



Comparative Study of Mango Based Agroforestry and Mono-Cropping System under Rainfed Condition of West Bengal

Babloo Sharma^{1*}, Sandeep Kumar Tripathi¹, P. K. Dhara¹, Pratibha Kumari², Santosh K. Meena³, Reena Kumari⁴ and Adyant Kumar⁵

¹Department of Soil and Water Conservation, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741 252, West Bengal, India.

²International Rice Research Institute, Philippines-Cereal Systems Initiative for South Asia (CSISA, India Office, Patna, Bihar), India.

³Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India.

⁴Department of Agricultural Engineering, N. M. College of Agriculture, Navsari Agricultural University, Navsari-396450, Gujarat, India.

⁵Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741 252, West Bengal, India.

Authors' contributions

This work was carried out as doctorate research work of first author. Author PKD was guide and helped in critical stages of the research period as data analysis and thesis writing. Rest all co-authors helped in research work as manage literature, improving language and statistical analysis.

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ABSTRACT

In India, the uncertainty of rainfed agriculture is high due to low and erratic rainfall, steep land slope and short cropping period. Objective of the study was to assess the effect of mango based agroforestry on productivity of cereal, oilseed crop and trees in highly degraded areas of West Bengal. This experiment was carried out on ongoing experiment plot of agroforestry systems at

*Corresponding author: E-mail: b.sharmabhu08214@gmail.com;

Regional Research Station of (B.C.K.V., started from 2007) Jhargram, West Bengal during two consecutive years i.e. 2014-15 to 2015-16. The experiment comprised two trees viz. gamhar (silvi tree) and mango (fruit tree) one cereal crop viz. maize and one oilseed crop viz. groundnut. The yield different entity was recorded and converted on per hectare basis. The highest yield i.e. groundnut equivalent yield was recorded 14.29 and 15.97 t ha⁻¹ in Mango+ Gamhar+ Groundnut treatment during 2014-15 and 2015-16, respectively, followed by Mango+ Gamhar+ Maize treatment. The lowest groundnut equivalent yield was recorded under maize mono-cropping treatment during two consecutive years. The highest gross return was recorded INR. 357334 and 478996 under Mango+ Gamhar+ Groundnut based system during 2014-15 and 2015-16, respectively. In this way mango based agroforestry system is more suitable and sustainable approach under rainfed condition as compared with mono-cropping systems.

Keywords: *Mangifera indica*; *Gmelina arborea*; Groundnut equivalent yield; B:C ratio; mono crop.

1. INTRODUCTION

According to the study by the World Agroforestry Centre, ICRAF, 43% of the planet's agricultural lands (more than a billion hectares) has more than 10% tree cover [1]. The potential of trees to bring improvements in nutrition, income, housing, health, energy needs, and environmental sustainability in the agricultural landscape, with the presence of trees being the principal component of an "ever-green agriculture". Indian agriculture is facing diverse challenges and constraints due to growing demographic pressure, increasing food, feed and fodder needs, natural resource degradation and climate change.

According to the report of the GOI, the forest cover in the country is 675,538 sq.km, constituting 20.55% of its total geographical area [2]. Out of this, dense forest constitutes 2.68% and open forest 7.87%. The forest cover in the hilly districts is only 38.34% compared with the desired 66% area. This fact is also common in the state like West Bengal Therefore, these calls for a new approach and in this way "agroforestry" could help to produce food and wood while conserving the ecosystem [3].

Water is the scarcest commodity limiting to the production potential of red and laterite zone of West Bengal. Therefore, location specific models have to be developed involving multipurpose tree species (MPTs), fruit crops and arable crops in an agri-silvi-horti system for increasing water use efficiency (WUE), productivity and sustainability of the system. Among the MPTs, Gamhar and eucalyptus offers many possibilities in supplementing a part of N-requirement of the associated crops through enrichment of the soil. Providing fuel wood, small timber to cater to basic needs of rural people of their sustenance in

dry areas [4]. Objective of the study was to identify source of higher income generating systems (i.e. mango based agroforestry system) in red and laterite zone under rainfed condition of West Bengal, where mono-cropping system is dominated.

2. MATERIALS AND METHODS

2.1 Experimental Details

The study was carried out at Regional Research Station (Bidhan Chandra Krishi Viswavidyalaya), Jhargram, District Paschim Medinipur, West Bengal, India during 2014-15 and 2015-16. The study site is located humid sub-tropical with short winter and long hot summer at 22.5°N latitude and 87.0°E longitude and at an elevation of 78.77 m above mean sea level under red and laterite zone (Fig. 1). The annual precipitation varies between 1100 to 1300 mm and temperatures vary between 16.4 - 38.8°C [7]. The experiment was laid out in a randomized block design having two trees viz. *Mangifera indica*, commonly known as mango (fruit tree) and *Gmelina arborea*, locally known as gamhar (silvi tree) and two field crops viz. maize (cereal crop) and groundnut (oilseed crop). The experiment was comprised 9 treatments (AF₁ = Mango+ Gamhar + Groundnut; AF₂ = Mango+ Gamhar + Maize; AF₃ = Mango+ Gamhar; AF₄ = Sole mango; AF₅ = Sole gamhar; AF₆ = Sole groundnut; AF₇ = Sole maize) with 3 replications. Seedlings of gamhar and grafted mango trees (variety Amrapali) were planted on 20 August, 2007. Mango trees were planted at a spacing of 10 m × 10 m and gamhar tree were planted between two fruit trees and rows as well as boundary plantation (tree to tree 5m × 5m distance). All the agronomic practices were kept uniform for all the treatments.

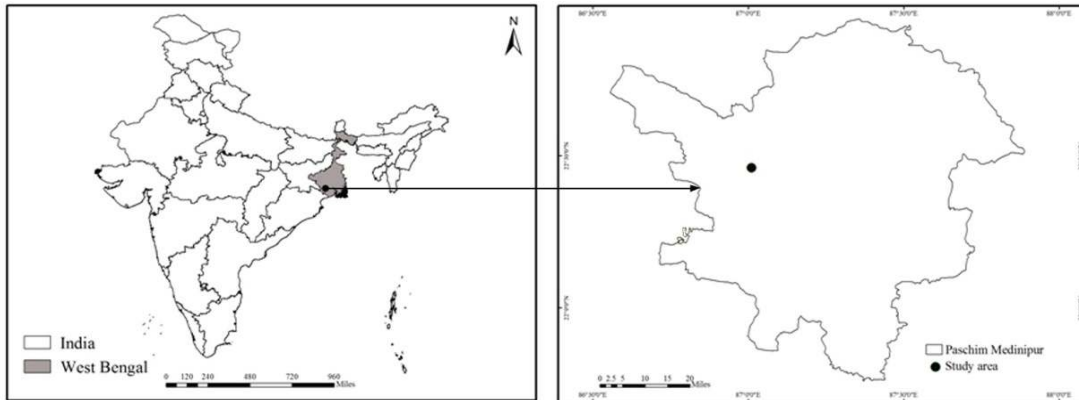


Fig. 1. Location of experimental site in West Bengal

Five trees in each treatment were randomly selected for computing growth parameter and yield. The parameter of selected trees was converted on per hectare basis. The yield of crops was obtained by three sample of one meter square of each plots. Yield data from sampling, converted into per hectare basis. Economics of different treatment was worked out by taking into account the return obtained from output of treatment (tree and crops) and investment. The investment of tree plantation was one time and converted into per year basis. The return of trees and crops were analysed on market selling price on which it was sold. The estimation of groundnut equivalent yield was calculated for different entities of experiment (gamhar, maize, groundnut and mustard) converted into equivalent yield of groundnut based on price of the produce using formula given below [7]:

$$Y_{ge} = \frac{Y_e \times P_e}{P_g}$$

whereas, Y_e = yield of different entities in experiment ($t\ ha^{-1}$), P_e = selling of different entities ($INR.\ ha^{-1}$), P_g = selling of groundnut ($INR.\ ha^{-1}$).

2.2 Statistical Analysis

The data gathered in each observation were statistically analyzed using analysis of variance technique suggested by Gomez and Gomez [5]. The critical differences were calculated to assess the significance of treatment means wherever the 'F' test was found significant at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Yield of Trees

The experimental finding of trees yield was improved under agroforestry system during both trial years. The fruit yield of mango tree was recorded highest 6.68 and $9.11\ t\ ha^{-1}$ under Mango + Gamhar + Groundnut during 2014-15 and 2015-16, respectively, followed by Mango + Gamhar + Maize and Mango + Gamhar (without intercrops) during both years. The lowest fruit yield was observed 4.70 and $6.06\ t\ ha^{-1}$ under sole mango planted experimental plot during 2014-15 and 2015-16, respectively (Fig. 2). Rathore et al. [6] reported that growing of leguminous crops inside the mango orchard had better in the fruit weight and fruit yield of mango under different mango based agri-horticultural models under rainfed condition of western Himalaya, India. Similar result was observed by Dhara and Sharma [7], and they stated that mango yield improved under mango-eucalyptus+ pigeonpea agroforestry system as compared with other agroforestry and monocropping systems.

The minimum volume yield of gamhar (1.83 and $1.87\ m^3\ ha^{-1}\ year^{-1}$ during 2014-15 and 2015-16, respectively) recorded under sole gamhar treatment (Fig. 3). Whereas, Mango + Gamhar + Groundnut recorded highest volume yield of gamhar tree during both years of trails. The Mango + Gamhar + Maize was recorded lower volume yield as compared with Mango + Gamhar + Groundnut, But higher than Mango + Gamhar and sole gamhar during both years of study. Das et al. [8] reported that the growth and timber volume yield of gamhar tree was higher under

gamhar with mango along with pigeon pea as compared to rest gamhar with mango based systems, whereas sole gamhar reported lowest growth rate and volume yield [8].

3.2 Yield of Intercrops

The yield of intercrops was decreased under agroforestry system as compared to monocropping system. The highest pod yield of groundnut was reported (2.43 and 2.40 t ha⁻¹ during 2014 and 2015, respectively) under monocropping system (Fig. 4). It was found 7.44 and 11.33% higher than Mango + Gamhar + Groundnut during 2014 and 2015, respectively.

Kernel yield of groundnut indicated similar trend as pod yield during both years. The grain yield of maize was recorded 3.74 and 3.57 t ha⁻¹ under Mango + Gamhar + Maize during 2014 and 2015, respectively (Fig. 5). It was 9.37 and 12.44% during 2014 and 2015, respectively, lower than sole maize treatment. The stover yield of maize was followed similar pattern as grain yield during both years. The average grain and straw yields of arable crops were more under sole cropping, but were statistically at par to those obtained from interspaces of various silvicultural systems during initial four years of establishment [9].

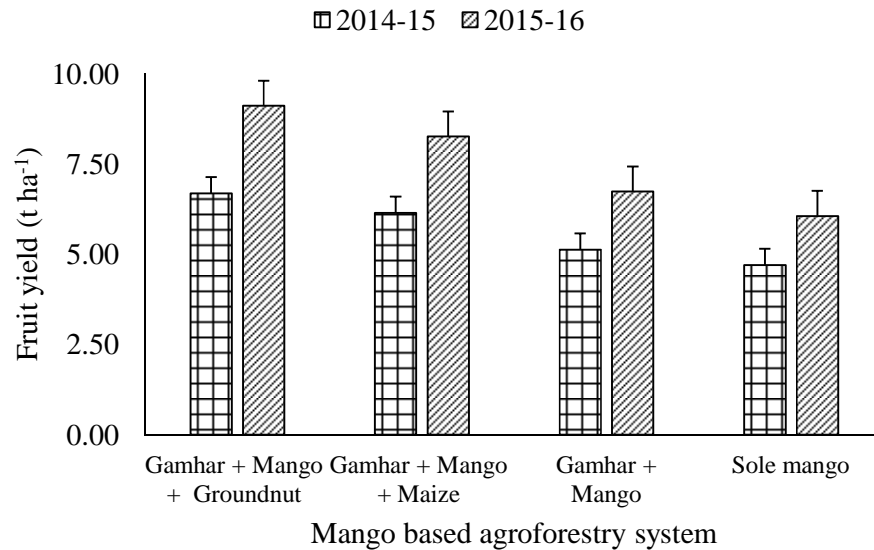


Fig. 2. Effect of agroforestry system and sole plantation on fruit yield of mango

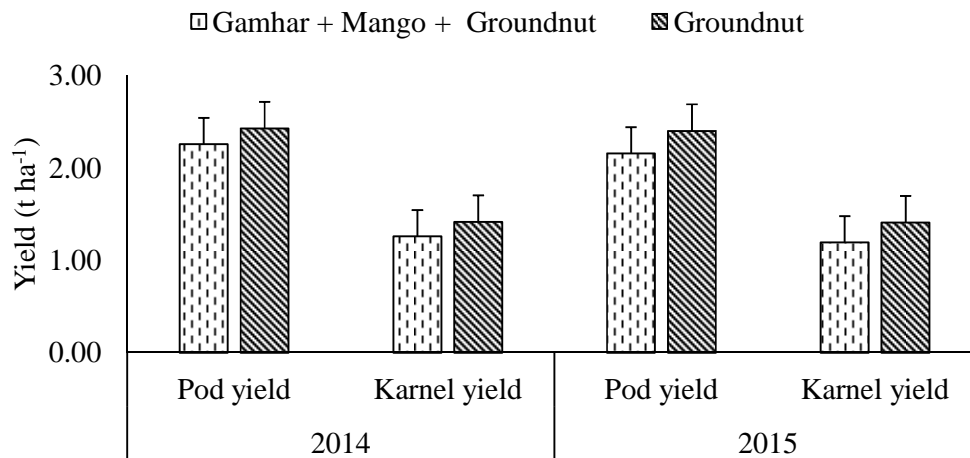


Fig. 3. Effect of agroforestry system and sole plantation on fruit yield of mango

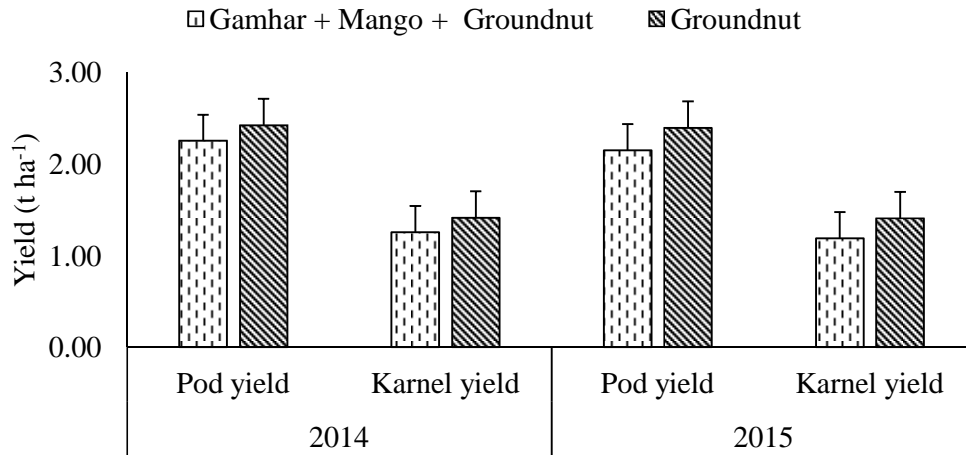


Fig. 4. Comparison of pod yield and Kernal yield of groundnut under multi cropping and mono cropping system

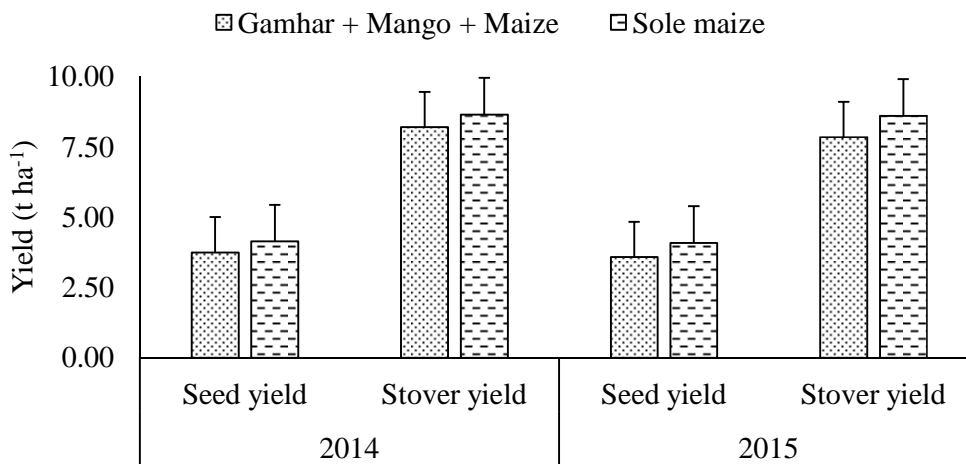


Fig. 5. Evaluation of seed yield and Stover yield of maize under multi cropping and mono cropping system

3.3 Groundnut Equivalent Yield

The data related to groundnut equivalent yield significantly influenced under agri+horti+silvi based agroforestry systems. The mango + gamhar + groundnut based systems were recorded significantly highest in terms of equivalent yield (14.29 and 15.97 t ha⁻¹ during 2014-15 and 2015-16, respectively) as compared with other agroforestry and mono-cropping field (Fig.6). The groundnut equivalent yield of horti+silvi system (AF₃) was inferior as compared with agri+horti+silvi based systems (AF₁ and AF₂), but superior over all mono cropping systems (AF₄ to AF₇) during both years. Lowest

groundnut equivalent yield was recorded under maize mono-cropping treatment (2.34 and 2.35 t ha⁻¹ during 2014-15 and 2015-16, respectively) followed by sole groundnut treatment. Rathore et al. [6] used the equivalent yield to evaluate reduction of yield of different intercrops under agri-horticultural based models as compared to sole cropping systems under rainfed situation of Western Himalaya, India during ten years of experiment.

3.4 Economical Behavior

The total cost of cultivation of particular treatment was recorded higher under mango based

agroforestry systems as compared to sole planting systems. The annual cost of cultivation in Mango+ Gamhar, sole mango and sole gamhar were decreased every year because there is one time investment in trees plantation in field after that need of small amount for their maintenance. The gross return was significantly high under mango based agroforestry system as compared with sole plantation. The highest gross return of INR. 357334 and 478996 ha⁻¹ were recorded during 2014-15 and 2015-16 respectively, under AF₁ followed by AF₂, AF₃, AF₅ and AF₄ during 2014-15 and AF₂, AF₃, AF₄

and AF₅ during 2015-16 (Table 1). The sole field crops (groundnut and maize) were showed lowest gross return during both years. The highest and lowest B: C ratios were recorded 7.19 and 1.50 under AF₃ and AF₆ during 2014-15 and 10.05 and 1.52 during 2015-16, respectively. Dhara and Sharma [7] reported that mango with *E. tereticornis* along with lady's finger followed by mustard was showed highest gross return compared to other agroforestry system and lowest under sole plantation under different mango based agroforestry system in red laterite zone of West Bengal, India.

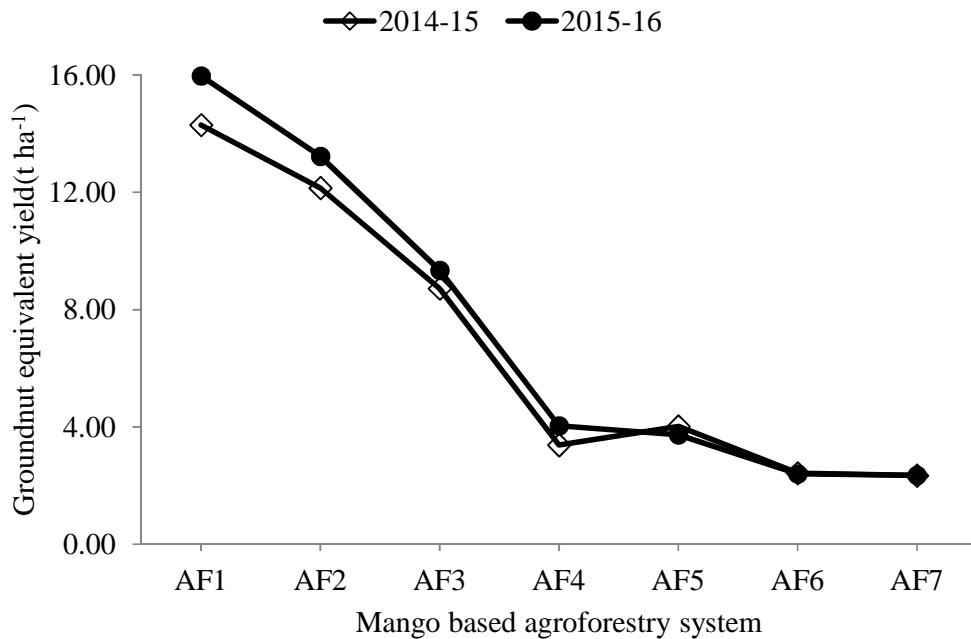


Fig. 6. Assessment of groundnut equivalent yield under different mango based agroforestry and mono-cropping system

Table 1. Economical statistics of the different mango based agroforestry and mono-cropping system

Treatment	Cost of cultivation (INR ha ⁻¹)		Gross return (INR ha ⁻¹)		B:C ratio	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
AF ₁	59084.00	58743.00	357333.68	478995.67	6.05	8.15
AF ₂	62588.00	66946.00	303723.71	396743.21	4.85	5.93
AF ₃	30310.00	27890.00	217992.39	280185.19	7.19	10.05
AF ₄	14610.00	13360.00	84540.00	121223.46	5.79	9.07
AF ₅	24250.00	22240.00	100510.73	111969.37	4.14	5.03
AF ₆	40549.00	47474.00	60625.00	71940.00	1.50	1.52
AF ₇	32447.00	38327.00	58576.00	70474.00	1.81	1.84
SEm±			4889.01	8386.95	0.13	0.20
C.D.			14422.57	24741.48	0.38	0.60

4. CONCLUSION

The production and productivity of mango and silvi trees were significantly improved with intercropping as compared with sole plantation. The production of arable crops as intercrop showed negative correlation with increasing age of silvi and fruit trees. Hence, the yield of arable crops was higher under sole cropping system as compared with fruit based agroforestry system. Whereas, growth and productivity of silvi and fruit trees showed positive co-relation along with field crops as intercrop. The gross return and B:C ratio were found higher in mango based system as compared with sole cropping system.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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