Asian Research Journal of Agriculture

14(2): 42-49, 2021; Article no.ARJA.70481
ISSN: 2456-561X

Productivity and Profitability Assessment of Lemon Based Agroforestry Systems in Bangladesh

Zannatul Ferdaous Bony[1], Md. Abiar Rahman[1*], Zabid Al Riyadh[1], Satya Ranjan Saha[1] and Mohammad Zakaria[2]

[1]Department of Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh.
[2]Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.

Authors' contributions

This work was carried out in collaboration among all authors. All authors contributed equally to the planning and design of the study. Authors ZFB and MAR performed the research work and statistical analysis. Authors ZAR, SRS and MZ wrote the protocol, managed the analyses of the study and wrote the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARJA/2021/v14i230123
Editor(s):
(1) Dr. Alice Maria Correia Vilela, University of Trás-os-Montes and Alto Douro, Portugal.
(2) Dr. M. Yuvaraj, Adhiparasakthi Agricultural College, India.
(3) Dr. Tancredo Souza, University of Coimbra, Portugal.
Reviewers:
(1) Hendra Wijaksana, Udayana University, Indonesia.
(2) Rômulo Maziero, Universidade Federal de Minas Gerais - UFMG, Brazil.
Complete Peer review History: https://www.sdiarticle4.com/review-history/70481

Original Research Article

Received 15 May 2021
Accepted 21 July 2021
Published 27 July 2021

ABSTRACT

A field experiment was conducted from May 2017 to February 2018 at the research farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University to evaluate the performance and profitability of three seasonal (Broccoli, Cabbage and Okra) and two annual crops (ginger and turmeric) in lemon-based agroforestry systems. The experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated thrice. For seasonal crops the treatments were sole field (T_0), 50 cm distance from tree base (DTB) with ginger (T_1), 50 cm DTB with turmeric (T_2), 100 cm DTB with ginger (T_3) and 100 cm DTB with turmeric (T_4). For annual crops (ginger and turmeric) the treatments were sole field (T_0) and four distance regimes (50, 100, 150 and 200 cm) from the lemon tree base in agroforestry systems. The results of the study revealed that the yield of seasonal crops decreased and the yield of annual crops and perennial trees increased in agroforestry than

**Corresponding author: E-mail: abiar@bsmrau.edu.bd;*

respective sole cropping systems. The yield performance of crops component was significantly decreased with the decreasing distance towards tree base in agroforestry systems. The economic analysis showed that the net return, benefit-cost ratio (BCR) and land equivalent ratio (LER) was higher in the lemon-based agroforestry system than sole cropping. Therefore, the cultivation of cabbage, broccoli, okra, ginger and turmeric under lemon-based agroforestry systems are economically profitable.

Keywords: Agroforestry; sole cropping system; lemon; benefit-cost ratio; land equivalent ratio.

1. INTRODUCTION

Bangladesh is a land deficient country with a population of 163 million; the availability of per capita arable land has been declined from 0.174 ha in 1961 to 0.048 ha only in 2018 [1,2]. The country is lying between the two contrasting settings in the Bay of Bengal to the south and the Himalayas to the north; it will be the one of worst sufferer country to climate changes due to its disaster prone and low elevation geography. Decreasing natural resources and increasing climatic vulnerability appeared as the great challenges to keep pace of food production in the background of increasing population [3]. Currently most of the land in the country suitable for cultivation is under cropping practices, having limited scope for expanding the cropland [4]. Since, there is very limited scope for expanding sole cropped area, the country has to develop combined production system integrating crops and tree which is now being called agroforestry system. Fruit trees-crops agroforestry systems can ensure year-round food and nutritional security and enhance incomes for small-scale farmers [5].

Recently there has been established many commercial lemon orchards in different agro-ecosystems of Bangladesh, which allows enough space for the cultivation of different crops in between the two line of lemon trees. During early establishment of lemon (*Citrus limon* L.) orchard, seasonal vegetable crops can be grown which can provide seasonal returns and even after profuse growth of lemon tree, partial shade tolerant crops can also be grown [6]. The performance of lemon orchard is hampered during winter and summer due to dearth of water. So, it will perform better by enjoying the resources that will be applied for vegetable crops. Though farmers are practicing lemon-based agroforestry system in small scale, yet these systems are modestly studied in Bangladesh. Cabbage (Brassica oleracea var. capitata), broccoli (*Brassica oleracea* var. *italica*) and Okra (*Abelmoschus esculentus*) are the most popular seasonal vegetables of Bangladesh. Turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*) are two annual herbaceous plants and consuming as major spices in the Indian sub-continent. Ginger and turmeric being shade loving crops could be cultivated in agroforestry system [7]. The compatible combination is necessary to get the potential benefits of the agroforestry. Considering the above facts, it was aimed to utilize the lemon orchard for maximizing the system's production. Therefore, the present study was conducted to evaluate the performance and economic return of different crops in lemon tree-based agroforestry systems.

2. MATERIAL AND METHODS

2.1 Experimental Location and Climatic Conditions

The field study was conducted at the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) farm located at 24°09´ N latitude and 90°20´ E longitude in the upland of terrace topography during the period from May 2017 to February 2018. The soil is silty-clay loam in texture which belongs to Salna series of Shallow Red-Brown Terrace soil. The study area has subtropical climate characterized by three distinct seasons; the monsoon (May to October), the dry season (November to February) and the pre-monsoon (March to April).

2.2 History of the Lemon Orchard and Development of Agroforestry Systems

Well established 3 years old Lemon orchard was selected to develop agroforestry system in order to assess the productivity and profitability of the systems. The lemon variety "Colombo" was transplanted on 9 February, 2014 at a spacing of 4.0 m × 4.0 m. The land was prepared thoroughly by disking followed by harrowing and laddering until a good tilth was obtained. During Kharif season, ginger (var. BARI *Ada1*) and

turmeric (var. BARI *Hulud1*) were planted at a spacing of 25cm×20cm, on 23 May 2017; Okra seeds (hybrid var. *Nayeem*) were sown at a spacing of 50cm×45cm, on 29 June 2017. In winter, healthy 35 day's old seedlings of cabbage (var. *ATLAS 70*) and broccoli (var. *Broccoli Green*) were transplanted on 20 November, 2017 at a spacing of 60cm×50cm. All seasonal and annual crops were fertilized according to the doses and methods of fertilizer recommendation guide, 2012 [8]. Plant protections along with all agronomic management practices were done regularly.

2.3 Experimental Design and Treatments

The experiment was conducted in a Randomized Complete Block design (RCBD) with three replications. This experiment comprised of five treatments for seasonal crops (Okra, Cabbage and Broccoli) viz. sole field (T_0), 50 cm distance from tree base with ginger (T_1), 50 cm distance from tree base with turmeric (T_2), 100 cm distance from tree base with ginger (T_3) and 100 cm distance from tree base with turmeric (T_4). There were also five treatments for annual crops (ginger and turmeric) viz. sole field (T_0) and four distance regimes like 50 (T_1), 100 (T_2), 150 (T_3), and 200 (T_4) cm from the base of the lemon tree in agroforestry systems. The performance of lemon tree was evaluated under three treatments e.g., sole plot, lemon with ginger and turmeric.

2.4 Data Collection and Statistical Analyses

Growth, yield and yield contributing characters were collected periodically from the experimental plots. All recorded data were processed, calculated and analyzed by using computer software such as MS-Excel and Statistx10. Necessary tests were done to compare the treatment means. One-way analysis of variance (ANOVA) was done and the mean differences were adjusted by Least Significant Difference (LSD) at 5% level of significance.

2.5 Cost-benefit and Land Use Analyses

Benefit-Cost analysis of crop production was done by calculating *on-site* and *off-site* costs and benefits of crops and fruit tree. The Benefit-Cost Ratio (BCR) was calculated by the following formula:

BCR = Gross return (BDT ha^{-1} $year^{-1}$) / Total cost of Production (BDT ha^{-1} $year^{-1}$).

The comparative advantage of land use through agroforestry and traditional farming was calculated in the term Land Equivalent Ratio (LER) by the following formula:

LER = Xi/Xs + Yi/Ys; Where, X and Y are the yields of crop components in agroforestry (i) and sole cropping system's (s).

3. RESULTS AND DISCUSSION

3.1 Performance of Broccoli

Growth and yield parameters of broccoli were found to be significant in lemon-based agroforestry system when compared to sole cropping system (Table 1). The maximum leaves number (19.67) of broccoli was found in sole field condition and the minimum (14.67) was noted in T_2 treatment. The highest leaf length and breadth (54.67 and 24.00 cm) was recorded in sole cropping system and significantly the lowest (46.00 and 19.33 cm) in T_1 treatment under agroforestry system. Both curd diameter and individual curd weight were the highest (15.33 cm and 0.48 kg) in sole cropping system, while significantly the lowest (9.67 cm and 0.38 kg) were observed at 50 cm distance from tree base (DTB) in ginger associated lemon-based agroforestry system. These results might be due to higher photosynthate production in full light conditions and lower competition of water and nutrients in sole cropping field which caused higher curd yield as compared to that of lemon-based agroforestry field. The present findings of the experiment corroborate to the findings of Santos et al. [9] who reported that the yield of broccoli reduced due to higher competition in intercropping system.

3.2 Performance of Cabbage

The growth and yield characteristics of cabbage were significantly influenced by the different treatments and it was observed that all studied parameters except outer number of leaves per plant were superior in sole cropped field (Table 2). Maximum number of outer leaves (21.13) was counted from 50 cm DTB in ginger associated lemon field and the minimum (17.33) was in sole cabbage field. The highest leaf length (30.50 cm), leaf breadth (27.10 cm), head diameter (22 cm) and head weight (1.58 kg) were recorded in sole (T_0) cropped field of cabbage. In contrast the lowest leaf length (25.67 cm), leaf breadth (23.30 cm), head

diameter (18.51 cm) and head weight (1.14 kg) were found at 50 cm DTB in ginger coupled lemon-based agroforestry system. Higher number of outer leaves with small size in agroforestry system than sole cropped field might be due to shade effect of lemon trees. In agroforestry systems inter competition for light, water and nutrients among the crop components were higher than sole cropping system, which resulted lower head weight of cabbage. Rahman et al. [10] has been reported similar effect of planting distances from tree base in cabbage production under agroforestry system. The present finding of the experiment is also supported by the finding of Miah et al. [11] who reported that the yield of cabbage was reduced under multipurpose trees in agroforestry systems.

3.3 Performance of Okra

Significant variation was observed in yield and yield contributing characters of okra as influenced by planting distances from tree base along with associated annual crops (Table 3). The highest number of fruits per plant (23.40), single fruit weight (17.34) and yield per plant (449.65 g) were recorded in sole cropped field. As compared to sole cropped okra, the yield reduction was noted by 19.26% in T_1, 20.01% in T_2, 8.69% in T_3 and 12.72% in T_4 under lemon-based agroforestry systems. The performance of okra significantly increased with increasing planting distances from tree base in agroforestry systems. These results might be due to increasing light percentage and decreasing competition for available growth resources (nutrients and water) among the components in agroforestry systems with increasing planting distances from tree base. Competition for light is an important factor in yields reduction of the plants grown closest to the trees [10,12] and the highest edible vegetables flower buds were formed under full sunlight situation [13]. The result of this experiment is in conformity with the result of Bhusara et al. [14] who reported that harvested lower okra yield in *Melia composite* based agroforestry than open field condition.

Table 1. Morphological characters of broccoli in lemon-based agroforestry and sole cropping system

Treatments	Number of leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Curd diameter (cm)	Curd weight (kg)
T_1	16.00b	46.00c	19.33b	9.67b	0.38b
T_2	14.67b	51.33b	20.27b	13.17ab	0.39b
T_3	16.75ab	48.83c	20.17b	10.17b	0.42ab
T_4	15.67b	53.17ab	21.33b	14.50a	0.44a
T_0	19.67a	54.67a	24.00a	15.33a	0.48a
CV%	9.88	5.04	7.23	9.09	16.80

Mean values followed by a common letter are not statistically different at the 5% level of significance by LSD

Table 2. Morphological characters of cabbage in lemon-based agroforestry and sole cropping system

Treatments	Number of outer leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Head diameter (cm)	Head weight (kg)
T_1	21.13a	25.67b	23.30b	18.51b	1.14b
T_2	19.27b	27.83ab	26.17a	19.67b	1.33ab
T_3	18.67b	28.83a	24.83ab	19.38b	1.18b
T_4	17.80b	29.17a	26.00a	20.67ab	1.48a
T_0	17.33b	30.50a	27.10a	22.00a	1.58a
CV%	6.42	10.55	6.00	6.16	5.67

Mean values followed by a common letter are not statistically different at the 5% level of significance by LSD

Table 3. Yield and yield attributes of okra in lemon-based agroforestry and sole cropping system

Treatments	Number of Fruits plant^{-1}	Single Fruit Weight (g)	Yield (g plant^{-1})
T_1 (50cm DTB with ginger)	20.40b	14.98b	363.03c
T_2 (50cm DTB with turmeric)	18.20c	14.39b	359.67c
T_3 (100cm DTB with ginger)	22.33ab	15.77ab	410.56b
T_4 (100cm DTB with turmeric)	20.50b	15.27b	392.46b
T_0 (Sole/Open field)	23.40a	17.34a	449.65a
CV%	5.08	6.18	3.77

Mean values followed by a common letter are not statistically different at the 5% level of significance by LSD

3.4 Performance of Ginger and Turmeric

Ginger and turmeric cultivated in agroforestry system grew more vigorously than respective sole cropping system (Table 4). Numbers of tiller and rhizome weight per hill are the most important growth and yield contributing characters for rhizome crops. Both the number of tiller and rhizome weight per hill of ginger and turmeric were increased gradually with the increasing of distance from lemon tree base in agroforestry systems. The highest rhizome weight per hill of ginger (123.32 g) and turmeric (170.89 g) were measured at 150 cm (T_3) and 200 cm (T_4) distances from tree base, respectively in lemon-based agroforestry system. However, the rhizome weight of ginger per hill was augmented by 4.18, 19.43 and 15.11% at 100 cm, 150 cm and 200 cm distances respectively, while reduced by 8.18% at 50 cm distance from lemon tree base under agroforestry as compared to respective sole cropping system.

In agroforestry system, turmeric planted at 50, 100, 150 and 200 cm distances from lemon tree base showed a significant increment in rhizome weight per hill by 2.66, 7.61, 16 and 23.38%, respectively when compared to sole cropped field. The positive effect of lemon-based agroforestry on the performances of ginger and turmeric might be due to suitable microclimatic condition. In shaded condition under tree, the growth and yield performances of turmeric and ginger increased than their respective open field [15-17]. Two authors have been reported similar effect of planting distances from tree base and higher yields of ginger and turmeric were reported in two different agroforestry systems [7,18].

3.5 Performance of Lemon

To evaluate the performance and profitability of the lemon tree under both the agroforestry and sole cropping system, several yield-related parameters were measured (Table 5). The maximum (112.11) fruits per plant were counted from ginger associated lemon field and the minimum (93.03) in sole lemon field. Though the fruit weight, length and diameter of lemon were insignificant among the treatments, superior sized fruits were harvested from agroforestry compared to sole lemon fields. However, all of these attributes caused an increment of yield per plant by 17.60% and 20% in ginger and turmeric associated lemon-crop agroforestry system respectively. The yield improvement of lemon in agroforestry system might be due to the fact that lemon trees simultaneously enjoyed a substantial amount of supplied inputs (water and fertilizers) to the seasonal crops. External inputs like fertilizers and irrigation applied to crop components in fruit tree-based agroforestry system increased the fruit yield of perennials components [19].

3.6 Economic and Land use Performances

Economic performances in terms of BCR and LER of different crop associated lemon-based agroforestry and sole cropping systems were calculated and presented in Table 6. The net returns were much higher in agroforestry system over their respective sole cropping systems. Among all cropping systems, the highest BCR (2.91) was recorded in lemon+ginger+broccoli agroforestry system and the lowest (1.55) in sole okra. LER was calculated on the basis of total yield produced from the systems.

Table 4. Growth and yield attributes of ginger and turmeric in lemon-based agroforestry and sole cropping systems

Treatments	Ginger		Turmeric	
	Number of tiller hill^{-1}	Rhizome weight hill^{-1} (g)	Number of tiller hill^{-1}	Rhizome weight hill^{-1} (g)
T_1 (50 cm DTB)	7.25b	94.80c	4.96b	151.25c
T_2 (100 cm DTB)	8.15ab	107.57b	5.21b	158.55b
T_3 (150 cm DTB)	9.38a	123.32a	5.77ab	170.89ab
T_4 (200 cm DTB)	9.42a	117.85 a	7.10a	181.78a
T_0 (Sole)	7.80ab	103.25b	4.75b	147.33c
CV%	9.18	6.54	20.86	5.33

Mean values followed by a common letter are not statistically different at the 5% level of significance by LSD

Table 5. Yield and yield attributes of lemon in agroforestry and sole cropping system

Treatments	Number of fruits plant^{-1}	Fruit length (mm)	Fruit diameter (mm)	Single fruit weight (g)	Yield per plant (kg)
Lemon+ginger	112.11a	84.54	59.74	157.24	17.84a
Lemon+turmeric	104.98a	87.36	61.77	171.53	18.20a
Sole lemon	93.03b	78.89	55.46	152.34	15.17b
LSD	6.52	8.00	8.28	25.69	2.87
CV%	2.79	4.14	6.21	7.06	7.64

Mean values followed by a common letter are not statistically different at the 5% level of significance by LSD

Table 6. Economic comparison of different crop associated lemon-based agroforestry and sole cropping systems

Systems	Total cost (BDT/ha)*	Total return (BDT/ha)*	Net return (BDT/ha)*	BCR	LER
Lemon+ginger+broccoli	390666	1136650	745984	2.91	2.08
Lemon+ginger+cabbage	388735	1095990	707255	2.82	2.05
Lemon+ginger+okra	394295	1100150	705855	2.79	2.09
Lemon+turmeric+broccoli	369371	984700	615329	2.66	2.07
Lemon+turmeric+cabbage	367440	944040	576600	2.57	2.04
Lemon+turmeric+okra	373000	948200	575200	2.54	2.10
Sole broccoli	238080	475200	237120	2.00	-
Sole cabbage	234861	417120	182259	1.78	-
Sole okra	244129	378880	134751	1.55	-
Sole turmeric	255273	529200	273927	2.07	-
Sole ginger	326113	855000	528887	2.62	-
Sole lemon	214327	455100	240773	2.12	-

** 1 US$= 84 BDT*

The LER was more than two times higher in agroforestry systems compared to respective sole cropping systems, as it is assumed that the LER of monocropping system is 1. The highest LER was 2.10 in lemon+ginger+okra agroforestry system which indicated that 2.10 times higher land would be required to get similar production from sole cropping as compared to agroforestry system. Higher BCR and LER in agroforestry were due to satisfactory yield from seasonal crops and improved yield of ginger, turmeric and lemon. Fruit tree-based agroforestry systems are potent to provide higher economic returns than other annual crops [20,21]. Several authors have been reported higher economic and land use benefits in different fruit tree-based agroforestry systems than sole cropped systems [22-24].

4. CONCLUSION

In a resource limited country like Bangladesh, lemon-based agroforestry systems can play a vital role in the production of multiple yield component throughout the year. Despite the sole cropping systems of seasonal crops provided

higher yield than their respective agroforestry, but the total system's production was higher in lemon-based agroforestry systems. The net return, benefit cost and land equivalent ratio were superior in agroforestry systems compared to sole cropping systems. So seasonal and annual crops could be successfully grown in lemon-based agroforestry and farmers might be encouraged to practices these systems for higher production, income generation and land use maximization.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. BBS (Bangladesh Bureau of Statistics). Statistical pocket book Bangladesh-2018, statistics and informatics division (SID), ministry of planning, Government of the people's republic of Bangladesh, Dhaka; 2018.
2. World Bank. Collection of development indicators of the World Bank; 2018. Available:https://data.worldbank.org/indicator/AG.LND.ARBL.HA.PC?locations=BD
3. Kabir MS, Salam MU, Chowdhury A, Rahman NMF, Iftekharuddaula KM, Rahman MS, Islam AS. Rice vision for Bangladesh: 2050 and beyond. Bangladesh Rice J. 2015;19(2):1-18. Available:https://doi.org/10.3329/brj.v19i2.28160
4. Timsina J, Wolf J, Guilpart N, Van Bussel LGJ, Grassini P, Van Wart J, Van Ittersum MK. Can Bangladesh produce enough cereals to meet future demand? Agril syst. 2018;163:36-44. Available:https://doi.org/10.1016/j.agsy.2016.11.003
5. Palada MC, Wu DL, Luther GC, Bhattarai M, Mercado Jr AR, Reyes MR. Establishing vegetable agroforestry system research at the World Vegetable Center; 2009.
6. Sarfuddin AFM, Siddique MA. Sabji Bagan: A Bengali book of horticulture. 1998;10-12.
7. Bhuiyan MM, Roy S, Sharma PC, Rashid MH, Bala P. Impact of multistoreyed agro-forestry systems on growth and yield of turmeric and ginger at Mymensingh, Bangladesh. Crop Production. 2012;1(1): 19-23.
8. FRG (Fertilizer Recommendation Guide), Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka; 2012.
9. Santos RH, Gliessman SR, Cecon PR. Crop interactions in broccoli intercropping. Biol Agric Horti. 2002;20(1): 51-75. Available:https://doi.org/10.1080/01448765.2002.9754948
10. Rahman MA, Saha S, Riyadh ZA, Saha SR, Current D, Rahman MM. Assessing the Productivity and Profitability of Cabbage in Jackfruit-Based Multistorey Agroforestry System in Bangladesh. In: Eckman K, Samadangla AO, Ralte L, Yanthan M. (eds) Integrated Land-Use Management in the Eastern Himalayas, Volume 3 Focus on Nagaland. Akansha Publishing House, Guwahati. 2019; 165-179.
11. Miah MM, Rahman MS, Amin MH, Rayhan SM, Hanif MA. Performance of cabbage under multipurpose tree species as agroforestry system. Bangladesh Res Public J. 2010;4(1):76-81.
12. Riyadh ZA, Rahman MA, Miah MG, Saha SR, Hoque MA, Saha S, Rahman MM. Performance of Aroid under Jackfruit-Based Agroforestry System in Terrace Ecosystem of Bangladesh. Annals of Bangladesh Agric. 2019;23(2):79-87. Available:https://doi.org/10.3329/aba.v23i2.50056
13. Gracie AJ, Brown PH, Clark RJ. Study of some factors affecting the growth and development of myoga (Zingiber mioga Roscoe). Scientia horticulturae. 2004;100(1-4):267-78. Available:https://doi.org/10.1016/j.scienta.2003.08.016
14. Bhusara JB, Dobriyal MJ, Thakur NS, Gunaga RP, Tandel MB. Performance of okra (Abelmoschus esculentus L. Moench) under different spatial arrangements of Melia composita based agroforestry system. Int J Curr Microbiol Appl Sci. 2018;7(05):3533-42. Available:https://doi.org/10.20546/ijcmas.2018.705.408
15. Pandey SB, Pandey M, Jadeja DB, Tandel MB, Nayak D. Growth and yield of ginger (Zingiber officinale L) under Sapota-Jatropha based agroforestry systems in south Gujarat. J Pharmacog Phytochem. 2017;6(6):247-51.
16. Khan SA, Hussain M, Noureen N, Fatima S, Ane NU, Abbas Z. Yield performance of

turmeric varieties intercropped with mulberry plantations. Am Eurasian J Agric Environ Sci. 2015;15:2076-2079.
Available:https://doi.org/10.5829/idosi.aejaes.2015.15.10.10185

17. Islam MS, Uddin MJ, Debnath L, Begum MS. Growth and yield of medicinal plants and spices under D. sissoo based agroforestry system. J Innov Dev Strategy. 2013;7(2):44-49.
18. Riyadh ZA, Rahman MA, Miah MG, Saha SR, Hoque MA, Rahman MM, Miyajima I. Performance of Spices as Lower–Storey Crop in Jackfruit–Papaya Multistorey Agroforestry System in Bangladesh. J Fac Agric, Kyushu Univ. 2020;65(2):223-231.
Available:https://doi.org/10.5109/4103694
19. Rahaman MA, Rahman A, Miah MG, Hoque MA, Rahman MM. Productivity and profitability of jackfruit-eggplant agroforestry system in the terrace ecosystem of Bangladesh. Turkish Journal of Agriculture-Food Science and Technology. 2018;6(2):124-9.
Available:https://doi.org/10.24925/turjaf.v6i2.124-129.1330
20. Bikash D, Ranvir S, Kumar S. Fruit based agro-forestry system for uplands. Horticulture and AgroForestry Research Programme. ICAR Research Complex for Eastern Region Ranchi, Jharkhand, India. 2008;341-345.
21. Hellin J, William LA, Cherrett I. The Quezungual system: an indigenous agroforestry system from western Honduras. Agroforestry Systems. 1999;46(3):229-237.
Available:https://doi.org/10.1023/A:1006217201200
22. Miah MG, Islam MM, Rahman MA, Ahamed T, Islam MR, Jose S. Transformation of jackfruit (*Artocarpus heterophyllus* Lam.) orchard into multistory agroforestry increases system productivity. Agrofor Syst. 2018;92(6):1687-1697.
Available:https://doi.org/10.1007/s10457-017-0118-1
23. Das DK, Chaturvedi OP, Jha RK, Kumar R. Yield, soil health and economics of aonla (*Emblica officinalis* Gaertn.)-based agri-horticultural systems in eastern India. Curr Sci. 2011;786-790.
24. Hossain J, Ahmed T, Hasnat MZ, Karim D. Screening of tomato varieties for fruit tree based agroforestry system. Int J Agril Res, Inn Technol. 2014;4(2):61-69.
Available:https://doi.org/10.3329/ijarit.v4i2.22652

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/70481