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Lac based intercropping system as carbon sink for climate change mitigation option in India

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INTRODUCTION

In recent times climate change has been identified as one of the most complex issues facing by the human causing several natural catastrophic climatic impacts. The planet's average surface temperature has risen 0.85°C during the period 1880-2012 (IPCC, 2014), a change driven largely by increased carbon dioxide and other human-made emissions into the atmosphere and it is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (IPCC, 2018). Scientists have reported many consequences of climate change each year, and many agree that economic, environmental and health consequences are likely to occur if current trends continue. And experts see that the trend is accelerating over the past 50 years. Forest plays a vital role in mitigating the diverse effects of environmental degradation and acting as a carbon sink of the terrestrial ecosystem. Trees and forest have an essential and central role to limit the rise in atmospheric carbon and slow down the climate change through sequestration and storage of atmospheric carbon.

Role of NTFPs in ameliorating environment

India is the fourth highest emitter of carbon dioxide in the world (Friedlingstein *et. al*., 2019). The emission is expected to grow every year pushed by economic growth. The change in land-use system for developmental activities and conversion of forest into agricultural land are the major sources for loss of forest area in India. Resource utilization and environment protection are always two contradicting processes in the context of development. However, NTFPs (Non Timber Forest Products) has been recognized as an important element for sustainable forest management and economic development. It constitutes an important source of livelihood for forest fringe communities across the world. It has been increasingly recognising its contribution to food security, diversified income sources and ecosystem services. The most promising contribution of NTFPs which has recently become important is the storage of carbon within trees. Trees are composed of approximately 50% carbon and, therefore they act as reservoirs for carbon storage if they remain in solid form (Sarkar and Manoharan, 2009). Lac is one of the important NTFPs for forest dweller of India having high market value globally. India has large lac host resources which can fulfil the demand for economic sustainability and climate change mitigation.

Lac is a natural resin of animal origin secreted from Lac insect belonging to family Tachardiidae (=Kerriidae). Indian lac insect (*Kerria lacca*) is the most widely exploited insect for cultivation. It has a wide range of applications in varnishes, paints, food, cosmetics, pharmaceuticals, perfumes, polishes, adhesives, jewellery and textile dye. Lac is mainly

produced in India, Myanmar, Malaysia, Thailand, Lao, Yuan province of China, Taiwan, Philippines, Vietnam, Cambodia and Sri Lanka. Among them, India is the largest producer, processor and exporter of the lac in the world with a production of 18746 tons and shares 1.99% of total NRG (Natural Resins and Gums) production in India (Yogi *et. al*., 2018). Jharkhand, Bihar, West Bengal, Madhya Pradesh, Chattisgarh, Eastern Maharashtra and northern Orissa are the major lac producers in India and over 90% of lac produce comes from these states. The two strains of *K. lacca i.e*., Kusmi and Rangeeni, are commercially exploited in India (Kapur, 1962; Ramani, 2005).

Distribution of lac insect

Lac insects are restricted to tropical and sub-tropical regions of the world and are distributed in the region lies between 60^{o} West to 125^{o} East longitude and 37.5^{o} North to 7.5^{o} South latitude (Srivastava, 2011). In India, lac is found in the forest of Himalaya Tarai, hilly regions of Jharkhand, Chattisgarh, West Bengal, Orissa, Madhya Pradesh, Utter Pradesh, some pockets of Deccan plateau, Rajasthan, Gujarat and Assam (Srivastava, 2011).

Lac host plant and their distribution

The major host plants include fourteen species in which *Kusum* (*Schleichera oleosa*), *Palas* (*Butea monosperma*), and Ber (*Ziziphus mauritiana*) are the excellent host in India. In addition to these host plants, *Flemingia semialata* and *F. macrophylla* are the emerging host plants which found to be economically suitable. In India, the number of host plants recorded for Indian Lac insect is 129 and out of which 19 host plants are of good quality and commercially important (Sharma, 2017). Lac host plants of Indian Lac insect and their distribution which are of commercial and specific importance is shown in table 1.

Table 1: Lac host plant of commercial and specific importance and their distribution

Host plant	Common name	Distribution
Butea monosperma	*Palas*	All over India
Schleichera oleosa	*Kusum*	All over India
Zizyphus mauritiana	Ber	All over India
Flemingia semialata	Van chhola/Semialata	All over India
Flemingia macrophylla	Bhalia	All over India

(Source: Sharma, 2017; Kumar and Kumar, 2013)

Lac based Intercropping system as carbon sink

In the lac growing states of India, the forest dwellers living in the forest and forest fringe traditionally cultivate the lac year-round. They are cultivating lac majorly in the forest and also in their farmland. More than 75% of tribal farmers are engaged in lac cultivation and it contributes a major part of their livelihood (Das and Kumar, 2013). In recent times, in order to assure an integrated source of income, the forest dwellers are cultivating lac along with seasonal vegetable crops. They are growing vegetable crops under *Palas*, Ber, *Kusum* and Semialata. Nowadays, most of the tribal farmers prefer Semialata, a shrubby leguminous plant to intercrop with vegetable crops as it is fast growing, possess short stature, satisfactory

coppicing response and can inoculate lac after one year of plantation. There are well established and successful of such system in farmer's field, which are being followed since time immemorial. One such example is rice field bunds surrounded with *Palas* trees in Madhya Pradesh and Chattisgarh. There are possibilities to explore utilization of gaps between rows of *Palas, Kusum* and Ber. Since the spacing requirement is different for different host and type, the proportion of intercrop will be different. Shade loving crops like turmeric, elephant yam, ginger etc., may be tried. Many studies have been reported that the farmers are getting benefits from such intercropping system in lac growing areas. Intercropping system can improve the crop yield and productivity considerably. It also provides certain environmental benefits and enriches the soil. There are many studies applying intercropping system to improve the income of the farmers and optimizing environmental stability. As such Lac based intercropping system not only improves the resilience of rural livelihood but also encourage environmental stability. This can provide a great potential of carbon sink in cropland for reducing the atmospheric concentration of CO_2 for mitigating climate change. Bhatt, 2016 reported that total carbon stock under Ber, *Palas* and *Kusum* plantation was 17552 kg/ha, 18816.93 kg/ha and 36573.55 kg/ ha, respectively. In Semialata plantation above ground biomass was 3166.66 kg/ha, which corresponds to 1583.33 kg carbon per hectare and below ground biomass was 5559 kg/ha, equivalent to 2229.6 kg carbon per hectare (Bhatt, 2017). However, the information on carbon stock under Lac based intercropping system is lacking. It has huge potential to provide significant mitigation options but they require proper quantification of carbon sink in the system. Thus, Lac based intercropping system creates carbon sink while enhancing the rural livelihood of lac growers.

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