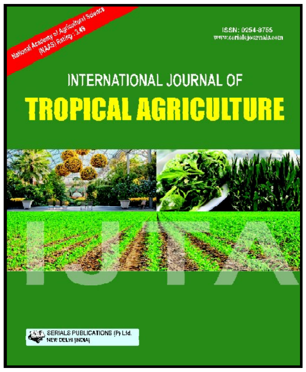

INTERNATIONAL JOURNAL OF TROPICAL AGRICULTURE

ISSN : 0254-8755

available at http: www.serialsjournals.com

Volume 37 • Number 2 • 2019

Integrated Farming System: A Climate Smart Agriculture Practice for Food Security and Environment Resilience

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Abstract: The small holders, who do sequester carbon and also reduce emissions, individually as well as collectively through integrated farming system practices, and qualify for the minimum tradable carbon amount are usually left isolated from opportunity, mainly because they do not have the capacity to comply with the rigid and expensive requirements of the carbon market schemes, especially the Clean Development Mechanism (CDM) protocol. Moreover, in most cases, they are also not organized in groups, which further preclude their participation in such ventures. This fact is of enormous importance to the Indian small holders, who comprise the majority of farmers, collectively contribute to a substantial load of carbon sequestration, and yet are unable to benefit from such opportunities, and are left wandering alone. By way of investment from developed countries, the CDM projects could also lead to a large positive impact on programs which are aimed at forest conservation and regeneration, through afforestation / reforestation, reclamation of degraded lands, integrated farming system, conservation agriculture practices and socio-economic development of rural communities, in addition to the global environmental benefits.

Key words: Integrated Farming System, Climate Smart Agriculture, Food security, Climate Change, Clean Development Mechanism (CDM)

1. INTRODUCTION

Human activities have resulted in the alteration of the composition of our atmosphere triggering change in the Earth's climate. The world's population has grown at an alarming rate with a corresponding increase in demand for natural resources, energy, food, and goods. It is obvious beyond doubt that the climate is changing. Climate has also been changing in the past, but its rate of change has been unprecedented in recent past years. It is true that no one could stop the climate from changing, but could do a lot for mitigating some of its effects and formulate adaptation mechanisms to it. Agriculture, especially the small holder producers have been at the receiving end of the climate change effects, resulting into not only in the fluctuating and unstable productivity, loss of natural resources and consequent livelihoods, but also to their survival.

Climate change and food insecurity are two most pressing challenges human beings are facing today and has emerged as the biggest twin challenge of this century. There are evidences that the increase in greenhouse gases caused by human activities is responsible for global warming and consequent climate change (FAO, 2007). Under the six emissions scenarios the global average surface temperatures are expected to increase by 1.1°C - 6.4°C this century [IPCC, 2007]. Climate change has its impact on almost everything on the earth and so on the food production. The agriculture plays a very important role in the economy of most of the nations of the developing world. For India, agriculture is the base of nation's economy, largely rainfed and dominated by smallholders (Singh 2008 and 2010). As per reports from a number of governments, non-government and intergovernmental organizations, the countries and agriculture especially practiced by smallholders are particularly vulnerable to climatic changes and they have least capacity to adapt to these changes. In most of the developing countries of the world, the agriculture is not merely a matter of cultural practice but it is the source of livelihoods of millions of smallholders and their dependents. Changing climate as predicted will not only affect the agricultural productivity but also heavily hit the lives and livelihoods of the smallholder families and ultimately lead to food insecurity to the concerned nation and the world (Singh et al. 2012). Business-as-usual scenarios of population growth and food consumption patterns indicate that agricultural production will need to increase by 70 percent by 2050 to meet global demand for food. South-Asian countries made tremendous progress in food production in 1960s, 1970s and 1980s. with an impressive growth of food production, India, Pakistan, Bangladesh and Nepal transformed themselves from countries with a chronic food deficit to countries that were almost self sufficient in early 1990s. Except Afghanistan, all these countries had exported some quantities of food grain in late 1990s. The dynamic growth in the agriculture sector has, however, recently been lost. Productivity of major food grains has slowed and has been decline for some crops (Kumar et al. 2008) with food production failing to keep pace with population growth (G. Rasul and A. Schild 2009). As a result, South- Asian countries are now finding it difficult to meet their population most basic food and nutritional needs and remain vulnerable to food insecurity (Table 1).

2. Impact of Climate Change on Food Security

The impacts of climate change will reduce productivity and lead to greater instability in production in the agricultural sector (crop and livestock production, fisheries and forestry) in communities that already have high levels of food insecurity and environmental degradation and limited options for coping with adverse weather conditions (FAO,2009). In India, this decline in food production since 1951 is now alarming, since the population is increasing in a geometric trend (Table.2). Further, the agriculture sector is not only among the most vulnerable sectors to the impacts of climate change; it is also directly responsible for the 14 percent of global greenhouse gas emissions. In addition, the sector is a key driver of deforestation and land degradation, which account for an additional 17 percent of emissions [FAO, 2010a]. The agricultural sector can be an important part of the solution to climate change by capturing synergies that exist

Table 1
Key features of agriculture and food security in South- Asia

Country	*Population*		*Agricultural Land*									
	2007 millions	*Pop. Growth rate (%)*	*Total land area (m ha) in 2003*	*Agrl. Land % of land area*	*Arable lands (% of Agrl. land)*	*Per capita land (ha) 2003-05*	*Irriga-ted crop land (%) 2002*	*Cereal production (m tones*)*	*Cereal produc-tion (Kg per capita (2003-05)*	*% of under nouris hed pop.*	*% GDP agricu-lture (2004)*	*% of Pop. in agricu-lture*
Afghanistan	28.1	1.36	65.2	-	20.8	-	29.6	0.12	-	35	36	23.36
Bangladesh	142	1.9	14.4	69.6	88.2	0.1	54.5	25.95 (11.2)	285	30	20	28.53
Bhutan	0.71	2.2	4.4	-	26.9	0.08	24.2	0.10 (12.4)	-	-	26	50.47
India	1095	1.6	32.7	60.9	88.6	0.3	33.6	196.84 (4.5)	219	21	20	25.45
Nepal	27	2.1	14.718	34.8	55.8	0.1	34.5	4.6 (8.5)	288	17	39	42.93
Pakistan	156	2.0	79.6	35.2	78.6	0.3	80.5	25.0 (8.4)	203	20	22	17.24
Maldives	0.30	2.5	0.30	-	28.6	-	-	-	-	-	8	10
Sri Lanka	21	0.9	6.561	36.4	38.9	0.2	33.3	-	155	22	15	19.17

*Figures in parenthesis shows variation in domestic cereal production

Source: World Development Report 2008; (Allauddin and Qulggin 2008)

among activities to develop more productive food systems and improve natural resource management (Sahoo,2014a). Sustainable utilization of natural resources will require management and governance practices based on ecosystem approaches that involve multi-stakeholder and multi-sectored coordination and cooperation. This is a crucial element for the transformation to climate resilient agriculture. More productive and resilient agriculture is built on the sound management of natural resources, including land, water, soil and biodiversity (Nanda and Garanayak 2010). Conservation agriculture, agroforestry, improved livestock and water management, integrated pest management and ecosystem approaches to fisheries and aquaculture can all make important contributions in this area. According to IPCC 4th assessment report, agriculture is currently responsible for about one third of the World's GHG emissions and this share is projected to grow, especially in developing countries. To support food security and boost incomes, agricultural systems in developing countries will be under pressure to increase productivity sustainably and strengthen the resilience of agricultural landscapes. Strategies exist to sequester carbon and reduce greenhouse gas emission reductions in the agricultural sector. Many of these strategies also improve food security, foster rural development and help communities adapt to climate change. However, tradeoffs may have to be made when seeking to reach different development goals, such as climate change mitigation and adaptation, sustainable agricultural production and poverty reduction.

Table 2
Population growth vis-à-vis Food grains production in India

Year	*Population (Millions)*	*Annual CGR (%)*	*Food Grain Production (M T)*	*Annual CGR (%)*
1950-51	361	-	50.82	-
1960-61	439	1.86	82.02	4.81
1970-71	548	2.30	108.42	2.92
1980-81	685	2.33	129.59	1.92
1990-91	838	1.94	176.39	3.19
2000-01	1027	2.13	196.81	1.02

Source: Economic Survey- 2007, Government of India

3. CLIMATE SMART AGRICULTURE: A FAO NEW INITIATIVE

Recently, Food and Agriculture Organization of United Nations (FAO) has developed a new tool box "Climate Smart Agriculture" looking to global climate change scenario and existing land-use policies, which is defined as "Agriculture that sustainably increases productivity, resilience (adaptation), reduce / remove GHGs (mitigation) and enhance achievement of national food security and development goals" is now the only panacea to achieve food security and future challenges on climate change [FAO,2010b and 2013]. Climate Smart Agriculture promotes agricultural best practices, particularly integrated crop management, conservation agriculture, agroforestry, improved seeds and fertilizer management practices, improved water and energy management practices as well as supporting increased investment in agriculture sector. It encourages the use of all available and applicable climate change solutions in pragmatic and impact focused manner .While resilience is a key, Climate Smart Agriculture is broader and calls for more innovations and pro-activeness on climate smart practices towards agriculture resilience which change in the way the farming to adapt and mitigate while sustainably increasing productivity. Further, Climate Smart Agriculture practices propose the transformation of agricultural policies and agricultural systems to increase food productivity and enhance food security while preserving the environment and ensuring resilience to changing climate. It has very different meanings depending upon the scale at which it is being applied. For example, at the local scale, it may provide opportunities for higher production through improved management techniques such as more targeted use of fertilizers. At the national scale it could mean providing a framework that incentives sustainable management practices. And at the global scale it could equate to setting rules for the global trade of carbon. It is not clear how actions at one scale may affect the others. For smallholder farmers in developing countries, the opportunities for greater food security and increased income together with greater resilience will be more important to adopting climate-smart agriculture than mitigation opportunities.

In the face of climate change, agriculture must be 'carbon neutral', farming activities would take out of the atmosphere a quantity of greenhouse gas equal to or greater than the amount they emit (Verchot 2007). At the very least, these activities should aim to meet future food requirements without further increases in emissions. Some practices with high potential for synergies over a wide range of circumstances can, however, be identified, such as avoiding bare fallow; incorporating crop residues; diversifying crop rotations to incorporate food producing cover crops and legumes; improving fodder quality and production; expanding low energy irrigation; expanding agroforestry; and adopting soil and water conservation techniques which contribute significantly for resilient agriculture and food production (Rabindranath *et al.* 2008; Lasco & Pulhin, 2009; Verchot, 2009 and Sahoo, 2014 b.).

Due to intensive agriculture several ills have also appeared in Indian agriculture, such as declining factor productivity, degradation of natural resource base, environmental degradation including ground water depletion & contamination and declining farm profitability & productivity (Gill *et al.*, 2009). To tackle such problems, farming systems approaches to research has been widely recognized, where whole farm is viewed as a system and interactions among the various components are taken into consideration (Nanda et.al.2007). Efficient integration of crops with animals (cow, buffalo, pig, goat, sheep, fish), birds (poultry, pigeon, duck), multipurpose trees and agro-forestry systems and other enterprises (bio-gas, apiary, mushroom, etc.) clearly showed the best advantages over conventional system of cropping under irrigated and rainfed conditions as well as in tribal areas (Jayanthi *et al.*, 2001). Integrated Farming System (IFS), which focused around a few selected inter-dependant, inter-related and often inter-linking production systems seems to be the viable alternative to ensure food, nutritional and economic-security, particularly to the large chunk of small and marginal farmers of the state (84%), which operate under complex-diverse-risk prone environment. Adoption of Integrated Farming System provides high opportunities of productivity enhancement, employment, income generation, nutritional security and a climate resilient agricultural production system by diversifying and integrating different components of farming viz., crop, horticulture, livestock and fisheries. The systems based on multiple recycling of carbon, energy and nutrients would also help minimize environmental loading with pollutants. Mixed farming involving crop-livestock integrations has become a way of life and means to livelihood in rural areas of the state, where livestock and livelihoods are intimately related. About 85% of livestock in the state are owned by the landless, marginal and small farmers and 80% of rural households depend on livestock from where they draw 30% of their annual income for sustenance. About 70% of total poultry are of local backyard breeds, which were again owned by the down trodden ones. The livestock component acts as a stabilizing factor in the system, thus needs strengthening of the crop and livestock linkage to enhance the economic viability and sustainability of the farming systems. Further, Livestock and livelihoods are intimately related and the ownership of livestock is more egalitarian than that of land (Swaminathan, 2010). Among various Integrated Farming Systems, pond based system-encompassing fish-rice-duck/poultry-vegetables and fish-cow/pig-duck/poultry-vegetables are feasible particularly, in rainfed lowlands. In this system, marginal land/wet lands are brought into productive use, animal wastes are used to fertilize fish pond/refuge and crop lands, while the lands in return produce crops which serve as food for animal, fish and men and the pond provides food for fish, duck and men. As system's dykes are comparatively wide, housing units for cow/pig/duck/poultry along with cultivation of economic varieties of plants such as vegetables and fruit plants are carried out, using pond water for life saving irrigation at different growth stages. Rice-fish-duck culture has great potential in this ecosystem. Ducks are eco-friendly who used to destroy harmful weeds, snails and insects from rice fields and improve soil fertility. Duck droppings serve as feed for fishes. Thus fish and duck together would ensure high profit due to higher fish yield, duck eggs, duck meat and enhanced rice yield. Profit of margin will be enhanced much more than any individual system. Besides, this can provide gainful employment to family members and improve their nutritional status. The dykes to be constructed for preventing escape of fish from the integrated system can be used for growing vegetables and other short gestation fruit trees like papaya, banana and drumstick to make the system more economically viable. Vegetables such as cucurbits, radish, brinjal, okra, leafy vegetables during *kharif* season and tomato, french bean, radish, bitter gourd, cucumber, cauliflower, cabbage, brinjal, pumpkin and leafy vegetables (coriander, amaranths and Indian spinach) can be grown during winter season. Vegetables such as snake gourd, bitter gourd, ridge gourd, bottle gourd or ash gourd can be grown throughout the year on raised platforms and okra, poi, cowpea, bitter gourd, ridge gourd and pumpkin in the field during summer season. Therefore, rice-fish-duck farming should be encouraged particularly in the rainfed lowland areas. Sunken and raised system need to be popularized in the low land waterlogged areas to enhance water productivity.

In the rainfed upland ecosystem, crop diversification, management of soil and water on the basis of watershed, creating water-harvesting structure in 10% area towards lower reach in sloppy land for life saving irrigation, growing suitable crops, livestock and adopting ancillary avenues of income appear important. The income from cultivation of cereals, pulses, oilseeds, spices, fiber crops, forestry species, cash crops, vegetables, fruits and flowers along with other enterprises like dairy, poultry, food processing, mushroom, honey bee and combination of all these enterprises or integrated farming systems utilizing the by-products of the main crop and engagement of family labour can contribute to better livelihood security. So, farming system aims for enhanced productivity, profitability, sustainability, climate resilient agricultural production, balanced food and nutrition, clean environment, recycling of resources, optimum utilization of farm resources like labour, animal power, machinery, finance & minimum dependence on external inputs, adoption of improved technologies, regulation of farm income, creation of employment opportunities, high input-output ratio, solving food, fodder, feed, fuel & fertilizer crisis, encouraging afforestation, promoting agro-based industries, and ultimately improving standard of living of the farming community (Gill *et al.*, 2009).

4. INTEGRATED FARMING SYSTEM AND CLEAN DEVELOPMENT MECHANISM

The small holders, who do sequester carbon and also reduce emissions, individually as well as collectively through different farming system practices, and qualify for the minimum tradable carbon amount are usually left isolated from this opportunity, mainly because they do not have the capacity to comply with the rigid and expensive requirements of the carbon market schemes, especially the Clean Development Mechanism (CDM) protocol. Moreover, in most cases, they are also not organized in groups, which further preclude their participation in such ventures. This fact is of enormous importance to the Indian small holders, who comprise the majority of farmers, collectively contribute to a substantial load of carbon sequestration, and yet are unable to benefit from such opportunities, and are left wandering alone. By way of investment from developed countries, the CDM projects could also lead to a large positive impact on programs which are aimed at forest conservation and regeneration, through afforestation / reforestation, reclamation of degraded lands, integrated farming system, conservation agriculture practices and socio-economic development of rural communities, in addition to the global environmental benefits. Now this is being looked upon as a major benefit with market instruments favoring the active involvement of industry in the mechanism. The potential for CDM related projects is quite high in India (UNFCCC 2008a and 2008b). Although it is not mandatory for Indian industries to meet any sort of targets under Kyoto protocol, they prefer to favor this phenomenon as it strengthens their claim for using the wastelands for this purpose in the country. India has the biggest scope for generating Certified Emission Reductions (CERs). The country currently has the largest number of CDM projects, but China is largest in terms of carbon tonnage. The Government of India has set up a National Designated Authority (NDA) to deal with the CDM projects in the country.

The global carbon market has been linearly expanding in recent years. From a meager of about 8 billion Euros in 2005, it has grown to about 92 billion Euros in 2008. Through this opportunity, a number of agencies, corporate houses and some large NGOs have benefited from it. The paid up benefits so far have been for reducing emissions, carbon sequestration, or both. Few such benefits have also accrued in India, but mostly for reducing the emissions. However, only large companies, which could qualify for the minimum tradable amount of carbon, afford to properly write the application, prove the additionality in emission reduction, and/or carbon sequestration and get their efforts/projects validated, mostly by external agencies at usurious costs, sometimes running to between 100 and 200 thousand dollars per case, have been able to cash on this opportunity.

Today, carbon finance is an important market-based tool that contributes to meeting greenhouse gas emissions objectives by providing a revenue stream for mitigation projects. It has played a catalytic role in leveraging other sources of finance in support of low carbon investments, in a ratio of 1:5. Carbon finance revenues can remove such initial investment barriers as social inertia, lack of awareness of climate change, and transaction costs, while providing financing for activities that reduce greenhouse gases. From 2002– 2008, it is estimated that CDM transactions raised over $100 billion of mostly private funds for low carbon investment (World Bank 2009). However, the potential impact of carbon finance is far from fully realized. While the CDM and Joint Implementation (JI) mechanisms are important tools for private sector action associated with significant developmental and social co-benefits, their leveraging potential remains largely unfulfilled. Experience demonstrates that there is room to exploit synergies between policies and financial instruments that would scale up carbon finance and mitigation. Efforts to improve the current mechanisms are steps in the right direction. Follow-through will be key. It is essential to consolidate the "learning by-doing" JI and CDM experience and make necessary adjustments.

5. CONCLUSION

Transformation, now need in global agriculture in the context of climate change and food security (Sahoo *et al.* 2014). In agriculture based countries, where agriculture is critical for economic transforming smallholder systems, is not only important for food security but also for poverty reduction, as well as for aggregate growth and structural change. In developing countries, increasing productivity to achieve food security is clearly a priority, which is projected to entail a significant increase in emissions from the agricultural sector in developing countries. It is the time to promote Integrated Farming System through Climate Smart Agriculture practices for a food secure world through the provision of science-based efforts that support sustainable agriculture and enhanced livelihoods while adapting to climate change and conserving natural resources and environmental services with focus on developing countries. Further, it will be a part of the solution by contributing to climate change mitigation, through carbon conservation, sequestration and substitution, and establishing ecologically designed agricultural systems that can provide a buffer against extreme events. So, Climate Smart Agriculture is important both for climate change mitigation as well as adaptation through reducing vulnerability, diversifying income sources, improving livelihoods and building capacity of smallholders to adapt to climate change. Further, strong local institutions are in need for identifying, coordinating and recognizing informal rights and strengthening customary systems while scaling up Climate Smart Agriculture.

REFERENCES

IPCC.-Climate Change Synthesis Report, (2007). Bernstein L, Bosch P, Canziani O, Chen Z, Christ R, Davidson O, Hare W, Huq S, Karoly D, Kattsov V, Kundzewicz Z, Liu J, Lohmann U, Manning M, Matsuno T, Menne B, Metz B, Mirza M, Nicholls N, Nurse L, Pachauri R, Palutikof J, Parry M, Qin

D, Ravindranath N, Reisinger A, Ren J, Riahi K, Rosenzweig C, Rusticucci M, Schneider S, Sokona Y, Solomon S, Stott P, Stouffer R, Sugiyama T, Swart R, Tirpak D, Vogel C and Yohe, G. Cambridge University Press, Cambridge.

FAO. (2007). Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities, Interdepartmental Working Group on Climate Change, Food and Agriculture Organization (FAO) of the United Nations, Rome.

FAO. (2009). Climate Change Mitigation Finance for Smallholder Agriculture: A guide book to harvesting soil carbon sequestration benefits. FAO, Rome.

FAO. (2010a). Carbon finance possibilities for Agriculture, Forestry and Other Land Use Projects in a Smallholder Context. FAO. Rome.

FAO, (2010b). "Climate Smart Agriculture" - Policies, Practices and Financing for Food Security, Adaptation and Mitigation. Food and Agriculture Organization of the United Nations , Rome.

FAO, (2013). "Climate Smart Agriculture"– Source Book, Food and Agriculture Organization of the United Nations, Rome.

Gill, M.S., Singh, J.P. and Gangwar, K.S. (2009). Integrated farming system and agricultural sustainability. *Indian Journal of Agronomy* **54** (2):128-139.

Jayanthi, C., Rangasamy, A., Mythili, S., Balusamy, M., Chinnusamy, C. and Sankaran, N. (2001). Sustainable productivity and profitability to integrated farming systems in low land farms. **In:** *Extended Summaries*, pp. 79-81. (Ed:A.K.Singh, B.Ganwar, Pankaj and P.S.Pandey), *National Symposium on Farming System Research on New Millennium,* PDCSR, Modipuram.

Kumar, P; Mittal, S and Hossain, M. (2008). Agricultural Growth Accounting and Total Factor Productivity in South-Asia: A Review and Policy Implications. Agricultural Economics Research Review, 21:145-172.

Lasco R, Pulhin F. (2009). Agroforestry for Climate Change Adaptation and Mitigation. An academic presentation for the College of Forestry and Natural Resources (CFNR), University of the Philippines Los Banos (UPLB), Los Banos, Laguna, Philippines.

Nanda, S.S. and Garnayak, L.M. (2010). Integrated farming for livelihood security in coastal ecosystem. Proceeding of National Symposium on Resource Management Approaches towards Livelihood Security held at University of agricultural Sciences, Bengalore, Karnataka. Dec.2-4, 160-167pp.

Nanda, S.S. (2007). Farming systems for different agro-ecosystems. *Presentation in the Seminar on Road Map for Agriculture Development in Orissa* held during 6-7 November OUAT, Bhubaneswar, Odisha, India.

Rasul, G and Schild, A. (2009). Food Security and Agricultural Sustainability in South-Asia. Proceedings od National Seminar on Food Security and Sustainability in India, Nov.07-08 at New Delhi, India, 32-41 pp.

Ravindranath, N.H.; Chaturvedi, R.K. and Murthy, I.K.. (2008). Forest conservation, afforestation, and reforestation in India; Implications for forest carbon stocks. Current Science, 95: 216-222. Sahoo, A.K. 2011. Climate Mitigation and Carbon Finance: Global Initiatives and Challenges. Book Published by New India Publishing Agency (ISBN 978-93-81450-02-4), New Delhi, India.

Sahoo, A K. (2014a). Climate Smart Agriculture: Transformation towards Green Economy and Global Power. International Journal of Tropical Agriculture. Vol.32 (1-2) January-June 2014 pp.317-324.

Sahoo, A K (2014b). Technological Challenges on Climate Smart Agriculture: A Global Issue. Proceedings of Annual Group Meet of All India Coordinated Research Project on Agroforestry on "Agroforestry Options for Climate Resilient Farming" held on 26th-28th July, 2014 at Bhubaneswar pp.89-91.

Sahoo, A.K., Nanda, S.S., Nayak.D and Singh, V.P., (2014c). Climate Smart Agriculture: Global transformation towards resilience and food security. In Extended Summaries of Odisha Chapter, Indian Society of Agronomy & Orissa University of Agriculture and Technology, Bhubaneswar Pub. pp.18-20.

Shames, S. and Scherr, S.J. (2010). Institutional Models for Carbon Finance to mobilize Sustainable Agricultural Development in Africa. US AID, USA

Singh, V.P. (2008). Agroforestry for food, livelihoods and environmental security. Paper presented during the India-Africa Summit, 10-12 Nov. New Delhi, India.

Singh, V.P. (2010). Addressing the Challenges of Climate Change for Securing Sustainable Livelihoods in India. IFAD Investment Strategy Paper for India. In: COSOP Document for India, IFAD, Rome. 27 pages.

Singh,V.P.; Nayak, D and Bohra, B. (2012). Agroforestry Science for Achieving an Evergreen Agriculture. In the Proceedings of the National Seminar on Agroforestry - an Evergreen Agriculture for Food Security and Environment Resilience, 02-04 February 2012, Navsari Agricultural University, Navsari (Gujarat) 396450, India.

Swaminathan, M. S. (2010). Enhancing the disaster resilience of agriculture. *The Hindu Survey of Indian Agriculture*: 7-10pp.

UNFCCC. (2008a). Challenges and opportunities for mitigation in the agricultural sector Technical paper.

UNFCCC. (2008b). Adhoc Working Group on Long-Term Co-operative Action under the convention. Fourth Session Poznan 1-10 December 2008.Ideas and submissions from intergovernmental organizations. Ideas and proposals on the elements contained in paragraph 1 of the Bali Action Plan. Paper No1 FAO and IFAD. Financing climate change adaptation and mitigation in the agricultural and forestry sectors.

Verchot, L. (2007). Design and best practices for agroforestry and community forestry carbon projects: A work plan for ICRAF in the CPR Alliance, ICRAF, Nairobi, Kenya.

World Bank. (2009). Carbon Finance for Sustainable Development, Annual Report, 92 pp.