# A REVIEW ON BENEFICIAL IMPACTS OF SHADE GROWN COFFEE AND SCOPE FOR TRIBAL WELFARE AND FOREST CONSERVATION IN VISAKHAPATNAM DISTRICT, ANDHRA PRADESH.

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**Abstract**

Agriculture expansion has resulted in the loss and degradation of native forests, which adversely impact the livelihoods of the marginalized and forest dependent communities. It also results in the loss of ecology, ecosystem services and economy of the region. Widespread loss of natural habitats in the tropics has led to increased interest in production landscapes such as agroforestry for biodiversity conservation. Thus this review paper attempted to explain the beneficial impacts by opting coffee agroforestry for tribal welfare and forest conservation. Shade grown coffee helps in conserving biological diversity by providing several ecosystem services such as erosion control and water recharge, thereby preventing the degradation and loss of surrounding habitat. It also provides livelihood and also increases women empowerment among tribal people. Hence, Coffee plantations should be considered as a complement to other conservation efforts for biodiversity conservation, as well as for sustainable management of resources.

***Keywords:*** Carbon sequestration, Deforestation, Biodiversity, Agricultural expansion, Conservation, Shade coffee and Sun coffee.

**Introduction:**

The geospatial studies in India indicated that forest area has been decreased from 8,69,012 $km^2$ in 1930 to 6,25,565 $km^2$ in 2013 resulting in a net loss of 2,43,447 $km^2$ (28 %) in eight decades. The major

cause for decline in area under forests was dominantly agricultural expansion. With the degradation of natural forests, several ecosystem services are at loss, and adversely impact the livelihoods of the marginalized and forest dependent communities (Ray & Ray, 2011 and Sudhakar Reddy et al., 2015), and result in the loss of ecology and economy of the region.

Widespread loss of primary habitat in the tropics has led to increased interest in production landscapes for biodiversity conservation (Anand et al., 2008). Although plantations and restored forests improve ecosystem services and enhance biodiversity conservation, but will not compensate the composition and structure of the original forest covers (Chazdon, 2008). However, most tropical countries with scarce land resources like India, have now realized the importance of Tree cover Outside the Forest (TOF) and accounting for the cover services.

Jose, 2009 suggests that agroforestry, especially near to forested areas, helps in conserving biological diversity by contributing to some ecosystem services such as erosion control and water recharge, thereby preventing the degradation and loss of surrounding habitat. It offers secure land tenure, increased farm income, restoring biodiversity, expanding corridors between remaining forest patches and maintenance of watersheds.

Visakhapatnam forest Circle, one of the circles with share comprises of three revenue districts of Visakhapatnam, Vizianagaram and Srikakulam. It has a geographical area of 23,53,700 ha of which nearly 28% (6,56,943 ha) is under forests. The Circle is divided into five Forest divisions viz. Visakhapantam, Narsipatnam and Paderu in Visakhapatnam district. Vizianagaram division covering the district of Vizianagaram and Srikakulam division covering the district of Srikakulam. Most of the forest area of the Visakhapatnam Circle falls in Eastern Ghats ranges. During 1992-93 an extent of 2,93,422 ha of the forest area in the circle was identified as Degraded (Singh, 2005).

Andhra Pradesh is non-traditional area for growing coffee. Coffee is grown in the agency areas of Chintapalli, Paderu and Maredumilli of Visakhapatnam and East Godavari Districts in Andhra Pradesh. The AP Forest Department had raised coffee plantations over an area of 1296 ha. As an under crop from 1960 to 1978. These plantations were handed over to AP Forest Development Corporation for maintenance. Further, during the period from 1979 to 1984, APFDC had also raised the plantations to an extent of 2714 ha. Thus,

at present with 4010 ha.of coffee plantations, APFDC is the single largest grower of coffee in Andhra Pradesh and also in the non-traditional areas for growing Coffee. The following are the Division-wise Plantations of Coffee (www.apfdcl.com/pages/Activities/Coffee.aspx)

| Division | Area in ha. |
|---|---|
| Paderu | 623 |
| Chintapalli (North) | 699 |
| Chintapalli (South) | 785 |
| RV Nagar (East) | 902 |
| RV Nagar (West) | 1001 |

The Hon'ble Chief Minister of Andhra Pradesh, on 17th October 2014 in connection with Hudhud Cyclone, has made an announcement that all efforts would be made by the Government of A.P for development of Coffee Plantation in Paderu Agency area including expansion of Coffee Plantation by 1.00 lakh acres more (40468 hectares). (GoAP, 2015), indicating that the coffee grown area in the Visakhapatnam district may expand by eight to ten times by the year 2025. Therefore it is necessary that the impacts of Coffee cultivation in the forested area needed an understanding and the present review is contemplated.

**Shade grown coffee:**

Coffee is one of the most traded commodities in the world (Anand et al., 2008) and ranks among the five most valuable agricultural exports from developing nations (Ricketts et al., 2004). Coffee is cultivated under both shade and direct sun light with conventional and organic management practices. Shaded coffee system has great economic and ecological significance as it grows in high biodiversity areas of the tropics (Soundari et al, 2016). Shade trees protected coffee plants against adverse environmental stresses such as high soil temperatures and low relative humidity.

**Augmentation of Ecosystem Services:**

**a) Biodiversity conservation**: Several studies have reported shaded traditional polycultures of coffee cultivation to be more conducive to biodiversity conservation than unshaded or monoculture shade plantations (Anand et al., 2008). Researchers opined that coffee plantations in Western Ghats have the potential to play a major role in wildlife conservation and harbor a rich assemblages of mammals, birds and

butterflies including rare and endangered species (United Nations COP-11 CBD edition, 2012). Studies in Western Ghats Biodiversity Hotspot in the Chikmagalur District of Karnataka, India, has found a total of 102 bird species, of which 12 were migratory and 90 were residents (Anand et al., 2008).

The studies in Mexico revealed rustic system (grown under native forest canopies) contained higher fruit-feeding butterfly diversity and an avifauna more similar to that found in forest reserves (Mas &Dietsch, 2004). In a research study it was analyzed that species richness of ground-foraging ants was not significantly different between the forest fragment and the organic farms, but it was significantly lower in the conventional farm than in the forest (Perfecto &Vandermeer, 2002).Species richness of all ants and birds and of forest ant and bird species was lower in most coffee agroecosystems than in forests, but rustic coffee had equal or greater ant and bird richness than nearby forests. (Philipott et al., 2008).

**b) Interlinking ecosystem services helps in enhancing crop productivity:** The productivity of crops depends on farming practices, abiotic conditions and ecosystem services provided by natural species communities (Classen et al., 2014). Pollination and natural pest control are two important ecosystem services contributing to crop productivity and food security. (Klein et al., 2007 and Classen et al., 2014). Ants, birds and bats increase crop productivity by reducing pest infestation rates in coffee-specific pest species (Johnson, 2000, Faminow and Rodriguez, 2001 and Mols & Visser, 2002;) and could increase pollinator activity (United Nations COP-11 CBD edition, 2012).

Crop pollination is an ecosystem service of enormous economic value. Roughly two-thirds of the world's crop species include cultivars that require animal pollination (Ricketts, 2004). Jeezer and Verweij, (2015) had found that cross-pollination increases about 50% of coffee yield compared with self-pollination. Ricketts, (2004) from his study interpreted that *Coffeaarabica* being a self-pollinating crop, can benefit from insect pollination by developing higher fruit set, heavier fruits and fewer seed aberrations. Researchers in Santa Fe, Costa Rica found that bee pollination showed about 20% increase in yield, reduce about 27% incidence of pea berries and 7% increase in farm income for the coffee plantations (United Nations COP-11 CBD edition, 2012). Ricketts, (2004), Ngo & Packer, (2011) and Classen et al., (2014), opined the important pollinators of coffee flowers were social bees (Apismellifera (Apidae: Apini)), stingless bees (Apidae: Meliponini), solitary bees, syrphids and butterflies.

Pests including herbivorous insects destroy about 35-40% of potential crop yields throughout the world (Classen et al., 2014). As the damage caused by pests and diseases pose great risks to small-scale coffee farmers, biological controls are necessary for reducing such mishaps (Jeezer and Verweij, 2015). Greenberg et al., (2000), Perfecto et al., (2004), Kalka et al., (2008) and Kellermann, et al., (2008) divulged that birds and bats has shown very effective control on arthropod abundance, pest infestation rates and herbivory. The local fauna can be used to great advantage for a mutually beneficial system to discourage pests and increase pollination.

**c) Soil enrichment along with Maintaining N,P,K & SOC:** According to studies in Karnataka, Shade trees with high species density and functional diversity will decrease the N losses and increase the capacity to retain nutrients. Tree pruning and litter collection for mulch application enabled significant increases in soil C and N in the top 20 cm, of up to 10.8 and 2.12 Mg $ha^{-1}$ respectively (United Nations COP-11 CBD edition, 2012). Organic matter in the multiple shade system correlated positively with total N. Due to its complex structure and diversity, the multiple shade system could be certified as shade or bird-friendly coffee (Romero-Alvarado et al., 2002).

Shaded coffee agro-ecosystems reportedly have higher total C stock and higher total litter biomass than full sun or open systems (Dossa et al., 2008; Evizal et al., 2012). Shade trees in coffee plantations can improve soil fertility through various ways. These include an increase in nutrient supply through N-fixation, reduced leaching by checking runoff, more efficient nutrient cycling by way of decomposition and improvement of soil physical properties thereby enhancing root growth (Wilson, 1985, Buresh and Tian, 1997 and Khanna, 1997). Shaded soil had significantly higher soil pH, N, P, K, Ca and Mg contents than unshaded coffee (Aim, 2016). Devi and Kumar, (2009) estimated organic carbon stock in soils ranges from 17.3 $kgm^{-2}$ to 5.3 and 3.7 $kgm^{-2}$in Karnataka state. Noponen et al., (2013) in Costa Rica and Nicaragua, suggested organic management caused a greater increase in SOC in 0–10 cm. Noordwijk et al., (2002) studies in Indonesia delineated that by converting all sun coffee to shade coffee systems while protecting the remaining forest, could increase average landscape level C stocks by 0.5Mg C $ha^{-1}$ $a^{-1}$ and partially compensated the forest loss.

**d) Mitigating climate change effects:** Coffee agroforestry systems can aid in increasing the Carbon sequestration of agro ecosystems through plant biomass and soil organic matter, since they have a higher input of organic material to the soil compared to single crop systems and they also increase recycling of nutrients within the system (Lorenz & Lal, 2014). Thus, shadetrees in coffee systems can mitigate the effects of climate change by enhancing a favorable micro-climate and increased carbon storage (Jeezer & Verweij, 2015). Soil in agroforestry system plays a crucial role in carbon sequestration (Lorenz & Lal, 2014).

**e) Water recharge:** In general, coffee agro forests are expected to have similar hydrologic functions and carbon sequestration services relative to native forest types they have replaced. Also, the presence of trees helps reduce the vertical hydrological flux as the deep and extensive network of tree roots can utilize more water (United Nations COP-11 CBD edition, 2012). Mulching has the capacity to reduce evaporation from the soil surface and thus very useful to conserve soil water over a long period (Lorenz & Lal, 2014).

**f) Provided Livelihood and increase women empowerment:** Globally, the coffee industry employs around 25 million farmers – mostly small holders in over 50 developing countries (Ricketts, 2004). Studies in Karnataka divulged that labour force in coffee farms constitutes indigenous tribal communities and contribute to above 60% of women workers residing in or near surrounding forest areas. As per data released by the Coffee Board of India, average daily number of workers employed on coffee estates has increased from 4,23,451 in 2003-2004 to 4,79,453in 2009-2010 (United Nations COP-11 CBD edition, 2012).

Despite the increase or decrease in coffee prices or productivity, shade trees will help farmers in generating income by providing additional products such as timber, firewood and fruits (Jeezer & Verweij, 2015). This kind of agroforestry systems help Reducing Emissions from Deforestation and forest Degradation (REDD) by reducing pressure on forest from further conversion to agriculture (Ehrenbergerova et al., 2016).

Agroforestry production systems reduce the pressure to clear additional forested lands for agriculture, as they allow for both the production of cash crops and the maintenance of tree cover (Schroeder, 1994).

**g) Primacy of Shade trees on coffee farm:** Trees in agroforestry are an essential part of natural ecosystems, and provide a range of benefits to the soil, other plant species and overall biodiversity (Murthy

et al., 2016). Muleta et al., (2011) found that shade trees help in preventing stunted growth and quick wilting of coffee plantsin South-Western Ethiopia. It also provides other benefits such as firewood, honey production, improvement of soil fertility and reduction of soil erosion. Shade trees have an added value of wood production, which can be expressed either in terms of woody biomass or carbon fixation (Ehrenbergerova et al., 2016). In an agroforestry based system the canopy of already existing forest trees can be used to maximum effect and at the same time conserving the native tree species.

**Scope for tribal welfare and forest conservation in Visakhapatnam district, Andhra Pradesh:**

A survey was conducted in the agency areas of Paderu and Chintapalli in Visakhapatnam district, Andhra Pradesh in the month of December 2017 with small tribal farmers on coffee cultivation practices while others on their role and wages in plantations under coffee board.

**Study area:**

Paderu mandal in Visakhapatnam District, Andhra Pradesh is a tribal belt at an altitude of 3650 feet MSL. It lies between latitudes of 18º18' to 17º 56' and the longitudes of 82º32' to 82º53'. Chintapalli mandal is located on the north eastern part of Visakhapatnam district in Andhra Pradesh State of India. It lies between latitude of 17º 44' 22" to 18º 04' 29" North and Longitude of $82^0$ 16'00" to 82º 38' 04" East. The main source of livelihood for the people in this area was found to be agriculture and they follow shifting cultivation practices. Warm weather with high rainfall for a period of 6 months is congenial for coffee plantations.

**Methodology:**

Information on coffee cultivation practices and the socio- economics of it were obtained through different techniques. Primary information about the farmers and farm labour were obtained through the PRA (Participatory Rural Appraisal) techniques in which the community shares information on their perceptions and practices. Through PRA, the list of farmers cultivating coffee in their lands was identified in the study villages and through them other information related to different practices in coffee cultivation were recorded.

This was followed by personal observations and inventory with special reference to the information on inter crops in coffee cultivation, periodicity of harvests, quantum of harvests, man power involved and so

on. For the purpose of survey formats were prepared with extensive literature review. These formats provide information on the type of cultivation and inter crops; products harvested; frequency and season of works and collection; quantum of collection per Hectare per season; and income generated.

**Results & Discussion**:

In Visakhapatnam agency areas, tribal farmers cultivate coffee mixed plantations under rustic systems. It helps in conserving biodiversity, alleviating soil erosion problems, as well as provide an alternate income if any problem persists in coffee plantation profits.

Annual Income from coffee mixed plantations cultivated by small tribal farmers in Visakhapatnam district was found to be around Rs.35,000 to 50,000 per hectare. On an average about 200-300 kilos of coffee beans and 8 to 12 kilos of pepper were produced from one hectare of land by the private farmers every year. The survey revealed that majority of the tribal coffee farmers face marketing problem of their produce due to frequent price fluctuations, low price reto their produce and on a major level exploitation by the traders.

From the survey it was conclude that coffee cultivation requires plenty of cheap and skilled labour for various operations including sowing, transplanting, pruning, plucking, drying, grading and packing of coffee. Tribal women were more keen in taking up this plantation activity compared to men. Wages for labours working in coffee board plantations in Visakhapatnam district was Rs. 222 per day in 2016-17.

According to India State Forest Report 2017 assessment, area under forest in Visakhapatnam is 3692 sq.km which constitutes about 33.08% of total geographical area of the district. Most of the forest area in the district is associated with coffee plantations. Coffee plantations area is maintained by coffee board in Visakhapatnam constitutes around 4043ha or 40.43sq.km.

An analysis of the geospatial images of the forests of the Visakhapatnam district reveal that the cover density was significantly high in the coffee grown areas, compared to the non-coffee areas. Even in the coffee grown areas, tree cover was less than moderately dense category (10-40%) in the non-coffee lands. As some of the locals mention that in these areas tree cover has become commensal to the coffee cultivation.

As per Centre's for people forestry survey in 2014 & 2015 (http://cpf.in/whatsnew/IFR-%20Policy%20Brief.pdf), Individual Forest Rights (IFR) titles under Forest Rights Act (FRA) 2006 were issued to 81,800 across the state of Andhra Pradesh for an extent of 170,731 acres. Of the 13 districts, Vishakhapatnam and Srikakulam districts recorded maximum recognition of Individual titles. In Visakhapatnam IFR titles were issued to 28808 for an extent of 54061 acres. In this IFR titles conferred lands, tribal could be encouraged to grow coffee for the sake of wean out shifting cultivation as well to maintain forest cover along with conserving biodiversity. Perhaps, 30% of this IFR title conferred lands could be promoted more for coffee cultivation.

**Conclusion:**

Shade coffee agroforestry under traditional cultivation exhibits a great significance in conserving biodiversity and enhancing ecosystem services. It plays vital role in gender empowerment by providing livelihood and in alleviating poverty. This would surely aid in nutrient recycling, enhanced species density and decreased nitrogen loss. Shade coffee plantations have the ability to trap carbon dioxide more than monoculture plantations. Hence it can be considered as a viable mitigation option for carbon emissions. As more forest areas in tropical regions are subjected to deforestation, it is necessary to consider shade coffee plantations as one means for conservation strategies. Plantations in the stretch of forests have rich biodiversity compared to those away.

According to Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006, the forest dwelling tribes have the right to cultivate in forest area. Therefore, tribal people should be encouraged in coffee cultivation by providing incentives to grow coffee under native shade trees for providing sustainable livelihood, wean out Podu cultivation as well as to conserve biodiversity and enhance the ecosystem services. Clean Development Mechanism programs would encourage farmers with incentives for traditional coffee cultivation that favor higher carbon-stocks and biodiversity conservation. Thus it would have social, economic and environmental benefits.

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