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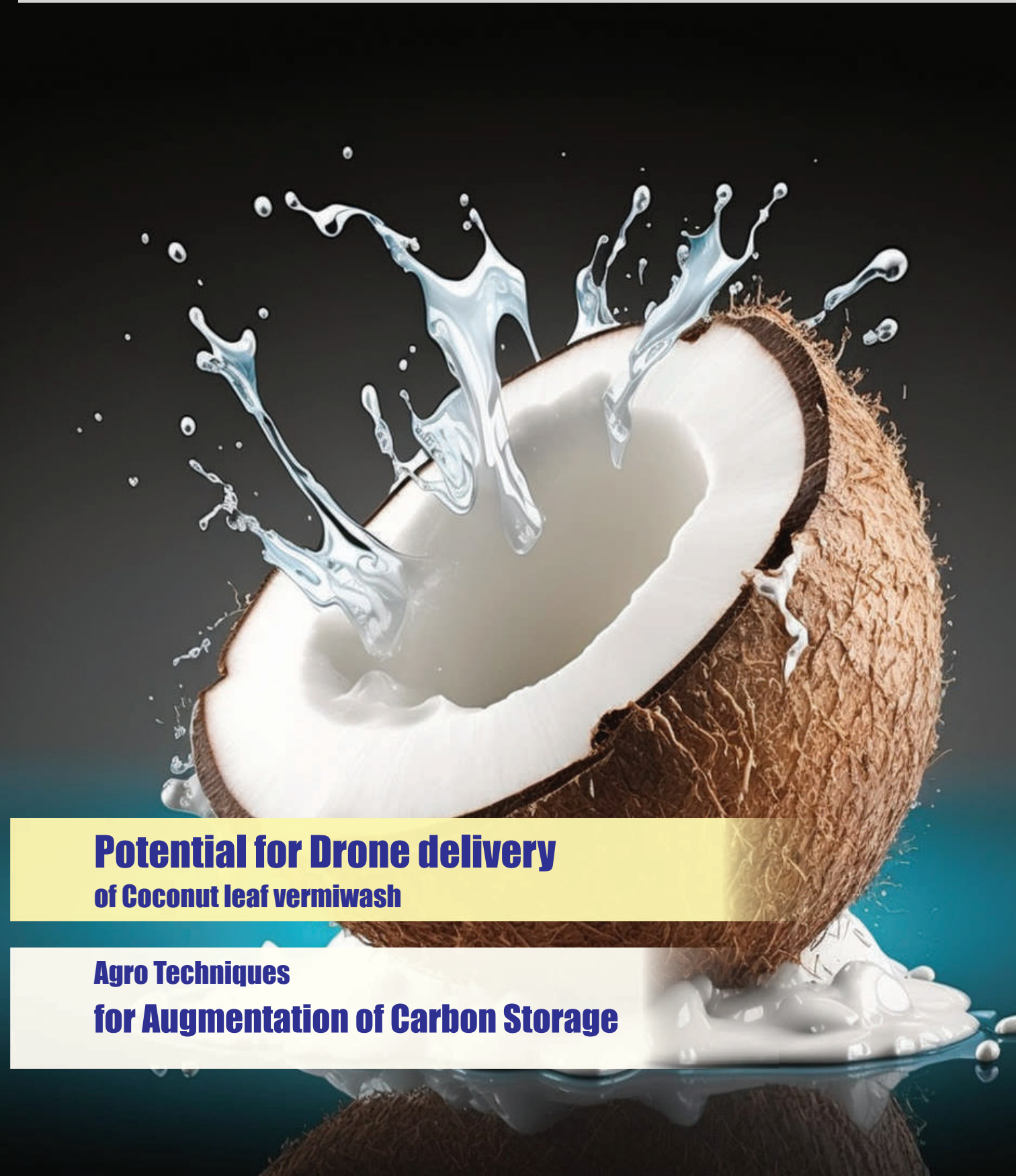
# Indian Coconut Journal



## Potential for Drone delivery
### of Coconut leaf vermiwash

## Agro Techniques
### for Augmentation of Carbon Storage

# Agro techniques for augmentation of carbon storage through crop residue recycling in coconut-based cropping system

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Healthy soil is the key towards sustainable agriculture. Healthy soil encompasses the ability of soil to sustain the plant growth, ensuring the soil fertility and its productivity, sustain the growth of soil microbes, resilient to climate change and associated vagaries and ultimately the balanced food production for feeding the millions. Soil organic carbon plays a key role on maintenance of the healthy state of the soil. On volume basis, the percentage composition of an ideal cultivable soil is 50 per cent pore space and 50 per cent solids. Of the 50 per cent solids, 45 per cent constitutes mineral matter and 5 per cent forms the organic matter, which in turn makes the soil healthy. The physical, chemical and biological properties of the soil are solely dependent on the soil organic matter. Soil organic carbon is a measure of the carbon contained within the soil organic matter.

*Basin managment*

The physical properties like soil aggregation, nutrient holding capacity and soil structure are improved by the organic matter content of the soil. Through the process of microbial mediated mineralization, soil organic matter becomes the source of nutrients and increase the microbial activity. In short organic matter enables better plant establishment. Apart from the focus on enriching soil organic carbon content, its maintenance or conservation is also equally important from the point of view of the emission as carbon dioxide, a major contributor towards the greenhouse gas effect. Carbon neutral farming is gaining momentum all across the world. Carbon neutrality is a state of net zero carbon dioxide emissions, which shall be achieved by balancing emission with its removal by assimilation/ sequestration or by eliminating emissions through the processes associated with transport, energy production, agriculture and industry. In agriculture systems, the state of neutrality can be achieved when the emitted carbon dioxide is absorbed in the soil itself.

The recently concluded COP27 summit held at Egypt, has underlined India's position of reaching

net zero by 2070. India's view of ensuring low carbon development is based on expansion of renewable energy sources as well as optimum and sustainable use of fossil fuel resources.

Agricultural related emissions of carbon dioxide account for around 24% of the global greenhouse gas emissions. The impact can be reduced by the adoption of conservation agriculture, cover cropping, incorporation of crop residues, agroforestry and increasing the cropping intensity. The practice of stubble burning should be avoided totally. This article elaborates the various agro techniques for augmentation of soil carbon storage in coconut-based cropping system.

Coconut, the tree crop having an average life span of 80 years, is the Kalpa Vriksha, with all the palm parts beneficial to mankind. On the basis of residue recycling potential, the entire tree can be categorised into removable, recyclable and reserve biomass. The removable biomass constitutes the harvestable nuts, whereas the recyclable biomass includes the leaves, husk, fibre, rachis and coconut shell, which can be recycled back through *in situ* palm residue recycling. It also has the capacity to be composted and be incorporated into the soil. The reserve biomass is the stem which will be incorporated only when the tree is felled. Studies conducted at ICAR-CPCRI have shown that 78 per cent of the total biomass is the reserve biomass, 20 per cent constitute the recyclable biomass and 2 per cent forms the removable biomass. Hence there is ample scope for turning in the palm residues into the soil. This practice can incorporate the organic carbon contained in the above ground biomass and thereby enriching the soil organic matter status. On an average, 1 ha coconut plantation produces approximately 14-20 tonnes of biomass which if incorporated in the soil may enrich the organic carbon status of soil. Through the destructive sampling and analysis studies done at ICAR-NIASM, it has been found that the mean carbon content in coconut biomass was 39.84%, with a carbon stock of 7.92Mg C/ha. The carbon sequestration rate was found to be 8.07 Mg C/ha . The net carbon dioxide mitigation potential in coconut orchard was 68.59 Mg $CO_2$ eq/ha (Chavan, 2022).

In the studies conducted with the assistance of Kerala State Planning Board, (2019), it was observed that the organic matter enrichment of the soil was facilitated by the addition of all the palm residues in sandy and laterite soils of Kerala. The palm residues such as leaves, husk and coir pith have the scope of being composted and becoming enriched in mineral composition and properties.

## Coconut leaf vermicomposting

It has been estimated that approximately 6-7 tonnes of fallen leaves are generated from a hectare of coconut garden. These leaves, owing to the content of lignin and polyphenols, will not be properly decomposed naturally, but the decomposition can be accelerated using the earthworm *Eudrilus sp.*

In cement tanks of 1 meter depth, coconut leaves which are withered for 2-3 months are cut and placed, over which a layer of cow dung slurry is applied. For 1 tonne waste, 100 kg cow dung slurry is required. This pre decomposition is continued for 2-3 weeks. After which 1000 worms per tonne of the substrate are introduced. The substrate will be converted to compost within a period of 60-75 days. Vermicompost contains 1.8 to 2.1 % N, 0.21 to 0.3 % P and 0.16 to 0.4 % K and organic carbon content of 18-20% (Gopal et al.2017).

## Coconut husk burial

Coconut husk burial is an effective technology for the retention of soil moisture, improving the water holding capacity of the soil, enhancing the available potassium status of the soil, improving the nutrient holding

capacity and reducing the leaching loss of nutrients for the soil particularly that of the sandy soil. The raw coconut husk is composed of 30% fiber and 70% pith with high lignin and phenolic content. Apart from the conservation of soil moisture and the enhancement of moisture holding capacity, husk is a potential nutrient reserve particularly that of potassium. It has been reported that on an average 100,000 husks contain potash equivalent to 1 tonne of muriate of potash, which is also made available to the palm (Subramanian et al.2009).

## Coir pith composting

Raw coir pith is the by product of coir industry, which in turn is the mesocarp fibre from coconut husk. Application of raw coir pith is not advisable owing to high amounts of lingo cellulose which hampers the growth of microbes as well as deleterious effects on root proliferation and development. Hence the composted coir pith is necessary for supplying the requisite quantity of nutrients and maintaining the soil health. It is the preferred soil conditioner and organic manure under the organic horticultural systems. Composted coir pith resembles the peat and has excellent moisture retention capacity. Thomas et al (2013) The bio conversion of raw coir pith to compost is facilitated by the addition of poultry manure in 45 days. During this process the bioconversion of raw coir pith to compost resulted in the reduction of C:N ratio from 100:1 to 21.42:1.

## Potential of native weed species in coconut garden

Weed management often presents a cumbersome task to the coconut farmers especially in the rainy season. But these weeds have the excellent potential to serve as mulch in the coconut basin. They can also be composted to provide nutrient rich compost which can be incorporated in the soil to provide the organic matter. The monocotyledonous weed species such as *Setaria sp., Cyprus rotundus, Cenchrus ciliaris, Commelina benghalensis, Brachiaria mutica* and that of dicotyledonous weeds such as *ipomeapestigridis, Agropyran repens* were collected and dried in the shade. These withered vegetation were fed into cement tanks of 1 m depth and 1m diameter, @20 kg per pit and 5kg dung 25 earthworms. Moisture was ensured by sprinkling water periodically. The well decomposed and pulverized compost was ready after three months. These compost samples were analysed for the available nutrients and were found to be rich nutrient sources such as N (0.5%), P(0.121%), K(0.71%), Ca (0.780%), Mg(0.19%), Cu(59.87 mg/kg)and Zn (22.5 mg/kg), Mn (77.38 mg/kg). The value addition from the common upland weeds in coconut gardens offers a novel approach for crop residue recycling in coconut based cropping system.

**Growing green manure crops in the coconut basin is an effective strategy to improve the soil organic matter content. It could also prevent soil erosion; improve the soil structure and the water holding capacity of the soil**

## Basin management with leguminous crops for enriching soil organic matter

Growing green manure crops in the coconut basin is an effective strategy to improve the soil organic matter content. It could also prevent soil erosion; improve the soil structure and the water holding capacity of the soil. It also enriches the soil fertility. Leguminous crops fixes atmospheric nitrogen in the root nodules. Crops

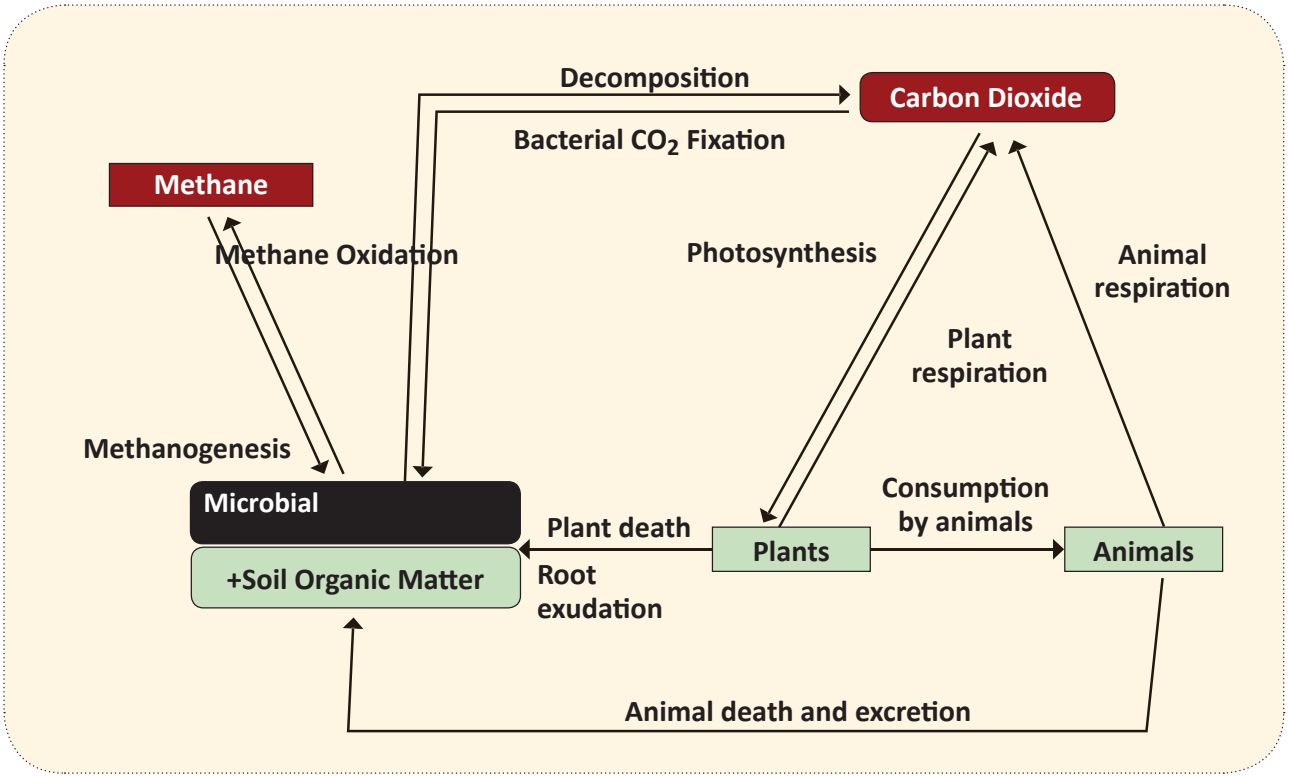


**Figure 1. Microbial mediated terrestrial carbon cycle (Gouglias et al. 2014)**

such as cowpea and sunhemp can be sown in the basin during the monsoon period from June to August and the biomass can be later incorporated in the coconut basins. 100g cowpea seeds can be sown in the basin during the time of application of first split (1/3rd of the total dose) fertiliser application. At the time of the 50 per cent flowering of the crop, it can be uprooted and incorporated in the basins. It has been estimated that the incorporation can contribute to approximately 25kg biomass per basin. The average nutrient content in cowpea biomass is 2.87%N, 0.22% P and 2.14%K. Incorporation of cowpea can contribute 145g N, 11g phosphorus and 108g potassium per basin. Hence it can substitute 29% nitrogen requirement, and 9 per cent requirement of phosphorus and potassium. The nutrient content of sun hemp biomass is 2.94%N, 0.18% phosphorus and 1.43% potassium and the availability of NPK per palm basin through the incorporation of sun hemp is 142g nitrogen, 9g phosphorus and 37g potassium, through which 29% substitution of nitrogen, 8% that of phosphorus requirement and 3% of potassium requirement can be substituted. Hence it can be seen that addition of green manure corps can contribute nutrients to soil and compensate for nutrient imbalances and additional requirements.

Glyricedia is a leguminous tree crop which can be grown in the interspaces of coconut garden particularly in the coastal sandy soils. Planting of three rows of glyricidia in between two rows of coconut with three pruning per year resulted in higher biomass yield of 7970 kg/ha. Application of glyricidia pruning from the interspace of one hectare of coconut garden supplied to the coconut palms 88% nitrogen requirement, 27% phosphorus and 13% potassium requirement of coconut palms. It can also enrich the micronutrients such as copper, zinc and boron. However, it may be ensured that wherever successful intercropping is possible, crops may be given preference considering the net returns.

## Microbe mediated carbon sequestration

Soil microbial community has a predominant role in carbon cycling and the composition of this community maintains the soil ecosystem services, regulates the turnover and delivery of nutrients and the rate of decomposition of organic matter. Decomposition of organic matter and soil respiration are crucial for

sequestering carbon in the soil and the emission of carbon dioxide. The terrestrial carbon cycle is maintained by the balance between photosynthesis and respiration. Thomas et al. (2010) found that in the high density multi species cropping systems, the microbial biomass carbon (MBC) was significantly higher in the root zone of coconut as compared to that of other component crops. Studies indicated that medium fertiliser levels supported higher microbial biomass and the ratio of microbial biomass to total carbon was also higher.

## Incorporation of intercrop residues

It has been estimated that intercrops such as elephant foot yam, ginger, turmeric, ragi and sesame has excellent carbon recycling potential when the residues of these crops are incorporated after their harvest. Addition of crop residues over the years resulted in improvement in organic carbon status. Mago et al. (2021) found that banana leaf biomass amended with cowdung is a good feed substrate for earthworms and 20–40% proportion of Banana crop biomass in waste mixture showed promising results of waste mineralization and earthworm growth. Hussain et al. (2008) found that the available biomass from 1 ha Arecanut based HDMSCS fertilised with 2/3$^{rd}$ fertiliser recommendation generated 6.28t/ha biomass from arecanut, 0.93t/ha from pepper, 2.08t/ha from banana, 0.58t/ha from clove and 0.71t/ha from citrus and it could generate compost to the tune of 8.4t/ha.

## Liming

Liming is an absolute pre requisite for the correction of soil reaction in acid soils. It is recommended to apply 1kg lime or dolomite two weeks prior to the fertiliser application. In the field experiments conducted at the farmers' fields in AEU-3 (Onattukara sandy soil) and AEU-9 (South Central laterite soil), it has been found that application of sufficient quantity of liming materials enriched the exchangeable calcium status of the soil.

*Ginger intercroping*

This resulted in the proliferation of earth worms in the soil, accelerating the organic matter turn over. This was evidenced by the profusion of the earth worm castings in the study sites.

## Balanced application of fertilisers

Soil test-based application of nutrients including the major, secondary and micronutrients will enhance their use efficiency and prevent the leaching loss. This will result in the reduced dependence to fossil fuels by fertiliser industry and thereby reduce the emission potential. Wherever possible, straight fertiliser should be applied to prevent the possible nutrient imbalance in the soil. On the basis of soil test data, if the content of available phosphorus is greater than 20 ppm, phosphatic fertiliser application can be skipped until the levels of available phosphorus are reduced. Regular assessment of available nutrients in the soil through scientific soil testing and integrated nutrient management reduce the dependency on chemical fertilisers and enable to explore alternate strategies to supply the needed nutrients for the particular crop.

## Way forward

- Reducing emissions and increasing the soil carbon storage has become the national mission towards sustainability.
- Coconut being the perennial plantation crop and having a global distribution in 93 countries globally has the vast potential to favour a climate resilient agriculture, along with enhancement of carbon storage in the coconut-based cropping system.
- Economic viability and environmental sustainability should be equally targeted for sustainable production
- Various agro techniques should be selected, tailoring to the prevailing agro climatic situations of the locality and also enhancing the soil sustainability and overall productivity of the crop.
- Selection of intercrops for crop diversification, cropping intensity, considering agro-climatic and socio economic situations
- Balanced nutrient application, *in situ* palm residue incorporation, composting are the potential strategies to facilitate maximum carbon storage and minimising emission from the coconut-based cropping system.