Effective carbon management for carbon market compliance by the rural sector in India

A. Ekka*, Md. Aftabuddin and Arun Pandit

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata 700 120, India

The increasing concentration of green house gases (GHG) in atmosphere and its dramatic impact on global environment drive countries around the globe to reduce their share of global GHG emission into the atmosphere. The GHG reducing mechanisms are traded under three Kyoto mechanisms namely; joint implementation (JI), clean development mechanism (CDM) and emissions trading (ET). Under CDM, developing countries can invest in carbon emission-reduction technologies and earn certified emission reduction credits which can be then traded in the carbon market. In India, most of the carbon projects are implemented in the energy sector. Very few projects are concerned with rural development. Also, carbon projects in India are not compliant with the policy of IPCC 2007 which says that sustainable development must have environmental, economic and social dimensions. Most of the projects are implemented by the private sector or companies and rarely rural livelihood aspect is considered. The study explores opportunities and intervention in the rural sector to harness the benefits of carbon projects in India. Three important areas of rural economy, viz. agriculture, forestry and energy management were discussed in detail where carbon emission can be managed to earn carbon credits. The article discusses the limitations of carbon trading and concludes by suggesting a road map for strengthening and making the rural sector compliant with carbon market for carbon trading.

Keywords: Agriculture, carbon markets, energy management, rural sector.

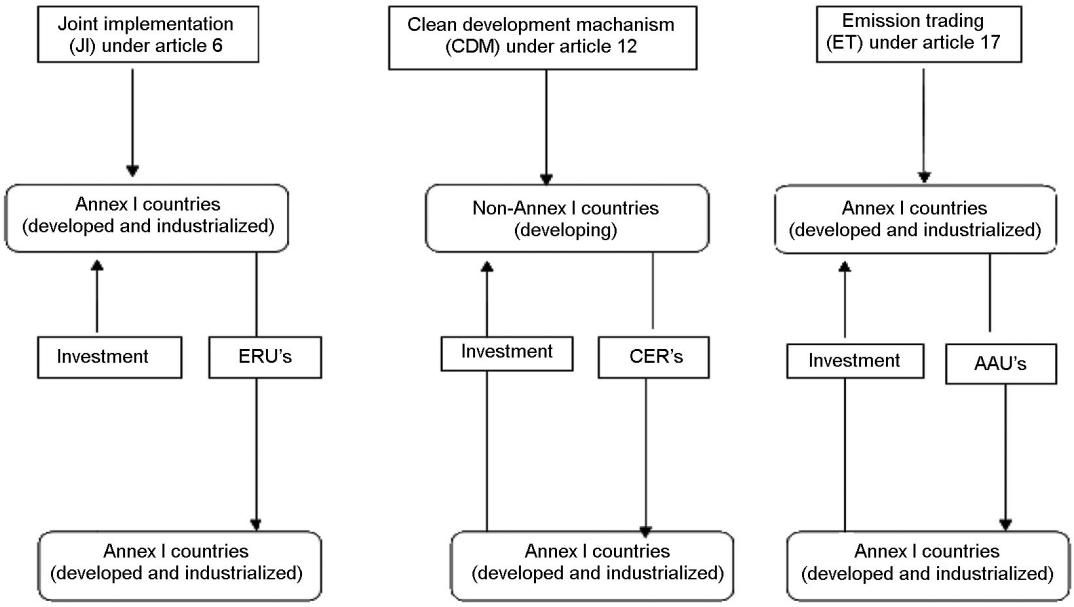
GLOBAL warming and climate change have become major threats and are being discussed in a majority of the national and international fora[1,2]. Climate change is a prominent sign of human-driven changes in the global environment. The emission of green house gases (GHG), most significantly carbon dioxide (CO_2), is accountable for global warming since industrialization[1,3]. However, majority of GHG emissions is contributed by combustion of fossil fuels[4], accompanied by huge deforestation[5]. The clearing of natural environment and various other anthropological activities have contributed much to global warming by increasing the temperature of earth by more than 2°C (ref. 6). Many scientists advocated curbing GHG emission by reducing the production of CO_2 (refs 7–9) to save the earth from further global warming. Reduction of GHG in environment is possible by either reducing its production by improved technologies or tapping already produced CO_2 by natural processes such as sequestration in forest and soil. The mechanism for reducing GHG was developed under the United Nations Framework Convention on Climate Change (UNFCCC). According to UNFCCC of Kyoto Protocol, GHG reducing mechanisms are based on three Kyoto mechanisms (Figure 1) namely: Joint Implementation, Clean Development Mechanism and Emissions Trading.

Under Joint Implementation, rich countries (annex 1 countries) can invest in any developing country (annex B countries) to meet their own emission reduction targets. This mechanism is also known as 'flexibility mechanism'. Emissions trading is also one of the flexibility mechanisms allowed under the Kyoto protocol in which rich countries (annex 1 countries) can buy or sell some portion of their emission allowances called as 'assigned amount units' (AAUs).

A clean development mechanism (CDM) involves investing in renewable energy projects or in afforestation/community tree planting called carbon sinks, which would contribute towards offsetting the GHG emissions targets. Tropical forests are also considered as potential natural resource for reducing GHG emissions, especially CO_2 by creating carbon pools[10–12], therefore, UNFCCC, started an ambitious programme called 'Reducing emissions from deforestation and forest degradation' (REDD or REDD$^+$). The programme aims at providing incentives to developing countries for reducing emissions from forested lands and investing in low carbon production technologies for sustainable development. All these activities are in totality known as carbon trading.

As per the conventions of Kyoto protocol, India being a developing country has no emission targets to be fulfilled. However, India can implement CDM projects[13]. Out of 892 CDM projects currently implemented in India, 84.32% comes under energy sector both in renewable and non-renewable sources, followed by projects on energy demand covering 7.4% of total CDM projects (Figure 2). Most of the projects are implemented by private sector or companies and they rarely considered rural livelihood

*For correspondence. (e-mail: aekka@icar.gov.in)



Participating country types

Annex I countries: Developed countries that have non-binding GHG reduction commitments plus countries with economies in transition (the EIT parties).
Annex II countries: Annex I countries excluding the EIT members.
Non-Annex I countries: Parties are mostly developed countries.
Annex B countries: Annex B of the Kyoto Protocol includes developed countries that have GHG reduction commitments.

Certificate types

Assigned amount unit (AAU): The allowance (setout in Annex-B) a country is permitted to emit.
Emission reduction unit (ERU): Certified emission reduction from the Annex-I country is transferred to another Annex-I country.
Certified reduction emission (CER): CERs are generated from projects under the Clean Development Mechanism (CDM), hosted in a non-Annex-I country.

Source: Refs 2, 43, 44.

Figure 1. Carbon trading under Kyoto mechanisms.

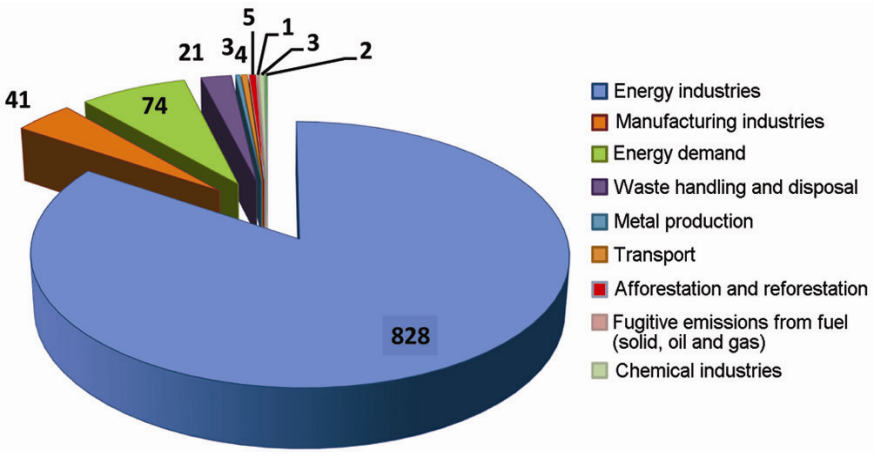


Figure 2. Number of CDM projects in various sectors of India. Source: www.cdmindia.gov.in.

aspect. Rural people have no knowledge about the carbon credits or trading and they are not stakeholders in the profits[14]. The study explores various prospects in rural sector to harness the benefits of carbon projects in India. Three important areas of rural economy, viz. agriculture, forestry and energy management are discussed in detail where carbon emission can be managed to earn carbon credits. Further, the article discusses the limitations of

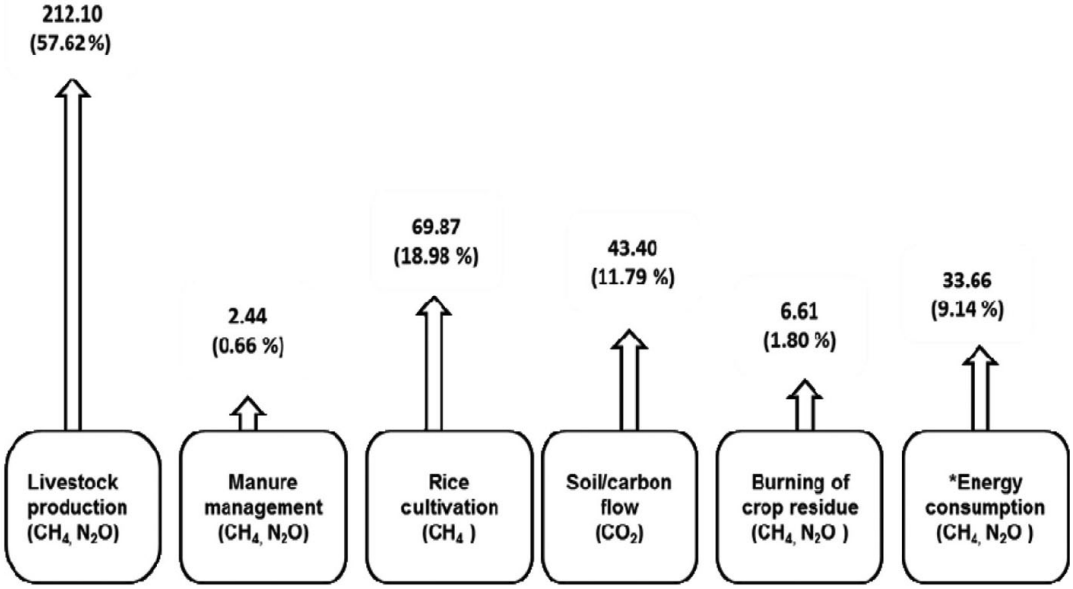


Figure 3. GHG Emissions from agriculture sector in India (million tons of CO_2 eq). Source: Ministry of Environment and Forests, 2007.

carbon trading and concludes by suggesting a road map for strengthening the rural sector for compliance with carbon market standards of carbon trading.

Opportunities for carbon management

The whole concept of carbon projects lies in minimizing carbon concentration in the atmosphere either by reducing carbon emission, avoiding emission or by carbon offsets. The three important sectors of carbon trading namely agriculture, forestry and bioenergy are considered for discussion owing to their suitable modification for implementing in the rural sector of India.

Agriculture and soil

The agriculture sector has immense potential to generate direct environmental services ensuring food production and economic growth in a sustainable manner[15]. In the process, it contributes 14% of global emissions[1] amounting to 6.6 $GtCO_2$/year in terms of global anthropogenic GHG emissions placing the sector as the fourth largest contributor. Certain agricultural practices such as use of chemical fertilizer, land conversion, destruction of pasture, livestock farming, rice-growing, burning of organic matter mainly slash and farm burn as such are some of the major causes of GHG emissions in India (Figure 3). The mitigation potential of agriculture under wide adoption of best management practices was estimated as 5.5–6 Gt of CO_2 per year globally by 2030 (ref. 1).

In order to achieve the target, certain agricultural practices and technologies can be implemented in our rural sector as follows.

Livestock and manure management. Livestock farming contributes to GHG emissions by ruminant fermentation and management of farm waste in an unscientific manner. Ruminant fermentation leads to production and emission of methane formed by microbial digestion of crude fibre by ruminants. Production of methane by ruminants can be reduced by management of feed, gut microbial flora and animal/farm waste. Production of methane depends both on type of feed provided to animal as well as type of microbial flora established in the gut. Managing the feed by providing the animal with some herbal supplement will help in reducing the substrate for methanogenic flora in the ruminant. Waste materials of both animal and farm origin can be properly utilized for production of biogases and fertilizers which will otherwise emit GHG in anaerobic condition.

Reducing the emissions from agricultural activities. Traditional method of rice cultivation through flooding leads to production of methane (CH_4) due to anaerobic fermentation while burning of rice straw emits CO_2 immensely contributing to global carbon net[16]. In India, crop production is mainly linked with sole use of nitrogenous fertilizers leading to emission of large quantity of N_2O. Cultivation of crop by tillage practices exposes the soil for more air availability leading to production of more CO_2. The GHG emissions from agriculture can be reduced by various ways such as limiting the use of nitrogen fertilizers, using more organic fertilizers, planting legumes, avoid leaving the soil bare, reducing tillage, changing the kinds of nitrogen fertilizers used, reducing burning of farm waste, allowing straw to decompose naturally, etc. Emissions can also be reduced by drying

the field between two crops and by practices such as crop rotation with low water requirement crop.

Increasing soil carbon storage: GHG emission can be reduced to about 89% by sequestering carbon in the agricultural soil[17]. Shifting from traditional agricultural practices such as zero tillage to tillage and residue- and organic manure-based to chemical fertilizer based system reduces the carbon storage of the agricultural soils and increased GHG in the atmosphere. By following simple agricultural practices such as crop rotation, residue management, reduced tillage, organic matter amendments and agroforestry, the soil carbon storage can be increased[17,18].

Forestry and land use

In India, about 23.4% of the total geographical area is under forests[19]. The carbon stocks maintained by forests has increased from 6244.78 million tonnes (mt) in 1995 to 6621.55 mt in 2005 which is enough to counterbalance 9.31% of total annual emissions of GHG in atmosphere[20], covering 100% emissions from all energy in residential and transport sectors, or 40% of total emissions from the agriculture sector. Although India's forests is a potential source for carbon mitigation, the immediate requirement of land for development of infrastructure is a direct threat to the forest cover *vis-à-vis* carbon mitigation potential.

The potential of forests in carbon mitigation can be achieved by realizing its employment generation and export earning potential. Nearly 27% of population in India including poorest and marginalized tribal people depend on forests for their income and livelihoods. The provisioning services of forests such as fuel wood, fodder, small timber, non-timber forest product (NTFP), medicinal plants, and other artisanal raw material are crucial to livelihood security of communities dependent on forests[21], where 75% of export income from forest sector is contributed by NTFP[22]. Besides, forests are essential for maintaining sustained agricultural productivity[23]. However, due to poorly defined resource rights for communities participating in agreements, the Joint Forest Management (JFM) model which was formed by community participation also failed to tap the potential of forests to improve livelihoods of local communities[21].

A study by Singh *et al.*[24] revealed that mining and industrial activities were dangerous to the land use pattern of India. In recent years, the Indian government created water harvesting instruments in form of ponds, watershed, etc. through change in land use which needs to be used as carbon harvesting mechanism by promoting social forestry. Afforestation in barren lands and abandoned mines can be one of the major activities for generating carbon credits under REDD$^+$ programme. The government scheme Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) should be linked with forestry programmes which would provide the twin benefit of employment generation and generating carbon credits by planting trees. As discussed by Mohapatra[25], improved management practices and forest protection from fire, putting a price tag on conservation and carbon, replacing climate and disease prone species and maintaining national parks and biospheres as carbon reserves are some of the important points that need to be revisited to capture the benefit from carbon trading.

Energy management: fossil fuel to bioenergy

At present, fossil fuels dominate all energy sources in India in which coal contributes 40% of primary energy supply and 59% of power generation[26]. Combustion of fossil fuel and industrial processes emits CO_2 to the tune of about 78% of the total GHG emission globally[27]. Bioenergy can significantly reduce the future demand for fossil fuel. Bioenergy is a form of renewable energy produced from living sources such as feedstocks, agricultural and livestock residues; energy crops municipal solid waste; and other organic waste streams. Bioenergy if produced sustainably, can help in reducing GHG emissions. Therefore, a significant reduction of GHG is possible by replacing fossil energy systems with bioenergy systems. Some bioenergy systems from agriculture such as biogas cow manure and biogas pig manure and biogas co-digestion have no net GHG emissions or are even associated with 'negative' emissions[28].

Although India has successfully implemented the renewable energy programmes by increasing its share from 2% in 2002 to 11% (18,155 MW) in 2010, it has not realized the full potential compared to traditional sources of energy[29]. According to a study conducted by TERI[30], 90% of rural energy requirement and 40% of urban energy requirement are fulfilled by biomass. A huge amount of carbon can be reduced through effective burning devices. The Ministry of New and Renewable Energy (MNRE), Government of India should support improved cooking stoves which would help to save fuel wood and thus could reduce dependence on forests. Bioenergy technologies should be encouraged to develop under CDM projects so that it can trim down dependency on fossil fuel, and reduce CO_2 emission in the atmosphere and create opportunities of employment generation for the rural sector.

Limitation of applying carbon management projects

Although carbon projects addressing issues such as biodiversity conservation, livelihood improvements and other ecosystem services have impacted both the atmosphere and society positively[31], there are some potential risks. Most of the rural poor are dependent on forest resources

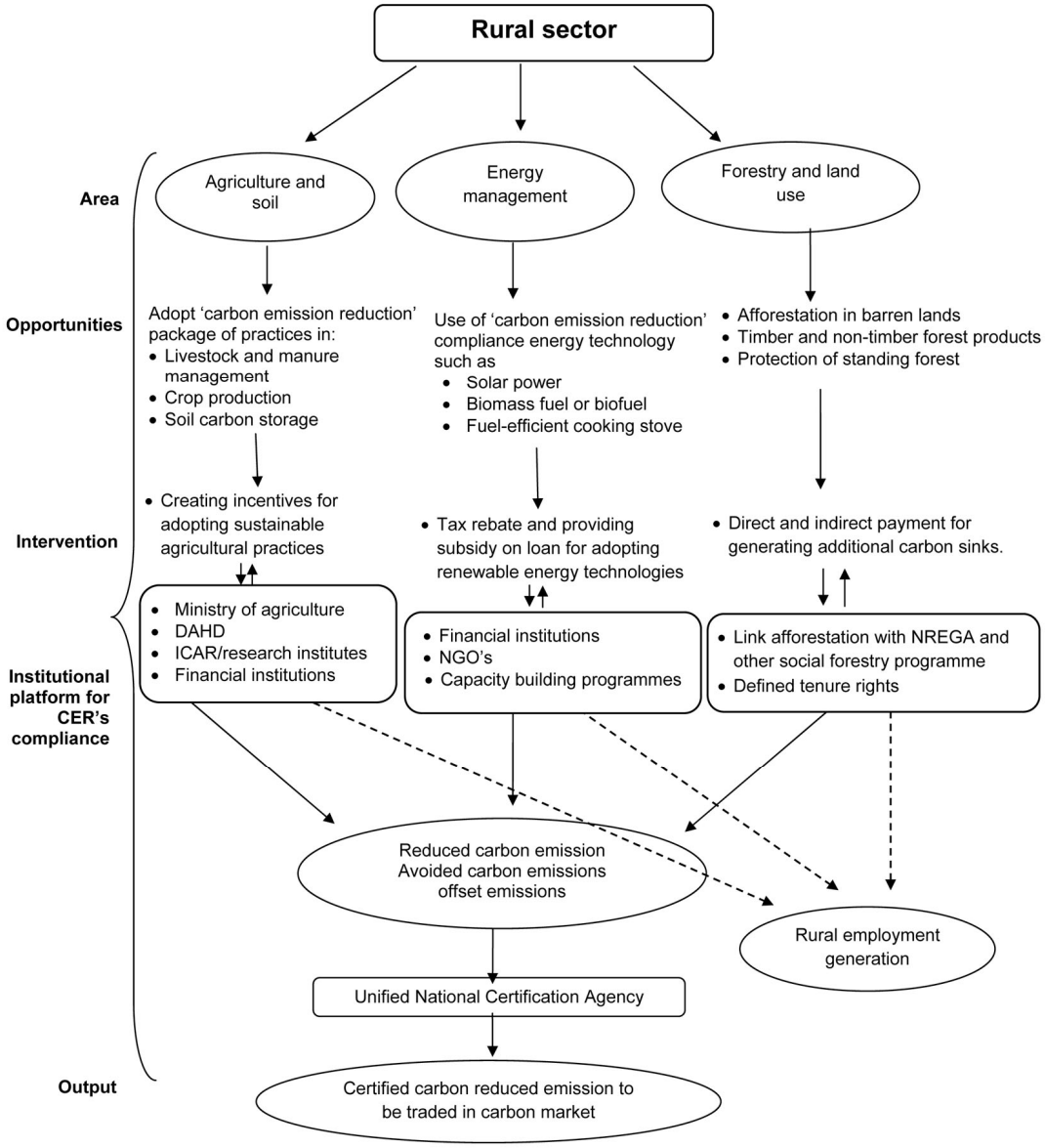


Figure 4. Road map for efficient carbon management in the rural sector.

for their subsistence and livelihood[32–35] in terms of labour and access to forest products such as fibre and food[36–38]. However, their access to forest and natural resources is at stake due to entry of many players into the carbon market, which puts the scope of their livelihoods at risk due to their direct dependence on forests[32]. Also, there is no alternative source of employment for the rural form. As forests are multistake natural resources, interest in its use by indigenous local communities, the state, agro-industrial, timber and mining concessionaires, and developers can lead to a conflict causing limited or no use[39]. Most of the mitigation projects under agriculture are not allowed under CDM as the projects do not generate the desired output[15]. Due to low returns, high transactions costs and high risks, smallholder agriculture will not be compliant to international markets in terms of carbon mitigation, although this has great potential for livelihood improvements. Thus, public finance has to be brought into the scenario to create avenue for tapping the potential of smallholder agriculture in realizing both the mitigation of carbon emission and creating employment[15], where smallholder farmers can be integrated in an environment of favourable policies, institutions, capacity building and agreed system of property rights[15].

Roadmap for carbon management

To strengthen the rural sector for carbon trading, first of all, we should learn lessons from the previously failed carbon projects. The area of carbon projects implementation

needs to be thoroughly assessed in terms of its potential, intervention and institutional compliance (Figure 4). The agricultural research institute should develop a package of practices which preferably reduces carbon emission and at least does not add carbon to the atmosphere and should be implemented by providing incentives to the farming community. Likewise, carbon reducing technologies such as bioenergy should be supported by subsidy or loan. The carbon credit earned by adopting those practices and technology should be monitored and registered under unified national certification agency. Also the potential of CDM and REDD^{+} projects to provide sustainable development and livelihood generation needs to be assessed. Decentralization of authority and resource control[40] can develop opportunities for the rural community to gain more share from natural resource management in a sustainable manner. In this regard, the tenure rights should be clearly defined and made a part of the carbon projects[41]. Further, involving local communities in planning and implementation of carbon projects may be part of decentralization and resource control. Therefore, capacity building of stakeholders is of prime importance for effective management of carbon and also to safeguard the livelihood. Awareness creation among local communities should be done through training, mass awareness programme, village-level meetings and exposure visits. Carbon policy should be incorporated through compulsory with social forestry programmes. Provision should be made that any agreement between companies and the local community for carbon trading should be monitored and managed by the government.

Conclusion

Various anthropogenic activities have pushed earth's ecological system into a critical threshold level at which a small change will have dire consequences in the long run. The increased concentration of GHG in the atmosphere has led to global warming and the final outcome is climate change which poses major threats[32] to world economy. Therefore, we are left with few choices, most important of which is to reduce carbon emissions from both man-made and natural sources by all possible means. Controlling GHG emissions involves, not only the mitigation *per se*, but also increasing the psychological and ethical awareness of all stakeholders and regulating powerful interest groups[42]. We need to understand that the principal objective of carbon management projects is to mitigate increasing global temperature and not to secure livelihoods. Therefore, the government should come forward to safeguard the interest of rural people living adjacent to natural ecosystems. If India can work on the loopholes and connect the gap between carbon trading and livelihood issues, India can proved itself to be pioneer in sustainable carbon management.

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