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Carbon Crediting in Agriculture- A Means to Achieve India's Climate Change Commitments

Sheri Vaishnav[1*], Sai Suvidh, M.[2], Yakadri, M.[1] and Ramulu, V.[1]
[1]*Department of Agronomy, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad-500030 India.*
[2]*Department of Agricultural and Environmental Sciences,*
College of Agriculture, Tennessee State University, Tennessee, USA.

(Corresponding author: Sheri Vaishnav)*
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ABSTRACT: Greenhouse gases (GHGs) from human activities including agriculture are the most significant driver of observed climate change since the mid-20th century. Agriculture is not only the emitter but also the sufferer of climate change. There is an immediate need to search for the ways to reduces GHG emissions from agriculture as it is the source of livelihood to 2/3rd of employed class in country. Carbon crediting a latest strategy emerging across the globe may become one of the tools that minimises adverse environmental impact in agriculture. Carbon crediting in agriculture will not only act as an additional source of income at farmers level but it also contributes to nations commitment at COP-26 for reducing emissions by 2030. Certain climate smart agricultural practices like reduced tillage, no tillage and alternate cultivation systems like dry direct seeded rice (DDSR), zero till planting and laser land levelling were already proved to have great potential in fixing atmospheric carbon (C) and in increasing soil carbon status. On the other side the same systems are also responsible for reducing the consumption of fossil fuels & agro-chemicals to sustain farming systems in a profitable path.

Keywords: Greenhouse gases (GHGs), agriculture, environment, carbon crediting.

INTRODUCTION

Since agriculture require energy from fossil fuels, agricultural activities contribute significantly to GHG emissions (Sharma *et al.*, 2021). According to Intergovernmental Panel on climate change (IPCC) report, during the years 2007 to 2016, 23% of the net anthropogenic global GHG emissions were attributable to changes in land use and agriculture. Reasons like increased traffic over field due to intensive agricultural practices (Agboola and Bekun 2019 and Shabbir *et al.*, 2020), Indiscriminate use of agro-chemicals, Puddled paddies, etc., has further aggravated the intensity of problem. Indian agriculture alone contributes to 14 per cent of total GHG emissions of the country annually (Pradeep *et al.*, 2016). Certain other agricultural practices like stubble burning have also assumed importance in the recent days causing disturbance to life through pollution and with high environmental risk. 1 mega gram of straw burned produces 3 kg of particulate matter, 60 kg of CO, 1460 kg of CO_2, 199 kilogramme of ash, and 2 kg of SO_2 when it is burned (Gupta *et al.*, 2006). In terms of greenhouse gas emissions, only China and the US are ahead of India. By 2030, its CO_2 emissions are projected to increase by almost 3% yearly, reaching 3.7 billion tonnes (Dhruv Sawhney, 2022). It is also anticipated that if no strategy is developed, GHGs from agriculture can upsurge upto 58% by the year 2050 in the whole world (WRI, 2019) stressing the urgency to act upon. Excess GHGs in atmosphere will increase temperature abnormally which is very severe as increased temperature may drastically reduce yield of food crops like rice due to speedup of growth process (Aswati *et al.*, 2022). This sparked an interest in developing sustainable methods to lower their concentration in the atmosphere and attain food security for all people throughout the world (Sadam *et al.*, 2021). Now major part of the world has come together through Paris agreement to act upon climate change. Paris agreement, which came into force in 2016, aims to restrict global warming to 1.5 ^{o}C to achieve a climate-neutral world by 2050. To realize the long-term goals of the Paris agreement, participating countries have pledged to come up with strategies to reduce GHG emissions (United Nations Climate Change n.d.). Narendra Modi, Hon'ble prime minister of India as part of the panchamrits pledged at COP-26 stated that India would cut the emissions intensity of its

economy by 45% by 2030 (this applies to all greenhouse gases, not just CO_2) (Shruti Menon, 2021).
Agriculture is the only means of living for almost 2/3rd of the employed class in India (Manoj and Divya 2020). There is an expeditious need to improve the agricultural practices to make them environment friendly and climate resilient. On the other hand, daunting challenge under Indian context to begin any initiative is to change the mindset of farmers or convincing farmers to adopt new technology. Technology with either visible benefits or monetary advantage can only go deeper in the farming communities. Carbon crediting system is such an activity where farmers are paid for decreasing GHG emissions by adopting climate resilient techniques in place of their regular practices which in turn will improves the soil health in long run. This single approach has multiple hidden benefits which are both environmental & economical in nature. After an extensive review of carbon crediting system across the world, a brief background and its relevance to Indian agriculture is presented in the below text.

A. Carbon Crediting

A carbon credit is a permit that allows the owner to emit a certain amount of carbon dioxide or other greenhouse gases. One credit permits the emission of one ton of carbon dioxide or the equivalent in other greenhouse gases (Will Kenton, 2022), the carbon credit is half of a so-called "cap-and-trade" program. Companies that emit pollution are given credits that let them emit pollution up to a specified amount. This cap is periodically lowered. In the interim, the business may sell any credits it does not require to another business that does. Thus, private businesses have two incentives to lower greenhouse gas emissions. If their emissions exceed the cap, they must first pay extra for credits. Second, by lowering their emissions and selling their extra allowances, they can generate income.

According to Shockley and Snell (2021), GHG emissions (especially CO_2) coming from agricultural operations are relatively low compared to industrial emissions. As a result, carbon-credit systems in the agricultural sector have gained wide attention globally (Shockley and Snell 2021) in achieving climate neutrality, where agricultural producers can earn extra revenue through selling their surplus of carbon credits to producers who emit higher amounts of GHGs. Moreover, the soil carbon pool has been estimated at approximately 3.3 times the size of the atmospheric pool (Lal, 2004).

Through the sale of their excess carbon credits to other producers who release more greenhouse gases, carbon-credit schemes enable agricultural producers to generate additional income (Lokuge, N., & Anders 2022). Thus, creating carbon credits for agribusiness would increase the resilience of Indian farmers by ensuring greater harvests, better soil health, and improved livelihoods (Dhruv Sawhney, 2022). The rising carbon emissions has been forcing big world economies to adopt more green initiatives. In the same line, Indian listed companies will have to produce their carbon emission report from 2023 onwards which offers great potential to agro-based carbon credits. Many private firms across the country have already ventured into this space and are working in association with farmers of Punjab and Haryana.

In India the carbon farming programme is being initiated by a private entity Grow Indigo (GIPL) initially with 4,000 ha in Punjab under the carbon farming programme with technical support from Indian Agricultural Research Institute (IARI) for validating claims of their adoption of sustainable practices (Sandip, 2022). Being the second-largest producer of important staples like rice, wheat, fruit, and vegetables in the world, India is well-positioned to lead the way in agricultural-related carbon credit trading. The industries that are unable to minimise their carbon footprints due to the nature of their operations, such as aviation, mining, or fertiliser makers, can purchase carbon credits from farmers through companies that have been validated by certifying organisations like Verra. According to estimates, the value of one carbon credit is around $10 in the global market (Sandip, 2022).

Indian agriculture is known for many transitions since its inception. Unlike other countries in India, agriculture is not just a business but it is a way of life on which half of the countries work force is dependent. Carbon crediting in this field will not only act as an additional source of income at farmers level but it also contributes to nations commitment at COP-26 for reducing emissions by 2030. There is a swift need to develop comprehensive framework and regulations (Scientific and Legislative) to operate in this business which will facilitate the entry of new firms so that the system can make way to every corner of the country.

B. Rewarding regenerative practices with carbon credits

To promote sustainable corporate practices and assist in achieving global net-zero targets, carbon credits, or certified emission reductions from climate-positive projects, are increasingly becoming popular. Global firms are increasingly showing interest in the voluntary carbon market, which is expected to be worth $1 billion in 2021. While most projects used to generate carbon credits are related to renewable energy and reforestation, there is growing awareness around the concept of ‘carbon farming’. A viable technique for more sustainably producing food and other goods is carbon farming. It aims to concurrently produce a wide range of natural farming techniques and commercial goods (Meenakshi *et al*., 2021). With the intention of trading these carbon offsets, these programmes stimulate offset production from soil carbon sequestration to increase agriculture's contribution to climate mitigation. For instance, Microsoft recently committed to buy $2 million of carbon credits from an

American farming cooperative, and US President Biden has called for a "carbon bank" to pay farmers for adopting regenerative agriculture practices. Agriculture-related carbon credit systems have, so far, been mostly confined to large scale holdings in developed economies, where farmers have greater access to information sources, technology, and the necessary mechanisation and equipment. However, the potential for impact in the developing world home to hundreds of millions of farmers working small acreages is colossal. We must establish a simpler validation and verification process of carbon credits to scale projects faster and support sustainable practices (Dhruv Sawhney, 2022b).

Scaling the income from agriculture without upsetting GHG emissions in coming days is possible by adopting climate smart cultivation practices like conservation agriculture, precision farming and other climate smart agricultural practices which are potent enough in improving climate resilience and yield of crop simultaneously. These practices also proved worthy in increasing soil carbon stocks where from farmer can earn additional income in the form of carbon credits. Though in the initial days of transformation from conventional practices to climate smart cultivation practices yields may not match the regular yields but in long run the yields were found on par. Sequestration of C in arable soils has been considered as a potential mechanism to mitigate the elevated levels of atmospheric GHGs (Das *et al*., 2013) which is possible through conservation agriculture [Theirfelder and Wall (2009); Ella (2016); Das *et al*. (2018); Jat *et al*. (2019)]. The essential role of macroaggregates in C sequestration is well reported by Dorodnikov *et al.* (2009). In general, microaggregates (<0.25 mm) are reported with less C than macroaggregates (>0.25 mm) Cambardella and Elliott, 1993 & Elliott, 1986 and adaptation of no tillage increases the proportion of macro-aggregates (0.25–2 mm) and reduces the proportion of micro-aggregates (0.05–0.25 mm) vis-a′-vis traditional tillage practices. Thus, Reduced tillage systems improve soil organic carbon as reported by Beare *et al*. (1994); Six *et al*. (2000); Lal (2007); Dillaha *et al*. (2010) and Cimelio Bayer, *et al*. (2016).

Table 1: Carbon sequestration status in different tillage systems.

Conservation/zero tillage	Crop	Study duration (Years)	Depth (cm)	Increase in C sequestration over CT (%)
ZT	Rice-wheat	4	0-5	11.0
PBB+R	Maize-wheat	3	0-30	19.4
ZTDSR/ZTM	Rice-maize	5	0-30	25.8
ZT	Wheat	12	0-10	17.7
ZT	Barley	7	0-5	26.1

(Source: Sonaka *et al.*, 2019)

CT: Conventional tillage; C: Carbon

Adopting climate smart practices like laser land levelling, alternate wetting and drying method of irrigation and dry direct seeding of rice reduces the adverse impact of rice on environment as reported by Houghton *et al*. (1996); Lipper *et al*. (2014); Aryal *et al*. (2015); Lampayan *et al*. (2015); Zhiqin *et al*. (2018); Susilawati *et al*. (2019) and Dhruv Sawhney (2022).

C. Conservation agricultural practices

Sequestration of C in arable soils has been considered as a potential mechanism to mitigate the elevated levels of atmospheric greenhouse gases (Das *et al*., 2013) which is possible through conservation agriculture. In an experiment where cotton-wheat were grown in sequence under conservation system for three years, plots where zero tillage with bed planting (ZT-B) and zero tillage with flat planting (ZT-F) had nearly 28 and 26% higher total Soil organic carbon (SOC) stock when compared with conventional tillage and bed planting (CT-B) (~5.5 Mg ha^{-1}) in the top 0–5 cm soil layer. SOC stocks were also found higher in zero tillage plots at 5-15 cm soil layer than conventional tillage (Das *et al*., 2013). In upland crop production systems, conservation agricultural practices increase soil nutrient status, residual water content, soil infiltration rate, and organic carbon content contrary to traditional systems (Thierfelder and Wall 2009; Ella, 2016). Retention of both-season crop residues in maize-wheat system had significantly improve SOC concentration in surface (0–5 cm) soil. The Permanent broad bed with residue (PBB + R) resulted in higher SOC pool at 0–30 cm soil layer (19.4 %) than in conventional tillage (CT) system with maximum carbon sequestration potential (Das *et al*., 2013).

D. Climate smart approaches (CSA) in crop production

A climate smart approaches tries to integrate climate change into planning and implementation of sustainable agricultural practices to increase the resilience of agriculture to climate variability through better adaptation to climate change and reduce agriculture's contribution to global warming (Lipper *et al*., 2014).

A recent study by Aryal *et al*. (2015) shows that crop yields are higher in laser levelled fields compared to traditionally-levelled ones, whereas the total duration of irrigation per ha per season was much lower in laser-levelled fields. The alternative wetting and drying (AWD) is a water management technology in rice, which helps counteract the increasing scarcity of water for agriculture. Under this system, rice fields are irrigated to the desired depth only and then, re-irrigated after some time, when the water dissipates (Lampayan *et al*., 2015). The AWD reduces irrigation water input in rice fields by up to 38% without any reductions in rice yield (Lampayan *et al*., 2015).

Rice based cropping system play an important role in the emission of greenhouse gases. Conventional flooded rice culture with puddling and transplanting is the major source of CH_4 emissions as prolonged flooding creates an anaerobic soil condition accounting for 10–20% (50–100 Tg yr^{-1}) emissions (Houghton *et al*., 1996). The total energy use was lower by 17–18% in DDSR and 15–17% in unpuddled transplanted rice than in puddled transplanted rice. Wheat consumed a lower energy of 12.5–19% when sown in zero tillage system than in conventional tillage. In both crops, the total global warming potential was lower for reduced tillage practices compared with the conventional counterparts. Higher energy-use efficiency with lower global warming potential could be a resilient and risk minimization strategy for crops in the rice–wheat systems established with reduced tillage under both irrigated and rainfed environments (Magar *et al*., 2022). GWP were reduced by 46.4% under DSR compare to TPR. Crop-establishment did not influence grain yield, indicating the potential of DSR as alternative methods of establishing lowland rice with low GHG emissions (Susilawati *et al*., 2019).

Table 2: Comparison of CT and CA for energy dynamics.

Conservation/zero tillage	Saving of energy in CA over CT	
	Parameters	**Increase or saving (%)**
ZT	Fuel saving Reduction in tractor operational time	75.0 81.0
ZT	Saving on input energy Output energy	12.6 27.9
ZT	Operational field capacity Specific energy Energy-use efficiency	81.0 17.0 13.0
ZT-raised bed	Saving in input energy Energy saving in land preparation Energy saving in irrigation	8.0 91.0 38.0
ZT-permanent bed	Energy saving in land preparation Energy saving in irrigation Energy-use efficiency	49.7-51.5 16.8-22.9 13.4-17.1

(Source: Sonaka *et al*., 2019)
CA: Conservation agriculture; CT: Conventional tillage

CONCLUSION

Certain conventional agricultural practices like puddling, intensive cultivation, *etc*., are responsible for elevated GHG emissions in the atmosphere. Encouraging farmers to adopt climate smart cultivation practices which enriches soil organic carbon status through fixing atmospheric CO_2 are valued through carbon crediting system. Carbon crediting is relatively a new concept with capacity to generate additional income to farmers can be used as a means to lessen the load of GHGs on environment and improve farmers income. Though this system is already popular in developed countries like United States of America it has equal importance and potential under Indian context too for which positive and immediate legislative and scientific backup is essential.

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