Sack Cultivation of Indigenous Shak: Prospects in Waterlogged Southwest Bangladesh

Abstract

A study on the Prospect and profitability of Indigenous Vegetables (Kalmi, Helencha, and Malancha Shak) was conducted in Shyamnagar Upazila of Satkhira district in waterlogged conditions from September 2020 to May 2021. T0= Control (No Urea and Vermicompost), T1= Urea (%): Vermicompost (%), 50:50, T2= Urea (%): Vermicompost (%), 75:25, T3= Urea (%): Vermicompost (%), 25:75, T4= 100% Urea, and T5= 100% Vermicompost were the six treatments used in the Completely Randomized Design (CRD) experiment. The treatments and various native marshland leafy greens differed significantly from one another. The vegetables in T2 (Urea (%): Vermicompost (%), 75:25) had the highest yield, gross and net income, and BCR, whereas the control had the lowest of all. When comparing the yields of various vegetables, Helencha Shak had the highest yield, gross and net income, and BCR, whereas Kalmi Shak had the lowest.

Introduction

Vegetables are considered as one of the most important food crops due to their high nutritive value, relatively higher yield and higher return. In addition to its nutritional value, it lowers poverty in developing nations like Bangladesh by creating jobs, raising incomes, and creating jobs (Mitra & Yonus, 2018). In Bangladesh, the last forty years have seen an enormous increase in the production of vegetables. Because Bangladesh (BD) is a large low-lying country, it is thought to be the most climate vulnerable nation in the world (Karim & Mimura 2008; The Asian Development Bank 2010; The World Bank 2011; USAID 2018). It is anticipated that Bangladesh will experience severe climate change effects, which could result in significant economic losses (Mirza 2003).

Approximately 8,000 hectares of flooded land in the district regions of Khulna and Jessore, Bangladesh. There are a number of reasons for the growing flood zones on the South West coast, including siltation of rivers, insufficient dredging and the occurrence of extreme weather (Formal Situation Report, 2020). Waterlogging currently affects about 5% of Bangladesh's entire land area (Rahman et al 2009). The Bangladesh Department of Forestry predicts that by 2100, it would rise to 14%. (Bangladesh Department of Forest, 2016).

Water-logging issues have plagued three coastal areas of South West Bangladesh (SWB) since the early 1980s. Tens of thousands of hectares may be affected, which would be disastrous for livelihoods and general well-being. During the final months of 2013, upazilas from Jessore, Satkhira, and Khulna were impacted by the most recent incident. The extent of the harm may be very serious. For example, during the Satkhira case in 2011, almost 27,000 dwellings were destroyed and another 43,000 houses were partially damaged (Ahmed and Alam, 1998). In order to prevent and mitigate water logging in the area, it is necessary to investigate the best adaptation methods (BARC, 1991).

Sack farming makes it possible for people to cultivate food in areas that are waterlogged, have little water, and little access to excellent soil. In areas where access to arable land and water is limited, people can grow food thanks to the sacks. Sack gardens' portability, compact size, affordability, effectiveness, productivity, and contributions to food security are their key features. A high-productivity soil mixture is placed inside of previously used feed and fertilizer sacks. On top of the bags or in holes carved into the sidewalls, vegetables are cultivated. By halting agricultural output 60–90 cm above the earth, this innovative method is incredibly efficient in assisting families in adapting to saline intrusion and waterlogging (Angrish and Datta, 2006).

So gardening in sacks solves the problems of wet land, scarcity of space, and lack of arable land. Sack cultivation is a useful technique for optimizing vegetable production on small plots of land. Thus, as an alternate method of vegetable gardening in this area, emphasis is currently placed on growing vegetables in Sacks under wet conditions. The goal of the current study is to evaluate the productivity and financial viability of locally grown vegetables grown in Southwest Bangladesh in waterlogged conditions.

Material and Methods

The field experiments were conducted in the waterlogged condition in Khulna University campus Khulna district and Shyamnagar Upazila of Satkhira district during the period from September 2020 to June 2021. The following experiments were conducted in Sack under waterlogged condition in the south-west Bangladesh. The experiments were laid out in a Completely Randomized Design (CRD) with five replications The three indigenous vegetables were used panting materials of which were collected from different areas of south-west Bangladesh.

Factor A: Three indigenous vegetables

1. Helencha (*Enhydra fluctuans*)
2. Malancha (*Jussiaea repens*)
3. Kalmi sak (*Ipomoea aquatica*)

Factor B: 6 levels of Manures and Fertilizers:

1. T0=Control (No manure and Fertilizer)
2. T1= Urea (%): Vermicompost (%); 50:50
3. T2= Urea (%): Vermicompost (%); 75:25
4. T3=Urea (%): Vermicompost (%); 25:75
5. T4 = 100% Urea
6. T5= 100% Vermicompost

No. of sacks: 6×3 ×5 = 90

Seedlings/cuttings of the vegetables were produced and 30 days old seedlings/cuttings were transplanted to the respective sacks containing different levels of Manures and Fertilizers. The recommended levels of fertilizers were mixed with the soil. The sacks were then placed in the submerged/waterlogged condition. All the intercultural operation was done following standard cultivation methods of the crops. The side of the Sacks was 90 cm × 60 com (sacks).

Old gunny bags were cut into pieces of 90 cm height keeping both ends open like cylindrical hollow columns. These bag pieces were then soaked in systemic insecticide and fungicide solutions to increase their longevity in waterlogged fields. These hollow open-end cylindrical mesh bags were fixed vertically on fertilized puddled soil and were kept stretched around its periphery by inserting 3-4 tough dry bamboo sticks (90 cm length) and few strong bamboo pegs along its inner walls, which was acted as pillars. The bamboo sticks and bamboo pegs were inserted 15 cm in soil for the firmness of the column. After this, Vermicompost and fertilized puddled soils were filled alternately in four layers of equal depth in the bag columns for healthy establishment of vegetable seedlings/cuttings in this soil column. Gunny bag-reinforced soil columns were tied with pillars using jute threads/plastic rope outwardly in circular fashion. The soil columns were left as such for fifteen days for drainage of excess water from the soil column.

After that, vegetable seedlings/cuttings were transplanted on top of the columns properly hoed by Nirani up to 10 cm depth. Seedling was sprayed repeatedly with fungicides and systemic insecticides as and when necessary to prevent pest and disease attacks (Ghorai et al., 2013; 2014 and 2016). Data was collected on yield, and profitability (Cost of production, Gross Return, net return and Benefit cost ratio).

Data analysis:

Data on different parameters was analyzed through Analysis of variance using computer software Statistix-10. Duncan's New Multiple Range Test (DMRT) was performed to determine the significant difference among the means within the parameters.

Results

The findings of the experiments in which 3 marshy land indigenous vegetables were cultivated to determine their prospect and profitability.

1. Helencha (*Enhydra fluctuans*)

Yield per sack

There was a considerable variation in the average yield of Helencha Shak depending on the amount of manure and fertilizer combination applied per bag (Table 1). T2 produced the best yield per sack (13.97 kg/sack) when Urea (%): Vermicompost (%), 75: 25 was used. T1 produced the second-highest yield per bag (12.83 kg/sack), using Urea (%): Vermicompost (%), 50: 50. The control (T0), which used vermicompost and no urea, had the lowest yield (7.87 kg/sack). Higher urea levels and vermicompost gave the crop an increased source of nutrients. Thus, there was a larger yield.

Cost of production per sack

Depending on the amount of manure and fertilizer combination used per sack, the average cost of production for Helencha Shak varied greatly (Table 1). The highest cost of production per sack (408.67 BDT/sack) was found in T2, where the recommended dose of urea (%): Vermicompost (%) was used 75:25 times. This was statistically similar to T1's (390.67 BDT/sack), where the recommended dose of urea (%): Vermicompost (%) was used 50:50 times. T3's (309.33 BDT/sack) recommended dose was used 25:75 times. The control (T0) had the lowest production cost (189.67 BDT/sack), when vermicompost was used instead of urea. In the higher urea and vermicompost concentrations utilized in the aforementioned treatments. Thus, the price went up.

Table 1. Yield and profitability of Helencha Shak as affected by integrated application of manure and fertilizer

Treatment	Yield sack^{-1} (kg)	Cost sack^{-1} (BDT)	Gross income sack^{-1}(BDT)	Net Income sack^{-1}(BDT)	BCR sack^{-1}
T_0	7.87e	189.67d	314.67e	122.40	1.32b
T_1	12.83ab	390.67a	513.07ab	12500	1.37ab
T_2	13.97a	408.67a	558.93a	150.27	1.65a
T_3	11.27bc	309.33b	450.67bc	141.33	1.46ab

T_4	10.60cd	262.67c	424.00c	161.33	1.61ab
T_5	9.29de	232.67c	371.73de	139.07	1.65ab
LS	**	**	**	NS	*
LSD	1.96	30.16	78.26	-	0.33

Note: T_0= Control (No Urea and Vermicompost), T_1 = Urea (%): Vermicompost (%), 50: 50, T_2 = Urea (%): Vermicompost (%), 75: 25, T_3 = Urea (%): Vermicompost (%), 25: 75, T_4 = 100% Urea, and T_5 =100% Vermicompost. LS= Level of Significance, LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letter differ significantly. **= Significant at 1% levels. NS= Not significant

Gross income per sack

Table1 shows that the average gross income of Helencha Shak changed dramatically according on the amount of manure and fertilizer combination utilized per bag. With Urea (%): Vermicompost (%), 75: 25 of the recommended dose used, T2 had the highest gross income per sack (558.93 BDT/sack). This was statistically similar to T1 (513.07 BDT/sack), where Urea (%): Vermicompost (%), 50: 50 of the recommended dose was used, and T3 (450.67 BDT/sack), where Urea (%): (%), 25: 75 of the recommended dose was used. The control (T0) had the lowest gross income (314.67 BDT/sack), since vermicompost (VC) was not used and no urea was added. Higher urea and vermicompost amounts were utilized in the T1 and T2. As a result, both the yield and gross income rose.

Net income per sack

Among the levels of manure and fertilizer combination utilized per sack, Helencha Shak's average net revenue did not significantly differ (Table 1). Numerically, however, the highest net in comeper bag (150.27 BDT/sack) was discovered in T2, where 75:25 of the prescribed dose of urea and vermicompost were employed. The lowest net income (122.40 BDT/sack) was noted in the control (T0), where neither urea nor vermicompost were utilized.

Benefit cost ratio per sack

Among the amounts of manure and fertilizer mixture utilized per bag, the average benefit cost ratio of Helencha Shak was considerable (Table 1). With Urea (%): Vermicompost (%), 75: 25 of the recommended doses used, T2 had the highest benefit cost ratio per sack (1.65), which was statistically similar to T1 (1.37), T3 (1.46), T4 (1.61), and T5 (1.65). The control (T0) had the lowest benefit cost ratio (1.32), with no urea and Vermicompost used.

2. Malancha Shak (*Jussiaea repens*)

Yield per sack

Table 2 shows that the amount of manure and fertilizer mixture utilized per sack had a substantial impact on the average yield of Malancha Shakwas.The application of Urea (%): Vermicompost (%), 75: 25 in T2 produced the maximum yield per sack and hectare (14.22 kg), while T1 (12.47 kg) produced the highest yield when Urea (%): Vermicompost (%), 50: 50 was utilized. The control (T0), which received no urea and vermicompost, produced the lowest yield (5.85 kg/sack). Vermicompost gave the plants a greater supply of nutrients due to the elevated urea levels. The yield was therefore higher.

Cost of production per sack

Table 2 shows that the average cost of producing Malancha Shak was varied greatly depending on the amount of manure and fertilizer combination utilized per sack. The highest cost of production per sack (408.67 BDT/sack) was found in T2, where the recommended dose of urea (%): VC (%) was used 75:25 times. This was statistically similar to T1 (390.67 BDT/sack), where the recommended dose of urea (%): Vermicompost (%) was used 50:50 times, and T3 (309.33 BDT/sack) where the recommended dose of urea (%): Vermicompost (%) was used 25:75 times. The control (T0) had the lowest production cost (189.67 BDT/sack), when vermicompost was used instead of urea. Vermicompost and increased urea levels were utilized in T2. So, the cost in this treatment was increased/higher.

Gross income per sack

There was a considerable variation in Malancha Shak's average gross income depending on the amount of manure and fertilizer combination utilized per bag (Table 2). The highest gross income per sack (568.67 BDT/sack) was found in T2, where the recommended dose of urea (%): vermicompost (%) was used 75:25 times. This was statistically similar to T1's (498.80 BDT/sack), where the recommended dose of urea (%): vermicompost (%) was used 50:50 times, and T3's (431.73 BDT/sack) recommended dose was used 25:75 times. The control (T0) had the lowest gross income (233.87 BDT/sack), as no urea was added and vermicompost (VC) was utilized. The crop received more nutrients from T2 due to the increased urea and vermicompost levels utilized in the treatment. Thus, there was a rise in gross revenue.

Table 2. Yield and profitability of Malancha Shak as affected by integrated application of manure and fertilizer

Treatment	Yield sack^{-1} (Kg)	Cost sack^{-1} (BDT)	Gross income sack^{-1} (BDT)	Net Income sack^{-1} (BDT)	BCR sack^{-1}
T$_0$	5.85d	189.67d	233.87d	44.20	1.25
T$_1$	12.47ab	390.67a	498.80ab	108.13	1.28
T$_2$	14.22a	408.67a	568.67a	160.00	1.39
T$_3$	10.79abc	309.33b	431.73abc	122.40	1.39
T$_4$	9.27bcd	262.67c	370.67bcd	108.00	1.41
T$_5$	6.82cd	232.67c	272.93cd	40.27	1.17
LS	**	**	**	NS	NS
LSD	4.27	30.16	170.89	-	-

Note: T$_0$= Control (No Urea and Vermicompost), T$_1$ = Urea (%): Vermicompost (%), 50: 50, T$_2$ = Urea (%): Vermicompost (%), 75: 25, T$_3$ = Urea (%): Vermicompost (%), 25: 75, T$_4$ = 100% Urea, and T$_5$ =100% Vermicompost. LS= Level of Significance, LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letter differ significantly. **= Significant at 1% levels. NS= Not significant

Net income per sack

Among the levels of manure and fertilizer combination utilized per bag, Malancha Shak's average net revenue did not significantly differ (Table 2). Nevertheless, T2 had the highest net revenue per sack (numerically speaking) at 160.00 BTK/sack, where 5(%): Vermicompost (%), 75: 25 of the prescribed dose was used. The control (T0) had the lowest net income at 44.20 BDT/sack, where neither urea nor Vermicompost (VC) were utilized.

Benefit cost ratio per sack

Among the quantities of manure and fertilizer mixture utilized per bag, the average benefit cost ratio of Malancha Shak was not statistically significant (Table 2). On the other hand, T2 had the highest benefit cost ratio per sack (1.39) numerically, with Urea (%): Vermicompost (%), 75: 25 of the recommended doses utilized, while T0 had the lowest benefit cost ratio (1.17), with no urea and Vermicompost used.

3. Kalmi Shak (*Ipomoea aquatica*)

Yield per sack

Table 3 shows that there were substantial differences in the average yield of Kalmi Shak (Ipomoea aquatica) depending on the amount of manure and fertilizer combination used per bag. T2 produced the best yield per sack (11.18 kg) with a Urea (%): Vermicompost (%), 75: 25 ratios. T1 produced the second-highest yield (9.93 kg) with a Urea (%): Vermicompost (%), 50: 50 ratios. The control (T0) group, which did not employ vermicompost or urea, had the lowest yield (4.74 kg). The crop received a greater supply of nutrients due to the elevated amounts of urea and vermicompost. Thus, there was a larger yield.

Cost of production per sack

The levels of manure and fertilizer combination utilized per sack resulted in significantly different average production costs for Kalmi Shak (Table 3). The highest cost of production per sack (408.67 BDT/sack) was found in T2, where the recommended dose of urea (%): Vermicompost (%) was used 75:25 times. This was statistically similar to the dose used in T1 (390.67 BDT/sack), where the recommended dose was 50:50 times. T3 (309.33 BDT/sack) had the highest cost of production per sack when the recommended dose was 25:75 times. The control (T0) had the lowest production cost (189.67 BDT/sack), when vermicompost was used instead of urea. The T2 used vermicompost and urea at higher amounts. Thus, the price went up.

Gross income per sack

Between the levels of manure and fertilizer combination utilized per sack, Kalmi Shak's average gross income fluctuated dramatically (Table 3). The highest gross income per sack (559.17 BDT/sack) was observed in T2, where the recommended dose of urea (%): vermicompost (%) was used 75:25 times. This was followed by T1 (496.67 BDT/sack), where the recommended dose of urea (%): vermicompost (%) was used 50:50 times, and T3 (391.67 BDT/sack), where the recommended dose of urea (%): (%) was used 25:75 times. The control (T0) had the lowest gross income (237.17 BDT/sack), since vermicompost and no urea were applied. In the treatments that employed vermicompost and greater concentrations of urea. There was a rise in those treatments' yield in addition to their gross and net income.

Table 3. Yield and profitability of Kalmi Shak as affected by integrated application of manure and fertilizer

Treatment	Yield Sack^{-1} (Kg)	Cost sack^{-1} (BDT)	Gross income sack^{-1} (BDT)	Net Income sack^{-1} (BDT)	BCR sack^{-1}
T_0	4.74e	189.67d	237.17e	47.50d	1.25b
T_1	9.93b	390.67a	496.67b	106.00b	1.27b
T_2	11.18a	408.67a	559.17a	150.50a	1.37a
T_3	7.83c	309.33b	391.67b	82.33bc	1.27b
T_4	6.65d	262.67c	332.67d	70.00cd	1.27b
T_5	5.92d	232.67c	296.17d	63.50cd	1.27b
LS	**	**	**	**	*

LSD	0.73	30.16	36.60	24.75	0.09

Note: T_0= Control (No Urea and Vermicompost), T_1 = Urea (%): Vermicompost (%), 50: 50, T_2 = Urea (%): Vermicompost (%), 75: 25, T_3 = Urea (%): Vermicompost (%), 25: 75, T_4 = 100% Urea, and T_5 =100% Vermicompost. LS= Level of Significance, LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letter differ significantly. **= Significant at 1% levels. *= Significant at 5% level.

Net income per sack

Among the quantities of manure and fertilizer mixture utilized per bag, Kalmi Shak's average net revenue was shown to be significant (Table 3). The study revealed that T2 had the highest net income per sack (150.50 BDT/sack) when Urea (%): Vermicompost (%), 75: 25 of the recommended doses was used. T1 followed closely behind with 106.00 BDT/sack when Urea (%): Vermicompost (%), 50: 50 of the recommended doses was used. The control group (T0) showed the lowest net income (47.50 BDT/sack), when neither urea nor Vermicompost were used. In the treatments that employed vermicompost and greater concentrations of urea. There was a rise in those treatments' yield in addition to their gross and net income.

Benefit cost ratio per sack

When considering the amounts of manure and fertilizer combination utilized per bag, the average benefit cost ratio of Kalmi Shak was noteworthy (Table 3). However, T2, where urea (%): vermicompost (%), 75: 25 of the required dose was used, had the numerically highest benefit cost ratio per sack and hectare (1.37), whereas the control (T0) and other treatments showed the lowest benefit cost ratio (1.27).

Comparative average yield and profitability of different Vegetable crops

Yield per sack

Table 4 shows a considerable variation in the comparative average yield of the vegetable crops employed in the experiment. The Helencha Shak had the best yield per sack (11.14 kilogram), followed by the Malancha Shak (10.97 kg/sack). Kalmi Shak had the lowest yield, weighing 5.67 kg per bag. Helencha Shak yielded more because she produced more larger-sized branches and leaves, which added to the overall weight.

Cost of Production per sack

The cost of production was not varied among the vegetables. In all the vegetable crops the average cost was same, which was BDT 298.95/sack.

Gross income per sack

There was significant variation among vegetable crops in respect of gross income of per sack (Table 4). The highest gross income per sack (438.85 BDT/sack) was observed in Helencha Shak followed by Malancha Shak (396.11 BDT/sack). The lowest gross income (385.59 BDT/sack) was recorded from Kalmi Shak. The average sale price of all the vegetables crops was the same. So, due to higher yield in Helencha Shak gave the higher gross income.

Net income per sack

Regarding net income per sack, there was a considerable difference between the vegetable crops (Table 4). Helencha Shak had the highest net income (139.90 BDT/sack), followed by Malancha Shak (97.17 BDT/sack). The Kalmi Shak had the lowest net income (86.64 BDT/sack). Every vegetable harvest had the same average retail price. Thus, the increased yield in Helencha Shak and Malancha Shak resulted in higher net and gross income.

Table 4. Comparative yield and profitability of the three indigenous vegetables as affected by integrated application of manure and fertilizer

Vegetables	Yield sack^{-1} (Kg)	Average Cost sack^{-1} (BDT)	Gross income sack^{-1} (BDT)	Net Income sack^{-1} (BDT)	BCR sack^{-1}
Helencha Shak	11.31a	298.95	438.85a	139.8a	1.51a
Malancha Shak	9.90b	298.95	396.11b	97.17b	1.32b
Kalmi Shak	7.71c	298.95	385.59b	86.64b	1.28b
LS	**	NS	**	**	**
LSD	0.99	-	39.94	39.94	0.16

Data in a column with same letter do not differ significantly and data with different letter differ significantly. LS= Level of Significance, NS= Not significant. **= Significant at 1% level.

Benefit Cost Ratio (BCR) per sack

Among the vegetable crops, there were notable differences in the benefit-cost ratio (Table 4). Helencha Shak has the greatest benefit cost ratio per sack (1.51), followed by Malancha Shak (1.32) and Kalmi Shak (1.28).

Discussions

Various factors, including species, cultivar, agronomic factors and climatic factors influenced the growth and yield (Khan et al.,2022: Naafe et al., 2022 and Haque et al., 2022). The Helencha Shak had the best yield per sack followed by the Malancha and Kalmi Shak. Helencha Shak produced more larger-sized branches and leaves, which added to the overall weight.

Among the six treatments, the vegetables in T2 (Urea (%): Vermicompost (%), 75:25) had the highest yield, gross and net income, and BCR. Vermicompost improve the soil structure and increase the water retention capacity (Bhanwaria et al., 2022 and Rivier et al., 2022). It also facilitates aeration of the soil. Vermicompost is the end product of a decomposition system in which many worms, decompose waste materials and produce vermicast (Domínguez et al., 2019 and Hu et al., 2021). As it contains water-soluble components, it is an excellent organic fertilizer and a nutrient-rich soil conditioner (Arutselvan and Nedunchezhiyan 2022).

On the other hand, T0= Control (No Urea and Vermicompost), T4 = 100% Urea, and T5 =100% Vermicompost had comparatively low yield. Nutrient levels and mineral balances are important management techniques to maximize crop yields and maintain high market quality (Mardanluo et al.. 2018). As the treatments, T$_2$ is the combination of urea and vermicompost results in higher fruit production. The utilization of vermicompost treatments, with their higher organic carbon, nitrogen, and phosphorus content, resulted in significantly greater vegetative yield compared to sole urea usage (Mahmoud et al., 2009). The use of vermicompost, which provides a consistent supply of plant nutrients throughout the growing season and at critical stages, in combination with urea contributes to higher fruit yield, improved nutrient uptake and increased plant vigor (Bhanwaria et al 2022, Rivier et al., 2022 and Olle, 2019) and increases magnesium, nitrogen and zinc uptake by raising the soil pH (Naiji et al., 2018, Ebrahimi et al., 2021, Zargar et al., 2020). so that the combination of urea and vermicompost leads to higher production.

Conclusion

The commercial cultivation of selected indigenous marshy vegetables in waterlogged condition are prospective and profitable. When Urea (%): Vermicompost (%), 75: 25 were employed, T2 showed the greatest values of all the metrics. Helencha Shak, Malancha Shak, and Kalmi Shak were the veggies that performed the best across all the parameters examined in the comparison examination of the three vegetables. The nation's rural population's malnutrition issue will be lessened if the output of green native vegetables rises and meets nutritional demands. Additionally, it will aid in improving the financial situation of the nation's marginal farmers

Recommendation

The experiments were limited to the Shyamnagar Upazila of Satkhira district and the campus of Khulna University. For a final recommendation, such tests might be carried out in the remaining regions of the nation.

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