RESEARCH ARTICLE

PERFORMANCE OF WINTER VEGETABLES CULTIVATION IN MANGO FRUIT TREE BASED AGROFORESTRY SYSTEM

M. S. Rahman^a, M. Saifullah^b, J. Rahman^c, K. N. A. Jewel^d, M. Yasmin^e^a Horticulture Research Centre, Bangladesh Agricultural Research Institute, Jamalpur-2000, Bangladesh.^b Member Director (A&F) and Chief Scientific Officer (Forestry Unit), NRM Division, Bangladesh Agricultural Research Council, Farmgate, Dhaka, Bangladesh.^c Agronomy Division, Bangladesh Agricultural Research Institute, Jamalpur-2000, Bangladesh.^d PBRG Sub Project (Forestry Unit), NRM Division, Bangladesh Agricultural Research Council, Farmgate, Dhaka, Bangladesh.^e Soil Science Division, Bangladesh Agricultural Research Institute, Jamalpur-2000, Bangladesh*Corresponding Author Email: saidurbari77@yahoo.com

This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ARTICLE DETAILS

Article History:

Received 25 May 2021

Accepted 28 June 2021

Available online 30 June 2021

ABSTRACT

An experiment was conducted at the farmers' fields of Naovangar char, Bolaier char and Laxmir char under Jamalpur and Sherpur region, Bangladesh. This experiment was also conducted at Regional Agricultural Research Station (RARS), Jamalpur, Bangladesh during the winter season of 2018-2019, 2019-2020 and 2020-2021. The objectives were to evaluate the performance of radish, sweet gourd and mustard leaf cultivation under mango fruit tree based agroforestry system, to increase the production of vegetables by using the fallow land under mango garden and to increase income of the farmers in char areas of Jamalpur and Sherpur. The experiment was laid out in Randomized Complete Block design (RCBD) with 3 replications. Three years experimental results revealed that, at Naovangar char, the highest radish equivalent yield (30.66 t ha⁻¹), gross return (Tk.306600 ha⁻¹), net return (Tk.225600 ha⁻¹) and BCR (3.7) were found from radish cultivation followed by sweet gourd and the lowest from mustard leaf cultivation (17.22 t ha⁻¹, Tk. 172200 ha⁻¹, Tk. 101200 ha⁻¹ and 2.4 respectively). At Bolaier char, the highest radish equivalent yield (30.33 t ha⁻¹), gross return (Tk.303300 ha⁻¹), net return (Tk.219800 ha⁻¹) and BCR (3.6) were found from radish cultivation followed by sweet gourd and the lowest from mustard leaf (17.88 t ha⁻¹, Tk. 178800 ha⁻¹, Tk.106800 ha⁻¹ and 2.4 respectively). At Laxmir char, the highest gross return, net return and BCR also followed the same trend. At RARS, Jamalpur, vegetables production under agroforestry system also followed same pattern. Radish cultivation exhibited remarkably higher radish equivalent yield (32.74 t ha⁻¹), higher gross return (Tk 327400 ha⁻¹), net return (Tk 238400 ha⁻¹) and BCR (3.6). The mustard leaf cultivation recorded the poorest performance regarding the said parameters. Prior to considering the obtained results from the study, it can be concluded that radish cultivation under agroforestry systems are more profitable than other winter vegetables cultivation. So, vegetables radish cultivation under mango fruit tree based agroforestry system might be encouraged in Jamalpur and Sherpur region in Bangladesh.

KEYWORDS

Agroforestry, Mango, Radish, Sweet gourd, Mustard leaf, Yield and Radish Equivalent Yield (REY).

1. INTRODUCTION

Bangladesh is one of the most densely populated countries of the world struggling hard to feed her 165.8 million people (BBS, 2018). If the current population growth rate (1.37%) continues, population will be increased to 180 million by the year 2025, and the country will face enormous problems to nurse her population. The country has only a land area of 14.39 million hectares, but due to the ever-growing population, per capita land area is decreasing at an average rate of 0.05 ha/cap/year since 1989 and therefore steadily declining the land: man ratio (Hossain and Bari, 1996). Like agriculture, forest is declining also with increasing population. A country needs 25% of forest land of its total area for ecological stability and sustainability. Unfortunately, Bangladesh is endowed with only 17% of unevenly distributed forests. It's clear that the country has no scope to expand forest and crop areas (BFD, 2011). So, combined production system integrating trees and crops together has to be developed. In these

circumstances, the practice of agroforestry is an authentic solution. Agroforestry, the integration of tree and crops or vegetables on the same area of land is a promising production system for maximizing yield and maintaining friendly environment (Nair, 1990).

Bangladesh has a long tradition of agroforestry practice. But management has always been extremely poor. Selection of plants, planting techniques, and also their utilization in most cases is poorly done, although the country is mostly dependent on farming system grown in and around human habitats. Because of the increasing population, quick urbanization, and other forms of development efforts, the agroforestry practices are being emphasized. It is assumed that total production of agroforestry is several times higher than that of annual crop system or forestry alone because of efficient use of growth resources viz. light, nutrient, water in this system. It is a sustainable and highly productive system that provides continuous production around the year.

Quick Response Code

Access this article online

Website:

www.taec.com.my

DOI:

[10.26480/taec.02.2021.74.78](https://doi.org/10.26480/taec.02.2021.74.78)

The per capita consumption of vegetable in Bangladesh is only 53 g, which is pretty below the recommended daily requirement of 200 g/head/day. The low consumption of vegetables creates a tremendous pressure over cereals and also causes malnutrition leading to several kinds of health hazards. The vegetables that are grown in Bangladesh is not sufficient. The demand of vegetables is increasing but unfortunately the area under vegetable production is decreasing due to increasing the area of rice and wheat cultivation. During the early establishment of mango (3-4 years) vegetables can easily grow in their surrounding areas. At the early establishment period of tree, the competition for growth resources (water, nutrients and light) between tree and associated crop is perhaps absent or minimum.

Plantation of mango tree in association with vegetables as agroforestry practice would be beneficial for socio economic development as well as for sound environmental condition. Hence, it would be wise to conduct experiments during the early period of the mango tree plantation in association with different vegetables in terms of growth and yield performance for identifying best tree-vegetables combination. If proper combination of tree and vegetables were selected, this technology would be stable and beneficial for fruit tree growers undoubtedly. Therefore, the present study was undertaken with the following objectives:

- i. To observe the performance of under storey winter vegetables in the mango-based agroforestry system.
- ii. To increase production and economic return

2. MATERIALS AND METHODS

The experiment was conducted at four location (Naovangar char, Bolaier char, Laxmir char and Regional Agricultural Research Station) of Jamalpur and Sherpur district of Bangladesh during the winter season of 2018-2019, 2019-2020 and 2020-2021. In this study, three years old mango (*Mangifera indica*) fruit tree which was planted in the experimental site during the year 2015 and this trees was used as fruit tree components of this study. Radish, Sweet gourd and mustard leaf was used as agricultural components of agroforestry practices. Average spacing of mango trees was 5m x 5m, canopy spread was 1.33m x 1.29m and tree height was 1.99m. Vegetables varieties were Long White Mino for radish, Tori-7 for mustard leaf, Bengal Sweet-2 for sweet gourd were used as under storey crop in this experiment. The experiment was laid out in Randomized Complete Block (RCB) Design with three replications.

The unit plot size was 6m x 4m. The spacing were 50cm x 30cm for radish, broadcasting for mustard and 2m x 2m for sweet gourd. Land was prepared by three times ploughing followed by laddering. Soil test-based fertilizer dose for every crop were used. The seeds/seedlings were planted on 25 November to 15 December 2018 and 2019, depending on crop and location. Insecticide and fungicide were sprayed as and when necessary to control the pest and diseases. Radish was harvested during 25 January to 10 February. Sweet gourd was harvested from 20 February to 3 March. Mustard leaf was harvested from 29 December to 5 January. Necessary data were recorded and analyzed statistically using statistical software STAR which was developed by IRRI. To compare yield and profitability of crops their economic equivalent yield in terms of radish called Radish Equivalent Yield (REY) was computed using the formula given by Ahlawat and Sharma (1993). $(REY) (t\ ha^{-1}) = \text{yield of test crop} (t\ ha^{-1}) \times \text{Price of test crop} (Tk\ kg^{-1}) / \text{price of radish} (Tk\ kg^{-1})$

Figure 1: Winter vegetables cultivation in association with mango trees at Naovangar char in Jamalpur sadar

Figure 2: Winter vegetables cultivation in association with mango trees at Bolaier char in Sherpur sadar

Figure 3: Winter vegetables cultivation in association with mango trees at Laxmir char in Jamalpur sadar

Figure 4: Winter vegetables cultivation in association with mango trees at RARS, Jamalpur

3. RESULT AND DISCUSSION

3.1 Yield of vegetables in agroforestry practice with Mango tree

Average yield and Radish Equivalent Yield (REY) of radish, sweet gourd and mustard leaf at farmer's field of Nao Vangar char, Jamalpur Sadar., Bolaier char, Sherpur Sadar., Laxmir char, Jamalpur sadar and Regional Agricultural Research Station (RARS), Jamalpur were presented in table 6. At Naovangar char, Jamalpur sadar, Jamalpur the highest average yield (30.66 t ha^{-1}) was found from radish, followed by sweet gourd (16.23 t ha^{-1}) and lowest yield (14.35 t ha^{-1}) was found from mustard leaf under agroforestry system. As the crops were different, Radish Equivalent Yield (REY) was considered for economic yield. Radish equivalent yield was the highest (30.66 t ha^{-1}) from the radish and lowest (17.22 t ha^{-1}) was from mustard leaf. At Bolaier char, Sherpur sadar, Sherpur, among the vegetables, radish produced the highest average yield (30.33 t ha^{-1})

followed by sweet gourd (16.63 t ha^{-1}) and mustard leaf produced lowest yield (14.90 t ha^{-1}) under agroforestry system.

The highest REY (30.33 t ha^{-1}) from the radish and the lowest (17.88 t ha^{-1}) was from mustard leaf. At Laxmir char, Jamalpur sadar, Jamalpur, the highest yield (33.16 t ha^{-1}) was found from radish, followed by sweet gourd (18.42 t ha^{-1}) and lowest yield (17.17 t ha^{-1}) was found from mustard leaf under agroforestry system. Radish equivalent yield was the highest (33.16 t ha^{-1}) from the radish and lowest (20.60 t ha^{-1}) was from mustard leaf. At RARS, Jamalpur, vegetables production under agroforestry system also followed same pattern. The highest average yield (32.74 t ha^{-1}) was found from radish and lowest yield (16.32 t ha^{-1}) was found from mustard leaf under agroforestry system. Radish equivalent yield was the highest (32.74 t ha^{-1}) from the radish and lowest (19.58 t ha^{-1}) was from mustard leaf.

Table 1: Average yield and Radish Equivalent Yield (REY) of winter vegetables under mongo-based agroforestry system during the rabi season of 2018-19, 2019-20 and 2020-21

Location	Vegetables	Yield (t ha^{-1})			Average yield (t ha^{-1})	Radish equivalent yield (REY) (t ha^{-1})
		2018-19	2019-20	2020-21		
Naovangar char, Jamalpur	Radish	29.10 a	32.88 a	30.00 a	30.66	30.66
	Sweet gourd	14.65 b	17.55 b	16.50 b	16.23	21.09
	Mustard leaf	10.30 c	16.94 b	15.80 c	14.35	17.22
	Red amaranth	10.50 c	18.11 b	17.00 b	15.20	18.24
LSD (0.05)	-	1.09	1.97	0.55	-	-
CV (%)	-	8.91	7.46	7.18	-	-
Bolaier char, Sherpur	Radish	27.30 a	32.50 a	31.20 a	30.33	30.33
	Sweet gourd	13.60 b	18.75 c	17.55 b	16.63	21.61
	Mustard leaf	9.20 c	18.60 c	16.90 b	14.90	17.88
	Red amaranth	10.30 c	20.18 b	18.25 b	16.24	19.48
LSD (0.05)	-	1.46	1.05	1.73	-	-
CV (%)	-	6.53	6.24	5.92	-	-
Laxmir char, Jamalpur	Radish	-	34.83 a	31.50 a	33.16	33.16
	Sweet gourd	-	18.50 b	18.35 b	18.42	23.94
	Mustard leaf	-	17.40 c	16.95 c	17.17	20.60
	Red amaranth	-	19.00 b	18.00 b	18.50	22.22
LSD (0.05)	-	-	0.98	0.63	-	-
CV (%)	-	-	5.87	6.09	-	-
RARS, Jamalpur	Radish	32.60 a	33.33 a	32.30 a	32.74	32.74
	Sweet gourd	14.90 b	18.81 c	18.60 c	17.43	22.65
	Mustard leaf	10.80 c	19.66 c	18.50 c	16.32	19.58
	Red amaranth	11.50 c	21.33 b	20.00 b	17.61	21.13
LSD (0.05)	-	1.31	1.69	0.88	-	-
CV (%)	-	8.11	7.43	7.13	-	-

Note: Average price of radish, sweet gourd, mustard leaf and red amaranth were 10, 13, 12 and 12 TkKg⁻¹ respectively.

3.2 Economic analysis

Cost-return analysis was done for assessing profitability. In all location, the highest gross return and net return were found from radish cultivation and lowest gross return & net return were found from mustard leaf cultivation under agroforestry system. BCR also followed the same trend. At Naovangar char, the highest gross return (Tk 306600 ha⁻¹), net return (Tk 225600 ha⁻¹) and BCR (3.7) were recorded from radish. The mustard leaf cultivation recorded the poorest performance regarding the said parameters. At Bolaier char, radish cultivation gives highest gross return (Tk 303300 ha⁻¹), net return (Tk 219800 ha⁻¹) and BCR (3.6). At Laxmir char, highest gross return (Tk 331600 ha⁻¹), net return (Tk 243600 ha⁻¹)

and BCR (3.7) were obtained from radish cultivation and these values were found lowest in mustard leaf cultivation under mango-based agroforestry system. At RARS, among the vegetables cultivation under agroforestry system, radish cultivation exhibited remarkably higher gross return (Tk 327400 ha⁻¹), net return (Tk 238400 ha⁻¹) and BCR (3.6). Mustard leaf cultivation recorded the lowest gross return (Tk 195800 ha⁻¹), net return (Tk 113800 ha⁻¹) and BCR (2.3). However, total cost was the maximum in sweet gourd in all location due to making trellis for supporting the plants. The radish production cost was second position and the lowest total cost was in mustard leaf cultivation under agroforestry system.

Table 2: Economic analysis of winter vegetables cultivation under mango-based agroforestry system

Table 2: Economic analysis of winter vegetables cultivation under mango-based agroforestry system						
Location	Vegetables	Radish Equivalent Yield (REY) (t ha ⁻¹)	Gross return	Total cost	Net return	BCR
			(Tk ha ⁻¹)			
Naovangar char, Jamalpur	Radish	30.66	306600	81000	225600	3.7
	Sweet gourd	21.09	210900	83000	127900	2.5
	Mustard leaf	17.22	172200	71000	101200	2.4
	Red amaranth	18.24	182400	70500	111900	2.5
Bolaier char, Sherpur	Radish	30.33	303300	83500	219800	3.6
	Sweet gourd	21.61	216100	86500	129600	2.5
	Mustard leaf	17.88	178800	72000	106800	2.4
	Red amaranth	19.48	194800	74500	120300	2.6
Laxmir char, Jamalpur	Radish	33.16	331600	88000	243600	3.7
	Sweet gourd	23.94	339400	91500	147900	2.6
	Mustard leaf	20.60	206000	81000	125000	2.5
	Red amaranth	22.22	222200	83000	139000	2.6
RARS, Jamalpur	Radish	32.74	327400	89000	238400	3.6
	Sweet gourd	22.65	226500	92500	134000	2.4
	Mustard leaf	19.58	195800	82000	113800	2.3
	Red amaranth	21.13	211300	86500	124800	2.4

Note: Average price of radish, sweet gourd, mustard leaf and red amaranth were 10, 13, 12 and 12 TkKg⁻¹ respectively.

4. CONCLUSION

In a limited resources country like Bangladesh, agroforestry system can play a significant contribution of the multiple components of yield and economic condition of the farmers. The results revealed that radish cultivation is the best among three tested winter vegetables in respect to yield, profitability and adaptability in mango-based agroforestry system. It may be concluded that vegetables radish can successfully grow in cultivation with mango tree as agroforestry system of Jamalpur and Sherpur, Bangladesh perspective.

ACKNOWLEDGEMENTS

This work is financed by the PBRG Sub-project "Upliftment of Farmers Livelihood and Enrichment of Environment through Improved Agroforestry Practices in Char Land Ecosystem of Bangladesh: BARI Component" under NATP Phase-2.

REFERENCES

- Ahlawat, I.P.S., Sharma, R.P., 1993. Agronomic terminology. 3rd edition, Indian society of agronomy, New Delhi.
- BBS. 2018. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics. Ministry of Planning, Government of the people's Republic of Bangladesh, Dhaka, Bangladesh.
- BFD. 2011. Homepage, Bangladesh Forest Department, www.bforest.gov.bd (Accessed 5 December 2011).
- Hossain, S.M.A., Bari, M.N., 1996. Agroforestry farming system. Agroforestry in Bangladesh (Hoque, M. A. e.) village & Farm Forestry Project. SDC. Dhaka & Bangladesh Agricultural University, Mymensingh. pp. 21-29.
- Hsiao, T.C. (1973). Plant responses to water stress. Ann. Rev. Plant Physiol. 24, Pp. 519-570.
- Nair, P.K.R., 1990. An introduction to agroforestry. Kluwer Academic publishers, ICRAF.