate-smart and at the same time straightforward for a small farmer to adopt. From an ecological perspective, they are climate-smart since these practices increase biodiversity, reduce GHG emissions and are thus sustainable in the long run. Also, from a financial standpoint such practices are feasible for small farmers without placing unfair demands on their finances. Such practices give farmers an opportunity to feed their families and sustain their livelihoods in the midst of climate change without putting undue pressure on the ecosystem or themselves. At the same time, CSA as a concept also includes practices like Urea-Deep Placement and use of genetically-modified crops that are neither climate-smart nor pro-poor. If there are any lessons to be learned from the Green Revolution, it is that increased fertilizer use and GM crops have done more harm to the ecosystem than good. From an ecological perspective, UDP and GM crops are not sound and they are financially unsustainable for a poverty-ridden farmer to adopt. The fact that such practices are being placed under the umbrella of "Climate-Smart Agriculture" highlights the dichotomy of this concept and proves agribusiness' vested interests in this area. Based on the examination of CSA interventions, it is clear that there are interventions that are truly empowering to the farmer and there are those that are designed to increase the farmer's vulnerability and reduce the environment's resilience.

CSA has the potential to move beyond being a catchphrase or a "green-washed Green Revolution" if it makes radical adjustments in the way it is being defined and applied. If Climate-Smart Agriculture needs to be relevant, it needs to be a system that supports the ability of the small farmer to feed themselves, their families and their communities. It must be a system that detangles the nexus between agribusiness and the politics of climate change. At the end of the day, policy makers must remember that CSA was introduced as a smart way of farming amidst climate change. Such a smart way of farming cannot be considered "smart", if the poor continue to remain poor and the hungry continue to suffer hunger. Thus, in its existing format, CSA cannot claim complete success in empowering the farmer. And CSA can attempt at bridging the gap between the underfed and overfed only if it addresses and initiates systemic changes in developed and developing countries at the local, national and global level.

Appendix A

Climate-Smart Agriculture:

- FAO (2010) defines CSA as an agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals.
- Neufeldt and al. (2013) claim that "any agricultural practice that improves productivity or the efficient use of scarce resources" can be considered climate-smart

Development Organizations: Includes all multilateral and international development aid agencies like UN, World Bank and FAO etc. Since this paper is a study into agricultural interventions, the term "development organizations" also includes agricultural development and research centers like IRRI, IFDC and CGIAR consortium of institutions.

Farmer: Throughout this paper, "farmer/farmers" is used to mean resource-poor or small-scale farmers. These three terms have been interchangeably used.

Financially sensible: In this paper, for an intervention to be considered financially sensible it must be practical from a financial standpoint for the farmer to adopt. In other words, one that does not lead to the farmer incurring repeated payments to third-party agencies. This does not imply that agricultural interventions are expected to incur zero cost, but it does imply that farmers must not be introduced to interventions that end with farmers furnishing constant payments to continue a certain agricultural practice.

Ecologically sound: Refers to any agricultural practice that does not degrade the environment but helps in mitigating climate change or adapting to it while directly or indirectly contributing to the food security needs of a farmer. It includes agricultural practices and innovations that ensure preservation or restoration of the ecosystem as a whole.

Sustainable diets: According to FAO (2009c), "Those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources."

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