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Development of *Neolmarckia Cadamba* (Roxb.) Bosser Based Agroforestry Models in Tarai Region of Uttarakhand, India

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ABSTRACT

Neolmarckia cadamba (kadamb) is a fast growing tree species, commonly grown as avenue plantation but being a fast growing deciduous tree, the species was introduced in Tarai Region of Uttarakhand on farmland under agroforestry. To find out the suitability with agricultural crops, an experiment was conducted from 2018 to 2022 at village Daluwala majabata and Daluwala kalan, District Haridwar, Uttarakhand, India where seedling of *N. cadamba* was planted as block plantation at the spacing of 6mx6m (T-1) and 6mx8m (T2) respectively at these places. On the basis of recorded data and projected value of two models were found economically viable.

On the basis of recorded data, calculated value of model-1 having the crop sequence as wheat (3crops) - finger millet (1crop) - sesame (1crop) showed the yield of these under storey crops 124.23q/ha, 290q/ha and 2.03q/ha respectively in plantation of *Neolmarckia cadamba* having spacing of 6mx6m at 3 year rotation. The cultivation cost of crops and management trees and sale calculated as Rs. 1.68 Lakh/ha and sale value of produce was calculated as Rs. 3.42 Lakh/ha with a net profit Rs.1.74 Lakh/ha showing the B:C ratio as 2.03. At 8 years rotation, the yield of wheat, finger millet and sesame was estimated as 186.34q/ha, 435.00q/ha and 3.15q/ha while the expected timber from the *N. cadamaba* at the same rotation was 2010.23q/ha from 280 trees with spacing of 6mx6m. The expected economic value of the model at 8 years rotation showed total cultivation and management cost Rs. 5.51 Lakh/ha and sale value of Rs. 18.48 Lakh/ha with a profit of Rs. 12.97 Lakh/ha with B:C Ratio as 3.35.

Similarly, model-2 having the sequence of under storey crops such as Maize (1crop) - sugarcane (2 harvestings)-wheat (1 crop) grown with *N. cadamba* plantation having its spacing of 6mx6m, shown the yield of 2.00q/h, 694.03q/ha and 31.17q/ha yield of *N. cadamba* as 98.53q/ha. The total cost on crop and tree species was Rs. 1.47 Lakh/ha and sale value of produce obtained from crops and wood from *N. cadamba* was Rs. 3.55 Lakh/ha. The net profit at 3 year rotation was 2.08 Lakh/ha with B: C Ratio as 2.41. At 8 year rotation of this model, the cumulative yield of maize, sugarcane and wheat grown on same pattern was estimated as 3.00q/ha, 1064.00q/ha and 46.75q/ha.

The wood production of *N. cadamba* was estimated 2010.23q/ha from 280 trees at 8 years. The total cost on management of crops and trees was estimated as Rs. 5.24 Lakh/ha and the sale value of the produce obtained from crops and trees was Rs. 18.73 Lakh/ha. The net benefit at this rotation of 8 years was Rs. 13.49 Lakh/ha with B:C Ratio of 3.57.

Based on the experimentation and expected value, models developed, *Neolamarckia cadamba* is recommended as a suitable species for agroforestry practices in the Tarai region of Uttarakhand. This fast-growing species exhibits a synchronic effect on understory crops, including wheat, sesame, finger millet, sugarcane, and maize, making it an ideal choice for the region with 6m x 6m spacing is suggested, accompanied by proper canopy management techniques such as pruning and lopping.

Key words: Agroforestry, *Neolmarckia cadamba*, models

Introduction

Agroforestry is a land management practice by integration of plants, agriculture crops and domestic animals. It plays multifaceted role in management of farmland including efficient nutrient cycling, nitrogen fixation, organic matter addition, and improving drainage. It underscores the need for diversification by promoting the integrated and holistic development of rainfed areas on a watershed basis through community involvement to augment biomass production through agroforestry and farm forestry. Besides, the agroforestry contributes a lot in food, fodder and timber productivity at domestic as well as commercial level and also generates employment at local level with livelihood improvement of rural people.

In India, agroforestry is being practiced in almost all agro-climatic zones with combination of different tree species with agriculture crops. The traditional agroforestry is modernized in India since last decades with introduction of exotic species like *Populus deltoides* and *Eucalyptus* spp. In present era, these exotic species are prominent under commercial agroforestry as the wood based industries supported the produce based on these species and market flourished rapidly with the introduction of the species. Later on, some indigenous species according to their agro-climatic suitability are also introduced under agroforesty practices.

The State Uttarakhand is situated in the Himalayan ranges an area of 53,485 km^2 between 30° 15' N latitude and 79° 15' E longitude with features an undulating topography. The state comprises 13 districts, with nine considered mountainous and the remaining 4 southern districts classified as plains including Tarai regions of the State. The core mountainous regions are repositories of biodiversity but are generally fragile and marginal in nature. Uttarakhand experiences a wide range of climatic conditions, varying from the sub-tropical humid climate of the Tarai region to the tundra-like climate of the Great Himalayan ranges. The variation in climate is more pronounced on mountain slopes and is a fundamental factor contributing to the high diversity of forests in these areas. Uttarakhand predominantly has an agricultural economy in its hilly regions, and most inhabitants in the hills primarily depend on forests for their daily needs, such as fruits, water, fuelwood, and timber.

Being highly varied topography and climatic conditions, there is a great diversification in agroforestry practices with different agriculture crops and tree species. In mountainous and hilly track, multi-purpose tree species with agriculture crops are naturally regenerated or grown by farmers usually for domestic use. The modernized commercial agroforestry is adopted in foothills and Tarai regions of Uttarakhand.

It is proven that fast growing exotic tree species under agroforestry are economically beneficial for farmers but some problems are now visualized and creating an alarm in future due to their susceptibility to pests and diseases and possibilities of drastic change in micro climatic conditions. Therefore, farmers are looking forward for new and indigenous species which are fast growing in nature and pest and pathogen resistant. In this category, *Neolmarckia cadamba* is a fast growing species which may show synchrony with agriculture crops under agroforestry specially, in Tarai regions of the Uttarakhand.

N. cadamba (Roxb.) Bosser locally known as kadamb in India is a large tropical tree with straight cylindrical bole belongs to family Rubiaceae. *N. cadamba* tree is fast growing in nature and can be grown in different parts of India. Considering the high demand of wood in India; *N. cadamba* may be recognized as one of the promising and potential trees, being grown under Agroforestry practices in the country. The wood of *N. cadamba* is a multipurpose in nature having white to creamy white color and straight grains with fine to medium texture wood commonly used in variety of services such as ply-wood, pencil making, match splints, pulp wood for paper, packing cases, toys, wooden slippers, flooring, carving and crates etc.

In Tarai region of Uttarakhand farmers are growing mostly poplar (*P. deltoides*) and Eucalyptus on their farmland. It is evident that poplar is a plywood producing species and cannot be used directly in making of wood based products (FAO, 2016). Further it is not insect pest and disease free. Therefore, farmers of Tarai area are desirable to diversify agroforestry practices with introduction of new fast growing species. In this direction *N. cadamba*, being a fast growing species may be promising to farmers. Keeping in view, a study on performance of *N. cadamba* with synchronization of understorey agricultural crops was conducted.

Material and Method

Survey and selection of experimental site

A reconnaissance survey was conducted to identify a suitable site for establishing an experimental agroforestry project featuring *N. cadamba* (Kadamb) in the Tarai region of Uttarakhand. During survey people were interviewed for their daily requirements with special reference to adopt the farm growing tree species on their farmland for timber production on commercial basis under agroforestry. An awareness and motivation programme was also conducted on agroforestry in the village Daluwala majbata for motivation of farmers for agroforestry so that land can be made available by farmers for agroforestry plantation After getting motivation from subject experts, farmers of village Daluwala majbata (located at $77^0$97'52"E longitude and $30^0$9'73"N latitude) and Daluwala kalan (located at $77^0$57'7"E longitude and $30^0$2'31"N latitude), with an altitude of 295m amsl in Tarai region of Haridwar district Uttarakhand, India were agreed for experimentation.

Experimentation and data recording

After getting sites for experimentation, two plots i.e. Plot-I at Daluwala majbata and Plot-II at Daluwala kalan each of one hectare were made were ploughed, removed weeds, leveled and fenced properly for protection of plants from wildlife and other wandering animals. An experimental design for planting of *N. cadamba* was drawn. According to design, plantation of 6 months old seedlings of *N. cadamba* were planted during monsoon season i.e. July - August, 2018 with two treatments of spacing i.e. 6x6 m (T1) and 6x8 m (T2) in Randomized Block Design (RBD) with three replications. An initial height and girth of *N. cadamba* seedling was recorded at the time of planting. Growth on the basis of height and girth increment was recorded in coming three years i.e. in 2019 and 2021 after monsoon season and averaged to find out the average growth increment. Canopy measurement in South – West and North – East directions was also done by measuring tape. Management of plantation along with agricultural crops including, weeding, hoeing and pruning was done as per requirement from time to time. Agriculture crops taken in Plot-I from 2018 to 2021 were *Triticum aestivum* (wheat), *Eleusine coracana* (finger millet) and *Sesamum indicum* (sesame) while in Plot-II, these were *Zea maize* (maize), *Saccharum officinalis* (sugarcane) and *Tritrticum aestivum* (wheat). Data recording on crop yield was done by quadrate method. Quadrates of size 1mx1m were laid out in experimental plots with 5 replications and crop produce of each quadrate was weighed in kg and averaged. The recorded data was calculated in quintal by following formula:

$$\text{Yield (Qtl/ha)} = \frac{\text{Yield in kg in } 1\text{m}^2 \times 10000}{100}$$

Calculation and estimation of wood volume and yield for 8 years rotation

Green branches for recording the data on fuelwood of 5 trees of *N. cadamba* after 50% lopping of four year plantation was taken, dried in sun and weighed to get weight in kg/ tree and calculated into q/ ha by using following formula:

$$\text{Fodder (q/ ha)} = \frac{\text{Weight in Kg/ x Number of trees per ha}}{100}$$

The wood volume and weight in ton/ha for 8 year rotation is projected on the basis of following volumetric equation:

Equation of volumetric calculation:

Mean height = -0.377333333333334+3.1265 x time

Mean Girth (m) = 0.0249+0.1503 x time

$$\text{Volume (Quarter girth formula)} = \frac{(\text{Girth}^2) \text{ x ht}}{16}$$

$$\text{Yield/ tree (t)} = \frac{\text{Volume per tree x wood density}}{100}$$

(Orwa *et al.,* 2009: www.worldagroforstry.org)

Economic analysis

The economic analysis of wheat, maize, sesame and sugarcane was carried out on the basis of cultivation cost and sale value. In the economic analysis of fuelwood and timber, the value of these products was determined based on their market price.

Cost of cultivation (Rs/ha)

The cost of cultivation of agroforestry models was worked out per ha basis. The requirement of labor and expenses for different operations such as ploughing, weeding, harvesting and threshing were calculated with the inflation rates. The cost of inputs like seeds, fertilizers and manure was calculated based on the actual amount invested. The cost and return comprising the expected establishment and maintenance cost of plantation was computed from 2018 to 2021. The estimated economic value including cost of cultivation, sale value and net benefit of kadamb based economically viable models was also calculated with inflation rates for the 8 years rotation period of Kadamb.

Gross returns

The prevailing local market prices (Rs. per quintal) were used to convert the economic value yield of crops and tree into gross returns in rupees per hectare.

The gross return was calculated by applying following formula:

Gross returns from agricultural crops

Sum of produce yield **x** sale value of produce

Gross returns from fuel and fodder from tree species

Sum of fuelwood yield **x** sale value of fuelwood

Net returns (Rs/ha)

Net returns were calculated by deducting the total cost (Rs./ha) from the gross returns (Rs/ha)

Net returns = (Rs/ha) = Gross returns – Cost of cultivation

Benefit – Cost Ratio

The benefit – cost ratio was calculated by dividing net returns obtained from the model by the total cost of cultivation of the same on the basis of the following formula:

B:C Ratio = Sale value (Rs./ ha) / Total cost (Rs./ ha)

Results

Economic value of models developed on the basis of data recorded from 2019 to 2022 is given as below:

A. Models with crop sequence as wheat, finger millet and sesame with Kadamb, Model with tree spacing 6mx6m

- **Kadamb+Wheat+Finger millet+Sesame**

In an integrated way, the total sale value of wheat, finger millet and sesame including sale value of Kadamb was Rs. 3.86 Lakh and the total cost (expenditure) of crops was Rs. 1.68 Lakh/ha. The net profit from the model was Rs. 2.18 Lakh/ha with B:C ratio as 2.30.

Model with tree spacing 6mx8m

- **Kadamb+Wheat+Finger millet+Sesame**

The total sale value of crops and produce from tree in this model was Rs. 3.77 Lakh with a cost of Rs. 1.68 Lakh and net profit was found as Rs. 2.90 Lakh/ha with B:C ratio as 2.24

B. Model with crop sequence as wheat, finger millet and sesame with Kadamb

Models with tree spacing 6m x 6m

- **Kadamb+Sugarcane+Wheat**

The total sale value of crops and produce from tree in this model was Rs. 3.65 Lakh with a cost of Rs. 1.47 Lakh and net profit was found as Rs. 2.18 Lakh/ha with B:C ratio as 2.48.

Models with tree spacing 6m x 8m

- **Kadamb+Sugarcane+Wheat**

The total sale value of crops and produce from tree in this model was Rs. 3.58 Lakh with a cost of Rs. 1.47 Lakh and net profit was found as Rs. 2.11 Lakh/ha with B:C ratio as 2.43.

As per economic value of above models; models having following sequence were observed more economical:

1. Kadamb+Wheat +Millet +Sesame model showed sale value of Rs. 3.86 Lakh/ha with net profit of Rs. 2.18 Lakh/ha
2. Maize+Sugarcane+Wheat model also showed sale value of Rs. 3.65 Lakh/ha with net profit of Rs. 2.18 Lakh/ha

Keeping the economic potential of above model-1 and model-2 a details account with estimated cost and benefit is tabulated in Table-1 and 2.

On the basis of recorded data of 3 years, calculated value, the model-1 having the crop sequence as wheat (3crops) - finger millet (1crop) - sesame (1crop) showed the yield of these under storey crops 124.23q/ha, 290q/ha and 2.03q/ha respectively in plantation of Kadamb having spacing of 6mx6m at 3 year rotation. The cultivation cost of crops, management trees and sale calculated as Rs. 1.68 Lakh/ha and sale value of produce was calculated as Rs. 3.42 Lakh/ha with a net profit Rs.1.74 Lakh/ha showing the B:C ratio as 2.03.

At 8 years rotation, the yield of wheat, finger millet and sesame is estimated as 186.34q/ha, 435.00q/ha and 3.15q/ha while the expected timber from the *N. cadamaba* at the same rotation is 2010.23q/ha from 280 trees from 1ha/ with spacing of 6mx6m. The expected economic value of the model at 8 years rotation showed total cultivation and management cost Rs. 5.51 Lakh/ha and sale value of Rs. 18.48 Lakh/ha with a profit of Rs. 12.97 Lakh/ha with B:C Ratio as 3.35 .

Likewise, model-2 having the sequence of under storey crops like Maize (1crop)-sugarcane (2 harvestings)-wheat (1 crop) grown with *N. cadamba* plantation having its spacing of 6mx6m, shown the yield of 2.00q/h, 694.03q/ha and 31.17q/ha yield of *N. cadamba* as 98.53q/ha. The total cost on crop and tree species was Rs. 1.47 Lakh/ha and sale value of produce obtained from crops and wood from *N. cadamba* was Rs. 3.55 Lakh/ha. The net profit at 3 year rotation was 2.08 Lakh/ha with B: C Ratio as 2.41. At 8 year rotation of this model, the cumulative yield of maize, sugarcane and wheat grown on same pattern was estimated as 3.00q/ha, 1064.00q/ha and 46.75q/ha.

The wood production of *N. cadamba* was estimated at 8 year rotation was 2010.23q/ha from 280 trees. The total cost on management of crops and trees was estimated as RS. 5.24 Lakh/ha and the sale value of the produce obtained from crops and trees was Rs. 18.73 Lakh/ha. The net benefit at this rotation of 8 years was Rs. 13.49 Lakh/ha with B:C Ratio of 3.57.

Discussion

Agroforestry is a land use management system that combines old knowledge with the modern innovations of the country and the ideas of the small thinking's and produces higher possibilities of economic returns of the goods with a significant contribution in increasing the tree cover outside forests and climate change mitigation (Dhyani, 2014). Agroforestry aids in meeting the demands of plywood, raw material for paper and pulp, small and bigger house making timber, protein-rich green fodder for livestock, fuelwood to daily consumption of the local peoples and also for the improving the environment by reduction of the pollution (NRCAF. 2013). The traditional agroforestry practices are in practice by the local people since ancient times with various multipurpose trees deliberately used by the farmers on their farm field and maintaining their density, frequency, and largely varied as per the local and climatic factors (Bijalwan *et al.,* 2014). The development and application of agroforestry techniques developed by local adopters are accepted techniques based on our knowledge, awareness, intelligence, risk orientation, thinking's and prediction of maximum output (Erakhrumen *et al.,* 2010). A local study says that the maximum quantity of fuelwood or firewood comes from the woodlots which are situated outside of the forest like agroforestry farms, as well as traditional sporadic regeneration of the tree covers in the boundary of the field (Horst and Hovorka, 2019). As a point of view its multiple uses, the species is quite suitable for making writing, printing and brown wrapping paper (Sarvan, 2019).

A significant social benefit through agroforestry affects marginal and small landholdings of the farmers because of the limitation of the land and increase the productivity by the agroforestry system in the same piece of field. The enrollment of the women and children in the agroforestry system is more beneficial because of the more care of the cultivation with the head of the family found in the Rajasthan, Uttar Pradesh, and Gujarat in India, where agroforestry was introduced found that more benefits to women conditions (Bose, 2015). Agroforestry vast prospective in India, the adoption rates are slow because present challenges lack the benefits of agroforestry like lack of market infrastructure, shortage of superior planting material, wood transportation, processing, insufficient research, cumbersome and frustrating legislation in respect of tree (Sharma *et al.,* 2017). The natural forest cover of India is declining, and timber productivity in forests has been assigned low in India. Agroforestry offers tested techniques to sustain the forest goods production and integrity of natural forests through the adoption of fast-growing foreign species are playing a significant role on agricultural lands. Adoption of agroforestry was essential to make successfully integrate the tree species under various types of agroforestry systems to increase productivity, generate income, reducing the gap between forest products (Bangarwa and Sirohi, 2018).

The adoption of agroforestry system by farmers can increase soil fertility, reduce soil erosion, reduce carbon emission, improve microclimate, cause ecosystem changes and improve the lifestyle of farmers (Rao, 2017). The old pattern farming practices and their supervision, like agroforestry systems, provide opportunities to enhance incomes through synchronized production of food, fodder, and firewood and reduce climate change effect (Tiwari *et al.,* 2017). However, the modernization in agrofrestry practices has more and more possibilities to enhance the productivity and income generation from a limited piece of land. The socio-economic benefits through agroforestry are very important in at last determined by farmers as a possible alternative practice to conventional 'modern' agricultural practices (Saha *et al.,* 2010). Agroforestry systems are reserves of a variety of timber species which are not give earlier benefits,which means growth time is higher. After two decades, these timber species give better results in comparison to initial stages (Dagar *et al.,* 2014).

The agroforestry also helps in carbon sequestration generally depends on the locality, species characteristics, adoption of a combination of the tree crop selection, species selection, quality of the production, and which type of practices were previously used in the many years in the agroforestry system (Dhyani *et al.,* 2016). Agroforestry focused basic needs of the growers like improving bio-fuels, employment, carbon sequestration, and farm productivity. This will be possible through appropriate research interventions, adequate investment, and suitable extension strategies, along with a forward-looking agroforestry policy (Dhyani *et al.,* 2017).

In relation to research on agroforestry and development of suitable agri-silvi models based on *Melia dubia* in Punjab, India, Singh *et al.* (2019) mentioned in their study that *M. dubia* is a suitable species for agroforestry in the Punjab and can gain 14m height with an average girth of 65cm in 4 years and also shows a synchronic effect on under storey crops like maize and wheat.

Similarly, *N. cadamba* is a fast growing tree species in nature and highly suitable for agroforestry for higher economic returns. The species is planted in many places in the tropics but production data are scarce. Most of the wood is used locally. Export data on the wood are mixed with data from other not well-defined lightweight woods. In India, alone, several hundred thousand ha are estimated to be planted with Kadamb and in the future, Kadamb might compete with the African woods (Sarvan, 2019). Because of its very fast growth, its ability to grow on a variety of soils, the absence of serious diseases and pests, and its favourable silvicultural characteristics, Kadamb is expected to become increasingly important in the near future, when supplies for plywood from natural forests are expected to decrease. In a compilation study on traditional agroforestry, Singh *et al.,* (2021) mentioned that Agroforestry is a system or modern scientifically improved technique for the cultivators to improve our security of socioeconomic conditions and environment cleanliness by the fixed size of the land cultivated all components in the same field. The reviewed results of agroforestry systems presented in a study conducted by Singh *et al.,* (2021) indicate that the nation's cultivators should be awake and aware of agroforestry system possibilities and competence, and these growers should contribute in developing the cultivation of agroforestry system viable as economically returns as well as environmentally returns for world farmers. It is clearly shown that traditional and present-day's scientific agroforestry practices fundamentally have several positive assets for the gaining profit of increased biodiversity, which helps environment reformation and economic return of output for the growers across the world.

In a study conducted by Singh *et al*., (2021) in Tarai region of Uttarakhand, it was concluded that *N. cadamba* may be promising species for farmers as the species shows a synchronic effect with crops like *Triticum aestivum* (wheat), *Eleusine coracana* (finger millet) and *Sesamum indicum* (sesame), *Zea maize* (maize), *Saccharum officinalis* (sugarcane) and *Tritrticum aestivum* (wheat). The study conducted is also supported with study conducted by Singh *et al.* (2021) to record the performance of *Gmelina arborea* and *Emblica officinalis* under agroforestry on fallow land in Tarai region of Uttarakhand and central region of Uttar Pradesh under which it was found that it was found that *G. arborea* and *E. officinalis* based agri-silviculture based agroforestry systems are suitable with slightly alkaline soil under rainfed conditions.

Conclusion

Based on the experimental models developed, *N. cadamba* is recommended as a suitable species for agroforestry practices in the Tarai regions of Uttarakhand. This fast-growing species exhibits a synchronic effect on understory crops, including wheat, sesame, finger millet, sugarcane, and maize, making it an ideal choice for the region. To optimize its benefits, a spacing of 6m x 6m is suggested accompanied by proper canopy management techniques such as pruning and lopping. This will ensure adequate sunlight penetration to the understory crops, promoting healthy growth and productivity for sustainable agriculture, enhancing ecological and economic benefits to local communities. By adopting this species and management strategy, farmers can diversify their income streams, improve soil health, and contribute to biodiversity conservation.

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Table-1. Projected Economic value of model - Kadamb+Wheat +Millet +Sesame (in Rs. Lakh/ ha) at 8 year rotation (2019 to 2026)

Total 280/ha trees with 6mx6m spacing											
As per calculation of actual data recorded in 3 years (2019 to 2022) in Rs. Lakh/ha											
Yield(q/ha) and Sale value of Crops (Rs. in Lakh)						Yield (q/ha) and Sale value of Kadamb fuel wood and *timber at 3 years age (Rs. in Lakh)		#Total cost of crops and trees	Total Sale value	Net profit	B:C Ratio
Wheat (3 crops)		Finger Millet green fodder (1crop)		Sesame (1 crop)							
Yield	Sale value	Yield	Sale value	Yield	Sale value	Yield	Sale value				
124.23	2.48	290.00	0.29	2.03	0.16	98.53	0.49	1.68	3.42	1.74	2.03
*Fuel wood 15.12q/ha as per recorded data and timber 83.41q/ha is calculated on volumetric equation of trees at 3 year age with sale value Rs. 500/q											
Cumulative estimation for 8 years with deviation/ year (except timber and fuel wood)											
Wheat (3 more crops)		Finger Millet green fodder (1crop)		Sesame (1 more crop)		Kadamb (Total wood at 8 years age)					
Yield	Sale value	Yield	Sale value	Yield	Sale value	Yield	Sale value				
186.34	**3.73**	**435.00**	**0.43**	**3.15**	**0.25**	**2010.23**	**14.07**	**5.51**	**18.48**	**12.97**	**3.35**

Deviation parameters used for calculation of tabulated above:

- 25.56% increase in expenditure of Rs. 1.68 Lakh on crops (sum of inflation rates from 2023 to 2026) + Rs. 60000.00/ha @ Rs. 10000/ha/ year canopy management (2023 to 2026)+ Rs. 280000.00/ha on harvesting on trees @ Rs. 1000.00/tree in 8th year (2026)
- 10% increase in sale value of the crop
- 10% reduction in crop yield and
- Yield of wood in 8th year=201.2231 tons (2010.22quital)/ha and sale price @ Rs. 7000/ tones or Rs.700/q

Average Rates of crops: - Wheat @Rs. 2000/q, Finger millet @Rs. 100/q and Sesame @ Rs. 8000/q

#Cost in 2020-21 2026 is calculated with inflation as per Statista (2022). India: Inflation Rate from 1987 to 2028, http://statista.com>statistics

Table-2. Projected Economic value of model - Kadamb+Maize+Sugarcane+Wheat (in Rs. Lakh/ ha) at 8 year rotation (2019 to 2026)

Total 280/ha trees with 6mx6m spacing											
As per calculation of actual data recorded in 3 years (2019 to 2022) in Rs. Lakh/ha											
Yield(q/ha) and Sale value of Crops (Rs. in Lakh) Crops						Yield (q/ha) and Sale value of Kadamb wood and *timber at 3 years age (Rs. in Lakh) Tree		#Total cost of crops and trees	Total Sale value	Net profit	B:C Ratio
Maize (1crop)		Sugarcane (2 harvestings)		Wheat (1crop)							
Yield	Sale value	Yield	Sale value	Yield	Sale value	Yield	Sale value				
2.00	0.17	694.03	2.27	31.17	0.62	98.53	0.49	1.47	3.55	2.08	2.41
*Fuel wood 15.12q/ha as per recorded data and timber 83.41q/ha is calculated on volumetric equation of trees at 3 year age with sale value Rs. 500/q											
Cumulative estimation As per for 8 years with following deviation/ year											
Maize (1more crop)		Sugarcane (2 more harvestings)		Wheat (1more crop)		Kadamb (Total wood at 8 years age)					
Yield	Sale value	Yield	Sale value	Yield	Sale value	Yield	Sale value				
3.00	**0.25**	**1064.00**	**3.48**	**46.75**	**0.93**	**2010.23**	**14.07**	**5.24**	**18.73**	**13.49**	**3.57**

Deviation parameters used for calculation of tabulated above:

- 25.56% increase in expenditure of Rs. 1.47 Lakh on crops (sum of inflation rates from 2023 to 2026) + Rs. 60000.00/ha @ Rs. 10000/ha/ year canopy management (2023 to 2026)+ Rs. 280000.00/ha on harvesting on trees @ Rs. 1000.00/tree in 8th year (2026)
- 10% increase in sale value of the crop
- 10% reduction in crop yield and
- Yield of wood in 8th year=201.2231 tons (2010.22quital)/ha and sale price @ Rs. 7000/ tones or Rs.700/q

Average Rate of crops : - Wheat @Rs. 2000/ q, Maize @ Rs. 8500/ qand Sugarcane @ Rs. 327.00/q

#Cost in 2020-21 2026 is calculated with inflation as per Statistica (2022). India: Inflation Rate from 1987 to 2028, http://statista.com>statistics