Monitoring of different Agri+horti Monitoring of different Agri+Horti System on Yield, Soil Chemical Properties and Total Return under New Alluvial Zone of Eastern India

Udita Mondal[1], Babloo Sharma[2] and P.K. Dhara[3]

[1]Department of Soil water conservation, BCKV, Mohanpur, WB
[2]Department Of Soil and Water Conservation, BCKV, Mohanpur, WB
[3]All India Coordinated Research Project on Agroforestry, Regional Research Station,
Bidhan Chandra Krishi Viswavidyalaya, Jhargram, Paschim Medinipur - 721 507, India
E-mail: [1]sharu.mondal@gmail.com, [2]b.sharmabhu08214@gmail.com, [3]drpratapdhara@gmail.com

Abstract—*Agroforestry is a land use system, which contributes pragmatically offers not only a sustained productivity, but also its sustainability over the longer period. Through this present study we introduce a new strategy through Agro-Horti cropping system in New-Alluvial zone where traditional Monocropping practices is neither providing a gainful employment opportunity, nor it generates sufficient income to meet the day-to-day expenditure of a family. To find out suitable Agro-Horti model, field experimental was conducted at Horticultural Research Station, Mandouri, B.C.K.V. Nadia.. The fruit plants were planted at a spacing of 10m × 10m And the gross plot size was around 7500 m^2. This alternative Agri+Horti system includes five intercrops, namely rice, mustard, lentil, cauliflower and wheat. As a kharif crop, we planted upland paddy followed by lentil along with a fruit crop of mango. In addition, cauliflower, mustard and wheat were sowed as rabi crops in the vicinity of the mango tree for the year 2014-15, 2015-16. Experimental results revealed an increasing rate of farmers income in addition to the improvement of the soil health compared to the previous monocropping system. In case of sole Mango cropping the income was 1,65,600. The maximum gross income was recorded when mango was intercropped with cauliflower(rabi crop) and it fetched a total return around Rs. 3,52,995followed by mango intercropped with lentil i.e. about Rs. 2,49,448. Fruit based Agri-Horti system not only increased the total return but also built up the soil health in term of the increase of the soil OC, pH and available N, P, K etc. Therefore, present study recommend an alternative Agri-horti intercropping systems for the better livelihood, income and sustaining soil-health over the New alluvial zone of West Bengal.*

Keywords*: Agri-horti cropping system, Monocropping, soil health, livelihood and total return.*

1. INTRODUCTION

Indian agriculture is facing diverse challenges and constraints due to demographic pressure, increasing food, feed and fodder needs, natural resource degradation and climate change. Therefore, diversification of land-use systems with Agroforestry is a necessary strategy for providing variety of products for meeting requirements of the people , insurance against risks caused by weather aberrations, controlling erosion hazards and ensuring sustainable production on a long-term basis, particularly in view of the effects of the climate change (**NCRAF, 2013**). According to the reports of the **GOI (2000)** emphasized the role of Agroforestry for efficient nutrient cycling, Nitrogen-fixation, addition of organic matter and for improving drainage and underlining the need for diversification by promoting integrated and holistic development of rain fed areas on watershed basis through involvement of community to augment biomass production through Agroforestry and farm forestry. Here, we would discuss about the New Alluvial Zone, because the study has been conducted under this area. Population density is more here. So, only mono-cropping cannot be the only livelihood policy. So, Introducing multiple cropping is the most desirable thing under this discussion.

Regarding the broad-objectives, the specific objectives of the study were:

i) To develop and standardize Agri+Horti system suitable in New Alluvial zone of West Bengal.

ii) To study the growth performance and yield of fruit tree and intercrops.

iii) Our aim is to produce more production per unit area per unit water use.

2. MATERIALS AND METHODS:

General features of the experimental area:

The experiment was carried out at Horticultural Research Station (Bidhan Chandra Krishi Viswavidyalaya), Mandouri, Nadia , West Bengal during two consecutive year 2014-15 & 2015-16. The study was started at the beginning of the rainy season in 2014 (June). The Regional Research Station is geographically situated in the New Alluvial zone of West Bengal at 22.43°N latitude and 88.34°E longitude and at an elevation of 9.75 m above Mean Sea Level (MSL). The site where the experiment was carried out falls under a humid Subtropical climate as it is situated just South of Tropic of Cancer. The maximum and minimum temperature varied from 68.33% to 92.38% during the period of investigation. The experimental site is situated under alluvial soil of Indo-gangetic plains with sandy clay loam texture, with good water holding capacity, well-drained, and with acidic to neutral reaction and moderate fertility status. Prior to the experiment the soil was analyzed. The experiment was done at ongoing mango research farm. The Mango was planted in 2007. The arable crops were grown as intercrops. The experiment was started in June, 2015 (*Kharif* season) followed by winter season(Rabi season). The information about the study is given below:

A. Experimental details:

a) Experimental design: Random Block Design

b) Number of replication: 3

c) Number of treatments: 6

d) Gross plot size: 150m X 50m=7500 m^2

e) Mango tree spacing: 10m X 10m

Table A1. Details of treatment combinations:

Treatment symbols	Treatment
T_1	Mango+Rice(*kharif)*
T_2	Mango+lentil
T_3	Mango+Mustard(*Rabi*)
T_4	Mango+Cauliflower(*Rabi*)
T_5	Mango+Wheat(*Rabi)*
T_6	Sole tree(Mango)

B.SELECTION OF CROPS AND ITS VARIETY:

The six crops were selected for intercrops in different Agri+ Horti system. Out of this, three crops were grown on kharif season which was grown after the harvesting for prior crop and dependent on residual soil moisture. The details of selected crop was given in table 2. these are suitable for the tropical humid condition.

Table B.1.Detail of the selected crops for experiment:

Sl. no.	Crop name	Variety	Season	Purpose
1.	Mango	Himsagar	Kharif	Fruit
2.	Rice	MW-10	Kharif	Cereal
3.	Cauliflower	Early Kunwari	Rabi	Vegetable
4.	Lentil	Gorima	Kharif	Pulse
5.	Mustard	B-9/Binoy	Rabi	Oilseed
6.	wheat	Pbw-343	Rabi	Cereal

C.ECONOMICS

In order to evaluate the economic feasibility of different treatments, the economics of various treatments were worked out in terms of net returns per hectare that the most remunerative treatment could be found out on yield basis and prevailing income from different crops was worked out on the basis of market rates of outputs at Nadia district(Table 2.2). The gross was calculated by total return of mango fruit and intercrop of each treatment from.

TableC1.The sole market price of Mango and Intercrops produce

Sl. No.	Particulars	Market price (Rs. ha-1)
1.	Mango fruit	25.00
2.	Rice grain	16.00
3.	Mustard grain	42.00
4.	Lentil grain	93.00
5.	Cauliflower	10.00
6.	Wheat grain	13.50

3. RESULT AND DISCUSSIONS:

There was an increasing trend under growth and yield of fruit trees with intercrops. It was revealed from the result that height of the fruit crops was greatly affected by intercropping with different arable crops. Height of mango was significantly higher in intercropping situation as compared to control (without crop). The plant height of mango tree under various intercrops varied from 6.35m under Mango+Cauliflower to 7.21m under Mango+Rice during December 2015, respectively. Whenever, in the case of sole tree the plant height is 6.01m. The mango fruit tree also varied from 72.36 q ha^{-1}. This yield varied because of supplementary and or complementary relation between some systems components can imply synergistic effects. The results are supported by the findings of **Dhara and Sharma (2015).**

Table 3.1: Growth and yield attributes of different intercrops under Mango plantation

Treatment	Mango		Intercrops		
	Height(m)	Yield(q ha^{-1})	Average plant ht.(cm)	Podplant^{-1} or Grain pannicle^{-1}	Yield(q $ha^{-1)}$
T_1	7.21	84.26	75.21	130.24	22.29
T_2	6.65	72.24	98.99	51.25	7.36
T_3	6.87	78.36	51.56	1.89	8.31
T_4	6.35	88.15	43.51	-	132.62
T_5	6.58	82.14	71.40	19.36	14.85
T_6	6.01	66.24	-	-	-
SEm(±)	0.07	0.88	-	-	-
CD (P=0.05)	0.21	2.61	-	-	-

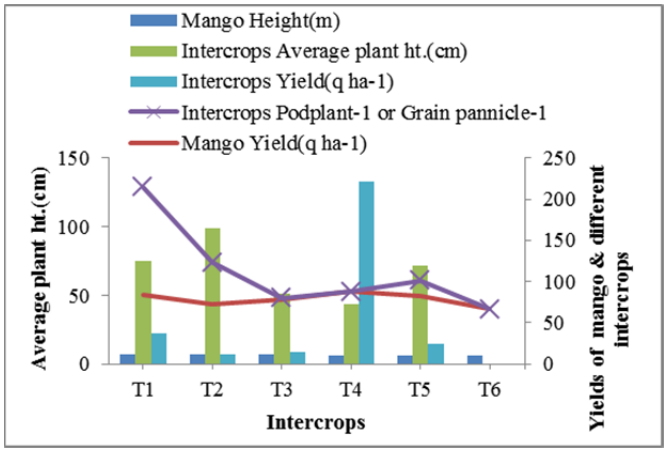

Fig. 1 Growth and yield attributes of different intercrops under Mango plantation

THE pH STATUS OF THE SOIL

The data pertaining soil pH at the end of experiment have been presented in Table 3.2 and depicted in Fig 2 . The data showed that tree-crop interaction influenced soil pH and recorded soil pH were 6.7, 6.6, 6.5, and 6.4 under the treatments T1, T2, T3, T4, T5, T6 respectively. The deviation of soil pH was recorded also. **Das *et al.***(2014) was in compliance with the fact that this Agro+Horti system improved the soil pH remarkably in this New Alluvial Zone of West Bengal.

Table 3.2. pH and Organic carbon status at the end of the experiment under Agri+Horti system

Treatment	pH of the soil	Deviation(%)	Soil Organic Carbon(%)	Deviation(%)
T_1	6.7	4.48	0.60	30.00
T_2	6.6	3.03	0.53	20.75
T_3	6.5	1.54	0.75	44.00
T_4	6.5	1.54	0.44	4.55
T_5	6.5	1.54	0.56	25.00
T_6	6.4	0.00	0.42	0.00

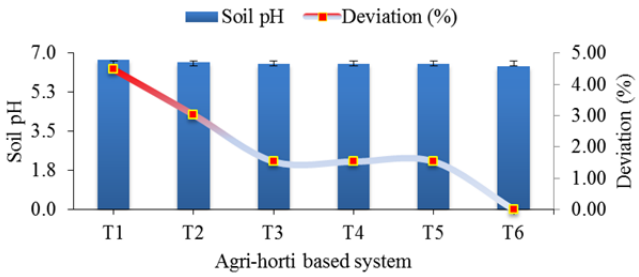

Fig. 2 pH status at the end of the experiment under Agri+Horti system

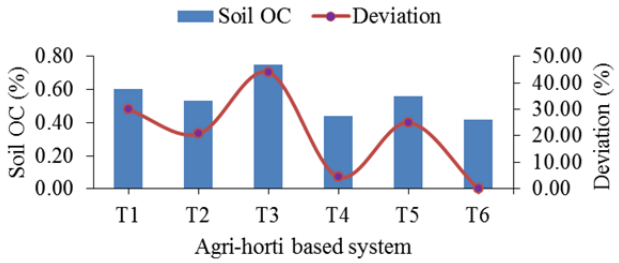

Fig. 3.organic carbon status at the end of the experiment under Agri+Horti system

4. THE ECONOMIC RETURN:

The economic table revealed that Fruit-based agroforestry system i.e. T_4 (Mango + Cauliflower) system fetched higher total return of Rs.313520.00 followed by T_3(Mango + Lentil) which showed a return of Rs. 297633.00. This is certainly due to additional yield of intercrops and fruits. These findings are in close agreement with those of **Banerjee *et al.*(2009).** The maximum net return were recorded when cauliflower in rabi was intercropped with Mango plantation system, closely followed by mustard intercropping. It is because of the higher productivity of crops under agri+horti system and consequently with a higher market price of the produce. The result is corroborated with that of **Dhara and Sharma(2015). Kaushik *et al.* (2002)** also reported that Horti-silviculture system showed maximum return in association with the field crops *(i.e.* under fruit-based Agri+Horti system. The economics of different treatments are presented in the following table:

Table 3.4. The economic return of the Mango based Agri+Horti system

Treatment	Fruit yield of mango (q ha $^{-1)}$	Yield of interc rop(q ha$^{-1)}$	Return of mango (Rs ha$^{-1)}$	Return from intercro p (Rs ha$^{-1)}$	Total returns (Rs. ha^{-1})
T_1	84.26	22.29	230375.00	35664.00	266039.00
T_2	72.24	7.36	210650.00	30912.00	241562.00
T_3	78.36	8.31	220350.00	77283.00	297633.00
T_4	88.15	132.62	180900.00	132620.00	313520.00
T_5	82.14	14.85	195600.00	19305.00	214905.00
T_6	66.24	-	-	-	165600.00

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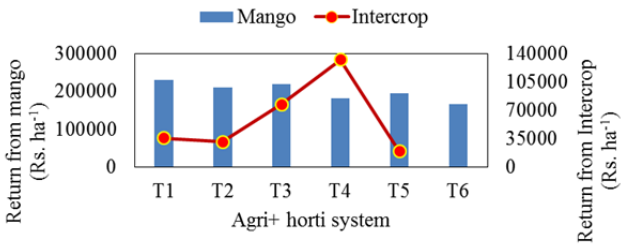

Fig. 4 Effect of different system on return of mango and intercrops

5. SUMMARY AND CONCLUSION

An investigation was carried out at the Horticultural Research Station, mondouri, Nadia, West Bengal and adjacent area to evaluate suitable intercrop for Mango based Agri+Horti system by studying the growth and productivity of intercrops under Mango plantation and their effect on the growth of the trees. The intercrops i.e. Rice, Mustard, Lentil, Cauliflower and wheat were grown in between the row spaces of mango plantation during the season of 2015.The tree height of Mango was observed highest when intercropped with Rice (7.21m) and the lowest height of mango with intercrops was 6.35m under mango + mustard intercrops. The height of mango tree under sole tree was 6.01m during December, 2015 respectively.Soil sample were collected from the exposed surface of pit at different depths from both the cropped land and open land the influence of the different intercrops in association with mango trees on some chemical properties of soil under the Agri+Horti system that was investigated. The highest soil pH (6.70) was observed in mango + rice association and least under sole tree (6.4). The percentage deviation of soil pH was found maximum 5.63% (Mango + Rice).Mango+ lentil intercropped system exerted the most significant increase in the status of the soil organic carbon (i.e. 0.75 %). Mango+ Cauliflower intercropped had the least effect (0.44%) in increasing the soil organic carbon status. The level of deviation percentage varies from 4.55% to 44.00%. It is maximum in Case of Mango + Lentil. The present investigation shows that it is technically feasible to integrate trees with agriculture crops on the same land during the same period and also enrich the soil properties by improving the status of organic carbon, pH and available status of N, P and K compared to that of open land. Based on the above study, it may be concluded that, out of the five intercrops, namely rice, mustard, lentil, cauliflower and wheat. The rice in *kharif* followed by cauliflower, mustard, lentil, wheat intercropped with mango is the most suitable for developing Mango based Agro- Horti based Agroforestry in New alluvial zone of West Bengal.Another Point we can conclude is that in case of diversification of Agroforestry selection of appropriate tree species, their quality planting material and remunerative crop combinations have been selected. The productivity and economic returns from the Agroforestry systems can be increased by meeting the water and nutrient requirement of the crops, trees and controlling their insect, pest and diseases. The degraded land in India, provided an alternative land use option for Silvi-horti-pasture. The option of alternative land use system, not only checks soil-erosion but also improves the productivity of land and mitigates the requirement of fodder, fuel, fruit and timber. The results on production of biomass through various silvi-horti-pasture systems on different degraded lands shoe that they are very much beneficial for getting higher biomass production from the same land on sustainable basis.

6. ACKNOWLEDGEMENT

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Plate 1. Plate 1.Mango+Paddy field at B.C.K.V. farm

Plate 2. Mango+ cabbage intercrop at B.C.K.V. Farm

Plate5 plate 3. Mango+ lentil intercropping

Plate 4. Mango+Mustard intercropping