PERFORMANCE ANALYSIS OF FLOATING SEEDBED USING DIFFERENT GROWTH PROMOTING FERTILIZERS

BIBEKANANDA SIKDER

DEPARTMENT OF AGROFORESTRY AND ENVIRONMENTAL SCIENCE
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207

DECEMBER, 2021

PERFORMANCE ANALYSIS OF FLOATING SEEDBED USING DIFFERENT GROWTH PROMOTING FERTILIZERS

BY

BIBEKANANDA SIKDER

REGISTRATION NO.1910307

A Thesis

Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka,

In partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE
IN
AGROFORESTRY AND ENVIRONMENTAL SCIENCE

SEMESTER: JULY-DECEMBER, 2021

Approved by:

……………………………
(Dr. Nazmun Naher)
Professor
(**Supervisor)**

…………………………..
(Dr. Md. Forhad Hossain)
Professor
(Co-Supervisor)

…………………………..
(**Dr. Nasrin Sultana)**
Chairman
Examination Committee

Department of Agroforestry and Environmental Science

Sher-e-Bangla Agricultural University

PABX: +88029144270-9
Fax: +88029112649
Web site: www.sau.edu.bd

CERTIFICATE

This is to certify that thesis entitled "**PERFORMANCE ANALYSIS OF FLOATING SEEDBED USING DIFFERENT GROWTH PROMOTING FERTILIZERS*"*** *submitted to the Department of Agroforestry And Environmental Science, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* **MASTER OF SCIENCE** *in* "**Agroforestry and Environmental Science**" *embodies the result of a piece of bona fide research work carried out by "**BIBEKANANDA SIKDER"** bearing Registration No.* ***1910307*** *under my supervision and guidance. No part of the thesis has been submitted for another degree or diploma elsewhere in the country or abroad.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: December, 2021

Place: Dhaka, Bangladesh

………………………………

(Prof. Dr. Nazmun Naher)
(Supervisor)

DEDICATED
TO MY
BELOVED
PARENTS
AND
RESPECTED
TEACHERS

ACKNOWLEDGEMENT

All the praises and gratitude are due to the omniscient, omnipresent, and omnipotent of almighty God, who has kindly enabled the author to complete his research work and complete this thesis successfully for increasing knowledge and wisdom. Guidance, help and co-operation have been received from several persons or authority during the tenure of the study, the author is grateful to them all who made a contribution to this research work.

In particular, the author really does not have adequate words to express his heartfelt sense of gratification, ever indebtedness and sincere appreciation to his benevolent teacher and research supervisor, **Prof. Dr. Nazmun Naher**, Department of Agroforestry and Environmental Science, Sher-e-Bangla Agricultural University, Dhaka-1207, for her constant help, scholastic guidance, planning experiment, valuable suggestions, timely and solitary instructive criticism for successful completion of the research work as well as preparation of this thesis. The author deems proud privilege to extend his extreme gratefulness and best regards to her venerable Co-supervisor, **Prof. Dr. Md. Forhad Hossain**, Department of Agroforestry and Environmental Science, Sher-e-Bangla Agricultural University, Dhaka-1207 for his keen interest, valuable advice, creative suggestions, co-operation and encouragement to bring this thesis up to its present standard.

It is also a great pleasure for the author to express his hearty appreciation to all teachers of Department of Agroforestry and Environmental Science, SAU, Dhaka-1207 for their suggestions during the research work. The author deeply acknowledges the profound dedication to his beloved Parents and Younger brother for their moral support, steadfast encouragement and continuous prayer in all phases of academic pursuit from the beginning to the completion of study successfully.

Finally, Last but not last the author is deeply indebted to his friends and well-wishers especially Shipan Sikder, Shaon Mondal, Milon Ray, Suvo Mondol, Bishal Halder, Shamim Hasan for their kind help, constant inspiration, co-operation and moral support which can never be forgotten.

Date: June, 2022

SAU, Dhaka — The Author

PERFORMANCE ANALYSIS OF FLOATING SEEDBED USING DIFFERENT GROWTH PROMOTING FERTILIZERS

ABSTRACT

Bangladesh is situated in low lying areas where a reasonable portion remains submerged for 6-9 months in year during and after monsoon which is increasing day by day due to climate change. Therefore this research was conducted to evaluate the floating seedbed output of okra and cucumber in prolonged period (6-9 months) of time at Nazirpur upazila. The experiment was conducted following a Randomized Complete Block Design (RCBD) involving three treatments with four replications viz. T_1: control (without organic and inorganic fertilizer), T_2: Organic fertilizer (cow dung) and T_3: recommended dose of inorganic fertilizers(NPK). In case of okra, the longest plant height (156.90 cm), maximum number of branches (5.50) and leaves (55.75) were found in the treatment T_3. Regarding yield parameters, significantly higher number of fruits plant^{-1}, fruit length (cm), fruit diameter (cm), individual fruit weight (g), fruits weight plant^{-1} (g) and yield (t·ha^{-1}) were 22.00, 16.38 cm, 6.48 cm, 21.67 g, 602.80 g, 12.12 t·ha^{-1} obtained respectively by applying the treatment T_3. The lowest output was recorded in control for all the cases. Similar trend of growth and yield were also observed during the cultivation of cucumber under the same treatment conditions. The highest value of BCR (1.07 and 1.63) was recorded from the treatment T_3 for both okra and cucumber respectively. So floating gardening is a sustainable farming method and income strategy for rural householders in coastal flood-prone regions of Bangladesh.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

LISTS OF ABBREVIATIONS

ABBREVIATION	FULL MEANING
ANEP	Agriculture and Nutrition Extension Project
APEIS	Asia-Pacific Environmental Innovation Strategies
BCCTF	**Bangladesh Climate Change Trust Fund**
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
DAE	Department of Agriculture Extension
FAO	Food and Agriculture Organization
GIAHS	Globally Important Agricultural Heritage System
GM	Gross Margin
GR	Gross Return
NR	Net Return
HYV	High Yielding Varieties
BCR	Benefit- Cost Ratio
IPCC	Intergovernmental Panel on Climate Change
TSP	Triple Super Phosphate

MOP	Muriate of Potash
NAPA	National Adaptation Program of Action
NGO	Non-Governmental Organization
PRA	Participatory Rural Appraisal
CV	Co-efficient of variation
d. f.	Degrees of freedom
DAT	Days After Transplanting
DMRT	Duncan's Multiple Range Test
e. g.	For example
%	Percent
@	At the rate
^{0}C	Degree centigrade
Agril.	Agricultural
Cm	Centimeter
et. al.	And others
g	Gram
J.	Journal
Int.	International

Sci.	Science
Tech.	Technology
Kg	Kilogram
LSD	Least Significance Difference
mg	Miligram
Hort.	Horticulture
Inst.	Institute
Appl.	Applied
Cons.	Conservation
SAU	Sher-e-Bangla Agricultural University

CHAPTER I

INTRODUCTION

Bangladesh is a land of rivers. Especially the rivers in the southern regions are playing a special role in agriculture due to their course. Today Bangladesh faces the multidimensional effects of climate change in the forms of flood, cyclone, sea level rising, drainage congestion, salinity in freshwater systems etc. Climate variability makes agriculture in Bangladesh highly vulnerable. It is inferred in the available literatures that crop production would be extremely vulnerable under climate change scenarios, and as a result, food security of the country will be at risk (Mahtab, 1989); (Warrik and Ahmed, 1996); (Huq *et al*., 1996); (Karim *et al*., 1998).

Bangladesh is well-known to be prone to the sea-level rise that is predicted to be associated with global warming. By 2080 there will be a rise of 38 cm and that up to 22 percent of world's coastal wetlands will be inundated as a result (Warrick *et al.,* 1996; Nicholls *et al.,* 1999). Scholars and institutions such as the Intergovernmental Panel on Climate Change are attempting to evaluate the socio-economic and ecological implications of such a rise in sea-level (Hoozemans and Hulsbergen, 1995) and it is clear that a portfolio of adaptive measures will be needed to cope with the situation. Some authors a reproofing large-scale migration (Nicholls and Mimura, 1998) and structural measures, which might not be feasible for a lower middle income country such as Bangladesh. Perhaps it is more realistic to propose that coastal populations might be best able to deal with sea-level rise if their vulnerability to economic shock is minimized.

Cultivable lands in coastal areas are often constrained by 7-8 months water stagnation. Even, when farm households manage to cultivate crops in their limited farm lands in low lying areas during monsoon, there is always risk for the crops to be submerged by floodwater. Even after flood, farmlands remain under water for a while due to poor drainage facilities and thus, farmers are unable to cultivate any crops on the submerged crop land. To overcome this adverse situation, local communities in southern Bangladesh are using their submerged lands for crop production by adopting 'Floating Garden' as alternative technology and growing different type of seedlings, vegetables, spices, etc. in floating bed as floating agricultural practices.

Bangladesh is situated in the lowest riparian region of the Ganges-Brahmaputra-Meghna River basins. In the wetlands of southern Bangladesh (parts of Gopalganj, Pirojpur and Barishal districts), local communities have had difficulties in securing farmlands to provide food and livelihoods during the monsoon season (from June to October). These vulnerable, marginalized communities are constrained by not having cropping space in terms of access to and/or ownership of land. In that season, these areas have been repeatedly affected by cyclones, heavy rainfall, flooding, salt damage caused by sea level rise and snow melting from the Himalayas, resulting in extremely low agricultural production. Floating beds can be prepared in places where water remains more than six months per year and an abundance of water hyacinth exist. Floating farms in costal districts of Barishal, Goplaganj and Pirojpur in the southern part of Bangladesh, most affected by floods, farmers don't have enough cropping space in terms of access to land, so people have learnt to make the most use of flood water. Floating bed cultivation could be one such measure in those area that avoid salt water intrusion because it offers new opportunities using indigenous knowledge and techniques that are well adapted to local environmental conditions (Chowdhury, 2004). In this context, a floating agricultural practice was developed to rear plants and crops in floating bed, made of water hyacinth, algae or other plant residues. The system is traditionally called “dhap” in Bangladesh and “kaing” in Burma, where a floating platform is made of decomposing heaps of water hyacinth, keeping the upper surface stuffed with mud or soil (Islam and Atkins, 2005). A scientific method similar to hydroponic or soilless agriculture practice was adopted. With the easily available, locally abundant materials, as water hyacinth (*Eichhornia crassipes*) and other aquatic weeds, local communities construct reasonably sized floating platforms or rafts on which vegetables and other crops can be cultivated. But lack of proper knowledge in building technique of floating bed, materials required for bed preparation, thickness of the bed, method of cultivation, dose of organic and inorganic fertilizers and method of application, intercultural operations done that impact on yield of floating bed vegetable production. The application of cow dung manure and vermincompost increases soil organic matter content, and this leads to improved water infiltration and water holding capacity as well as an increased cation exchange capacity. Use of organic manures is essential for proper growth and development of crops. In addition to being a good source of plant nutrients, organic manure improves texture, structure, humus, aeration, water holding capacity and microbial activity of growing media and soil and thus helps to increase the productivity. Organic manure contains all plant nutrients in a relatively small amount. On the other hand, inorganic fertilizers contain large amount of specific plant nutrient in a readily available form. Therefore, inorganic fertilizers in combination with organic manure may lead to better performance regarding growth and yield of the crops. So, it is necessary to find out an appropriate dose of organic and inorganic fertilizers to obtain economic yield from floating bed vegetables production.

Okra is rich in vitamins A and C, as well as antioxidants and anti-inflammatory. It stabilize blood sugar, prevent and improve constipation, helps to lubricate the large intestines due to its bulk laxative qualities. Its also used for healing ulcers and to keep joints limber, neutralize acids, treats lung inflammation, prevent diabetes, protects from pimples and maintain smooth and beautiful skin. Cucumber reduces chronic inflammation and also prevents constipation. Eating cucumber hydrates human scalp preventing hair loss due to dryness. It further makes the hair lustrous and healthy. The water content of cucumber can flush out all toxins from the body which also related to natural treatment for kidney stones. Cucumber helps to relief from migrane.

Considering the above facts, the present investigation was undertaken with the following objectives:

1. To determine the yield of vegetables grown on floating seedbed by using organic and inorganic fertilizers and

2. To evaluate the economic return of okra and cucumber grown in floating seedbed by using organic and inorganic fertilizers

CHAPTER II

REVIEW OF LITERATURE

Review of literature in any research is essential because it provides a scope for reviewing the stock of knowledge and information relevant to the proposed research.

2.1. Research Work on Floating Seedbed

Alam and Chowdhury (2018) reported that Floating Vegetable Garden (FVG) is a unique hydroponics production system constructed with aquatic weeds, (especially water hyacinth- *Eichhornia crassipe*), which have been developed in the flood-prone areas of Bangladesh, especially suitable for the poor and smallholder farmers. Effective adaptation actions and knowledge transfer would provide farmers with added resilience and coping ability in circumstances of a changed climate system. This floating technique is helpful to grow vegetables and other horticultural crops almost year-round, providing numerous, economic, social, ecological, and agricultural benefits to the local population. Results revealed that some 63 percent of the respondents use their own premises to cultivate FVG and about 80 percent of the floating beds can sustain 4-6 months during monsoon in the study area. Some 74 percent respondents reported that the construction of a floating bed is quite reasonable (BD Taka 700-800/-. About 85 percent of sample respondents reported that they can make BDT 1600-2000/- as profit from each floating bed under use.

Pyka *et al.* (2020) showed that floating gardening is a sustainable farming method and income strategy for rural households in coastal flood-prone regions of Bangladesh and contribute to food security by nutrient intake growing vegetables. Coastal people of Bangladesh have practiced this farming method to grow vegetables and seedlings on floating beds and thereby secure food production and farmers income with adverse climatic shocks. Areas that cannot be cultivated are made usable, and the achievable income ensures the security and variety of food in the season of the floating gardens.

Mandal *et al.* (2013) conducted a research to evaluate the effect of thickness of floating beds on the growth and yield of okra, Indian spinach, cucumber and red amaranth, from 2013 to 2014, at Gopalganj district in Bangladesh. The thickness of the floating bed was reduced each month due to a gradual decomposition of water hyacinth, and as the rotten material fell into the water and soil. The rate at which the floating bed became thinner accelerated through time. For all the vegetables results was found in response to the 2.5 m thick bed which was significantly similar to the 2.0 m thick bed in both growing seasons.

Bala (2018) conducted a study on floating garden and found that the average cost of floating garden's crops production were different in the different categories (marginal farmer, small farmer and medium farmer) farmer. For the marginal farmer, per acre total cost and variable cost were found Tk. 208,490 and Tk. 93,990 respectively. For the small farmer, per acre total cost and variable cost were found Tk. 219,900 and Tk. 111,400 respectively. For the medium farmer, per acre total cost and variable cost were found Tk.225, 950 and Tk. 125,450 respectively.

Shahidul (2018) conducted a study on disaster prone area of Banaripara upazila Barisal, Bangladesh to find out the existing agricultural production system and how climate change is affecting agricultural cropping pattern. According to the resource map, there have very small amount of forest cover and forest reserve areas in the study areas. The stratification of the surveyed villages indicated that there were three wealth groups in both villages. On the context of the status of the three wealthy groups, it implies that vulnerabilities and adaptive capacities among groups vary accordingly in the two villages studied. From the field survey, it was clear that that the local responses on climate changes were more significant on their perceptions. It has been reported that the area becomes extremely hot during the day but during the night it remains very cold. This study also showed variation on rainfall patterns in different seasons. The average minimum temperature is decreasing but the average maximum temperature is increasing. The Rabi crops are less vulnerable to change rainfall rate in winter as the production rate of potato, vegetables and banana are increasing trends or constant. In Kharif season, paddy, mustard and wheat production varied with the rise and fall of rainfall intensity. In Kharif-II season, transplanted aman production showed the constant trends of production but the vegetables production fluctuated with the fluctuation of rainfall and temperature.

Mohsin and Tarana (2019) was carried on a study is to find out the role of floating cultivation on livelihood practice of coastal people in Barishal district of Bangladesh. They found that most of the surveyed farmers (60 percent) of the area learnt the floating cultivation technique as an indigenous practice. Half of the surveyed farmers opined that the land in the area remains submerged for 5-7 months a year. About one-third of the sampled farmers produce rice, while another one-third keep the land fallow when the water is drained out. The main reason for being engaged in floating cultivation, as identified by the farmers is that floating cultivation provides income during disaster when all other livelihood options are mostly unavailable. The cost incurred in a season is about BDT 1000 for10floating beds whereas the corresponding income is about BDT 2000 per month from 10 floating beds.

Roy *et al.* (2011) carried out an investigation on the present situation on floating bed agriculture system on Kotalipara upazila under Gopalganj district. The findings of the study revealed that three-fourth (74%) of the farmers had medium to high knowledge on floating agriculture system. Benefits derived from the production of Turmeric on the floating bed as single cropping is higher (6550TK) than the plain land. Profit from cultivation of Ladies finger with Bottle gourd as intercropping on the floating bed is higher (2120TK) is higher than the plain land. It is also found that profits become double when production is done early or late.

Kabir *et al.* (2020) conducted a study to reveal various seedling production scenario on floating beds including environmental aspects associating seedling production at Nazirpur upazila in Pirojpur district of Bangladesh. The study showed that 68% farmers did seedling production for business purpose, and 30% as both own and business. During floating cultivation on beds about 50% farmers used their own producing seed and 26% from market. The farmers cultivated 21 different types of vegetables and spices seedlings where highest number of seedling was Bottle gourd (19.11%) followed by Papaya (13.82%) and Chili (12.60%). They used urea as a common fertilizer on floating bed which enriched by TSP (46%) and DAP (40%) during cultivation.

Ghosh *et al.* (2017) found that at Banaripara and Wazirpur upazila of Barisal District the farmers of the study area had moderately to less a favorable opinion (83%) towards floating agriculture as a means of cleaner production. Their findings suggested that it is important to explore knowledge and arrange training for the farmers on floating bed preparation, selecting suitable crops, the intercultural operation of crops and so on.

Islam and Atkins (2007) showed that floating-bed cultivation has proved a successful means to produce agricultural crops in various wetland areas of the world. In freshwater lakes and wetlands, vegetables, flowers, and seedlings are grown in

Bangladesh using this floating cultivation technique, without any additional irrigation or chemical fertilizer.

Irfanullah *et al.* (2009) showed that floating gardening is a form of hydroponics or soilless culture. It is an age-old practice of crop cultivation in the floodplains of southern Bangladesh, where aquatic plants such as water hyacinth (*Eichhornia crassipes*) are used to construct floating platforms on which seedlings are raised and vegetables and other crops cultivated in the rainy season. The platform residue is used in the preparation of beds for winter vegetable gardening. The input–output analysis revealed floating gardening to be a feasible alternative livelihood option for the wetland dwellers. The method provided targeted landless people with parcels of land in the monsoon, enabling them to grow vegetables. Floating gardening and associated winter gardening appear to have the potential for introduction to other parts of the world where aquatic weed management is a major problem.

Haq *et al.* (2004) characterized that the procedure of floating agriculture can even contribute to the maintenance of healthy wetlands.

Rahman and Alam (2003) reported that floating agriculture is an environmentally-friendly option for increasing land availability for agriculture. Since people are increasingly confronting adverse effects of climate change, it is simply a matter of changes in weather patterns that ultimately determines crop survival; too little water or too much can damage crops, and people could be left with not enough food to live, along with higher risks in food safety and security.

Dasgupta *et al.* (2016) concluded geographically, Bangladesh is a climate-induced vulnerable country. In southern regions, as well as southwestern coastal areas and the Haor region of Bangladesh, the land is submerged under flood water for 7-8 months.

This usually restricts the use of land for cultivation. The condition becomes very acute if flood is more and if it is persistent than usually expected (as in the floods of 1988, 1998 and 2007).

Kreft *et al.* (2016) stated that the global climate risk index for the period 2000-2019 is based on average values over a twenty year period. The long term climate risk index (CRI) the 10 countries which are most affected from the last two decades, Bangladesh ranked 7th among those ten. The responsible means are impacts of weather-related events like storms, floods, and heat waves.

Haque *et al.* (2019) said Bangladesh a low-lying South Asian country is highly susceptible to the adverse impact of global climate change particularly to sea level rise (SLR) due to its unique geographical settings and poor socio-economic condition of the vulnerable people. Scientific projections showed that projected SLR ranged from 0.53-0.97m in 37 coastal stations for the year of 2100, where the predicted global SLR is 0.09-0.88m.

2.2. Floating Adaptation Technology

Hossain (2014) said that the southern, southwestern and the coastal areas of Bangladesh remain submerged for long periods every year, especially during the monsoon season. People in these areas have been coping with submerged/flooded conditions for generations. The people of these areas depend on agriculture. They have adopted a method of cultivation, locally referred to as "Vasoman Chash," meaning floating agriculture, since the time of their forefather's. This system is similar to hydroponics, which is a scientific method whereby the plants are grown in the water and they derive their nutrients from the water instead of from the soil. The production rate is high from this kind of agricultural practice. Floating agriculture is a possible local knowledge based technology which would help in attaining sustainable livelihood security in the vulnerable areas like waterlogged areas in Bangladesh.

Saha (2010) stated that due to multidimensional manifestations of climate change, along with different social and economic problems, Bangladesh is facing many challenges in achieving sustainable development. Since some parts of Bangladesh remain flooded for a prolonged period of the year, agriculture is the hardest hit and this in turn has a serious impact upon the lives of the farming population, which also leads to the loss of farming hands who have been the mainstay of a largely agricultural economy. In this scenario, alternative farming practices like hydroponics agriculture hold great promise. Farmers can use their submerged lands for crop production by adopting scientific methods like hydroponic agricultural practice, or floating agriculture, where plants can be grown on the water in a bio-land or floating bed of water-hyacinth, algae and other plant residues.

Alam and Chowdhury (2018) cited that many communities have already developed indigenous floating cultivation methods as an adaptive strategy to reduce their vulnerability due to possible climate change. Floating Vegetable Gardening (FVG)- an age-old indigenous farming practice in Bangladesh, can play a vital role in this regard, particularly in the waterlogged areas. Basically, FVG is a unique hydroponics production system constructed with aquatic weeds, (especially water hyacinth- *Eichhornia crassipe*), which have been developed in the flood-prone areas

of Bangladesh, especially suitable for the poor and smallholder farmers.

Hossain (2020) said that floating bed vegetable cultivation is now extended to wetland areas and long term water logging areas from southern parts of Bangladesh. Vegetables and other horticultural crops are now being cultivated in this method and getting popularity day by day. This method of cultivation is now providing numerous socio-economic, ecological and agricultural benefits towards climate change to local people.

Awal (2014) conducted a research work on riverbed siltation along with back water effect due to sea-level rise and high tide is leading to prolonged water-logging in south-west Bangladesh in recent two to three decades. Gradual siltation is the main source of the problem on the riverbed triggered by inadequate runoffs in the southern reaches caused by the polders constructed under the Coastal Embankment Project (CEP) during the sixties. For removing water logging effect, plinth rising and elevating the local habitats and physical infrastructures can be considered as an immediate and short-term measure whereas operation of Tidal River Management (TRM) technology might be considered for long-term or permanent solution for raising the low lands or beels. For continuing crop production local people are engaged in floating agriculture, crop production with Sorjan method, and fish cultivation in lowland to utilize the water-logged land around the southern region. They elevate and widen the surroundings of that waterlogged land utilized for vegetable and fruit production. Such local practices can properly be screened and piloted befitting to climate change adaptation to the water congestion areas of the country. The interventions may also be applicable to other agro-climatic regions or countries suffering from the similar problem.

Moniruzzaman *et al.* (2020) described that two third of the arable land is inundated in monsoon due to low lying of geographical position and adverse effect of climate. A part of these monsoon wetlands are used for floating cultivation by the local farmers for their livelihood which is commonly known as “Vasoman Chash”, a method of hydroponics. This century aged traditional agricultural method is being practiced in haor regions of Bangladesh. Matured water hyacinth is the most important component for making raft or bed for floating cultivation. Paddy straw, Son ghash (*Imperata cylindrica*), Noll ghash (*Hamerthria protensa*), Topapana (*Pista stratiotes*), ash twigs and desiccated coconut fibers are also used for making bed.

Shaibur *et al.* (2019) conducted a study to find out the adaptation strategies with water logging condition in Beel Kapalia region of Bangladesh. Supper cyclone SIDR (2007) and AILA (2009) were severely responsible for waterlogging condition. To ameliorate this problem, various types of coping strategies such as floating agriculture, mixed culture, hanging vegetable culture, shrimp culture were practiced.

Maruf (2020) stated that around a quarter part of Bangladesh is flooded for several months a year, affecting agriculture in particular - this has far-reaching consequences for the lives of the rural population. Especially during the monsoon season, many people in water-rich areas suffer from food shortages and nutrient deficiencies, mainly due to crop failures and lower incomes. Through the use of floating gardens, smallholder farmers can use flooded areas that would otherwise be unmanageable for months. The study shows floating gardening is a sustainable farming method and income strategy for rural households in coastal flood-prone regions (especially Barishal, Pirojpur and Gopalganj district) of Bangladesh. Floating gardens contribute to food security by nutrient intake growing vegetables. Areas that cannot be cultivated are made usable, and the achievable income ensures the security and variety of food in the season of the floating gardens.

Pantanella *et al.* (2010) cited that floating agriculture was an indigenous soilless system widely diffused in Meso-America and South East Asia. It was practiced for thousands of years before the advent of modern agriculture and allowed farmers to crop in flooded areas where no other land uses were possible. Plants grew on rafts made of composted water weeds, which were piled up on water bodies, by simply stripping nutrients released from decaying organic matter. In the vision of sustaining livelihoods and refining climate change strategies, floating agriculture can be adopted as a low-tech production system with almost no use of chemical fertilization. Floating rafts could improve productivity per unit of land and support water fertilization strategies in integrated agriculture aquaculture systems (IAAS), where leaching of nutrients in water improves pond primary production and sustains fish growth. Floating agriculture could also be adopted as bioremediation tool to reduce the impact of aquaculture effluents from nutrient-rich ponds.

Yellin (2013) showed floating gardens were an effective habitat solution in urban rivers. Results indicated a nearly 100% increase in the fish abundance in the river immediately surrounding the floating gardens when compared to traditional docks.

Pavel *et al.* (2014) conducted an economic evaluation of the floating garden as a means of adapting to climate change in Bangladesh. The study showed that the monthly income of some farmers using such gardens increased from US$12.02 to US$48.08. These folk farmers lacked alternative work especially during the monsoon period. The floating garden uses available natural resources, adjusts to wet conditions and helps the flood-prone people to earn a living, and can be an adaptive response to frequent disaster events in Bangladesh.

2.3. Climate Change

APEIS (2014) conduct a research work on floating agriculture is not a new practice in Bangladesh; it has traditional roots in practices dating back to the country's forbearers, although the scientific component is a recent addition. According to their needs, people in different parts of Bangladesh have adopted, modified and named this practice differently (Islam and Atkins, 2007; Irfanullah *et al.,* 2007), such as baira, boor, dhap, gathua, gatoni, geto, kandi and vasoman chash and floating agriculture; all these names are present this same traditional cultivation practice that can be scientifically referred to as hydroponics. Actually, this practice is most successful in the coastal areas that are adjacent to the sea bank areas, which remain submerged for long periods, especially in the monsoon season, as well as the wet land haor areas (flood at lowland spreading across the middle of the Meghna River basin) (Yoshini and Merabtene, 2007), which halsore main flooded for long periods. The practice helps mitigate land loss through flooding, by allowing cultivation of these areas to continue. In this way, the total cultivatable area can be increased and communities can become more self-sufficient. In addition to this, the area under floating cultivation is upto10 times more productive than traditionally farmed land (Haq *et al.,* 2004) and no additional chemical fertilizers or manure is required. When the crops have been harvested and floating rafts are no longer required, they can be used as organic fertilizers in the fields or incorporated into the following years floating beds as a fertilizer (AEPIS and RIPSO, 2004; Saha, 2010).The approach uses water hyacinth, a highly invasive weed with prolific growth rates, in a highly beneficial way. By harvesting water hyacinth, areas covered by the weed are cleared, with the beneficial side-effect of reducing breeding grounds for mosquitoes and improving conditions for open water fishing.

Hasan *et al.* (2018) stated that Climate-smart agriculture (CSA) is a suggested pathway to the improvement of food security in a changing climate. The Department of Agricultural Extension under the Bangladesh Ministry of Agriculture has been promoting CSA with farmers through climate field schools since 2010. This study investigated the impact of adoption of CSA practices on the household food security of coastal farmers in southern Bangladesh. Factors determining household food security were also explored. Data were collected from 118 randomly selected farmers of Kalapara sub-district in Patuakhali, Bangladesh. They identified 17 CSA practices that were adopted by the farmers in the study area. Those practices were saline-tolerant crop varieties, flood-tolerant crop varieties, drought-resistant crop varieties, early maturing rice, vegetables in a floating bed, 'sorjan' method of farming, pond-side vegetable cultivation, the cultivation of watermelon, sunflower or plum, relay cropping, urea deep placement, organic fertilizer, mulching, use of pheromone trap, rain water harvesting and seed storage in plastic bags or glass bottles. The farmers adopted on average seven out of these CSA practices. Increasing the adoption of CSA was important to enhance food security but not a sufficient condition since other characteristics of the farmers (personal education, pond size, cattle ownership and market difficulty) had large effects on food security. Nevertheless, increased adoption of saline-tolerant and flood-tolerant crop varieties, pond-side vegetable cultivation and rainwater harvesting for irrigation could further improve the food security of coastal farmers in southern Bangladesh.

BCCTF (2017) conducted a study titled, "Floating Gardens of Bangladesh: A Community Based Adaptation for Combating Climate Change". Impacted by our innovation the national government in Bangladesh has come forward to implement the technique, for example, the National Adaptation Program of Action of Bangladesh identified promotion of floating gardening as one of its 15 adaptation projects. The revised also recognized the potential of this traditional practice. But it was only in early 2013 that the Government of Bangladesh approved a US$ 1.6 million project under its to promote floating gardening for climate change adaptation. This 3-year project will be implemented by the Government's agricultural extension wing in 40sub-districts of 8 districts all over the country. Challenges lies in the areas identified for the project were poor and water logged ones, getting the people for the initial arrangements were quite difficult for us in the formative months. Once they realized the potential of the farming technique, the skepticism has evaporated. One of the important lessons learnt in this process is that, small ideas can have the potential to bring in remarkable change in the lives of poor.

Siaga *et al.* (2018) declared that Floating culture system (FCS) is the only feasible way for crop cultivation during high and prolonged flooding period at riparian wetlands. Three FCS treatments applied were: P1 , with gunny sack layer placed at interface between water surface and growing media; P2 , without gunny sack at the interface; and P3 , bottom part of growing media was immersed in water at 2-3 cm depth. These treatments were compared to P0 , conventionally cultivated chili pepper as control. Result of this study revealed that chili pepper cultivated using FCS (P1 , P2 , and P3) significantly outperformed those of conventionally cultivated (P0) as indicated by higher growth and yield. Among FCS treatments, P2 produced the highest marketable yield (248.9 g plant^{-1}).

2.4. Nutritional value of Okra and Cucumber

Mainly okra is rich in vitamins A and C, as well as antioxidants and anti-inflammatory. It stabilize blood sugar, prevent and improve constipation, helps to lubricate the large intestines due to its bulk laxative qualities. Its also used for healing ulcers and to keep joints limber, neutralize acids, treats lung inflammation, prevent diabetes, protects from pimples and maintain smooth and beautiful skin. Okra juice is used to treat sore throat associated with coughing. Decoction of okra leaves and fruits are used to treat urinary problems. Okra juice used to treat diarrhea with fever and related abdominal pains. Okra seeds are used to treat and prevent muscle spasms. Cucumbers contains 95% water to fights dehydration. Cucumber is considered a good source of nutritious fiber that helps one`s body function properly. The combination of fiber and water in cucumbers prevents constipation and can increase the regularity of bowel movements. Cucumber is known for its anti-cancer properties. It can reduce the spread of cancerous cells throughout the body and decrease the risk of cancer developing in your body. Cucumber reduces chronic inflammation and also prevents constipation. Eating cucumber hydrates human scalp preventing hair loss due to dryness. It further makes the hair lustrous and healthy. The water content of cucumber can flush out all toxins from the body which also related to natural treatment for kidney stones. Cucumber helps to relief from migrane. The magnesium in cucumber, helps to keep blood pressure in control, provides a boost to human immunological system. Cucumber contains flavonoids, tannins and other antioxidants, this helps to bring down the pain by controlling the number of free radicals released in the body. Finally cucumber fights against bad breath.

CHAPTER III

MATERIALS AND METHOD

The experiment was conducted to analyze the performance of floating seedbed in Nazirpur upazila. This chapter includes a brief description of the location of the experiment, materials used in the experiment, design of the experiment, treatments of the experiment, floating bed preparation, raising of seedlings, seedlings transplanted on floating bed, application of manure and inorganic fertilizers and other intercultural operations, data collection and data analysis procedure, cost return analysis which are presented below under the following headings-

3.1. Experimental Site

The experiment was conducted at Mugarjhor village in Matibhanga union of Nazirpur upazila under Pirojpur district, Bangladesh. The site is located between 22^0 48′ 32″ north latitude and 90^0 02′ 40″ east longitude. The experimental area is situated in the southern part of Bangladesh where water remains more than six months per year. A part of costal district, the area is mostly affected by floods.The farmers don’t have enough cropping space in terms of access to land, so people have learnt to make the most use of flood water.

3.2. Duration of the experiment

The experiment was carried out during summer season from May, 2020 to October, 2020.

3.3. Experimental material

Water hyacinth (*Eichhorniacrassipe*)is the main material required for floating bed preparation. Along with Dulalilata*(Hygroryzaaristata)* andTepapana*(Pistiastratiotes)* also required. Okra (*Abelmoschusesculentus* L.) and cucumber (*Cucumissativus* L.) seeds were used as planting materials in this study. The floating bed (dhap) was prepared with desired thickness, width and length. The size of each unit floating bed (dhap) was 2.5 m height (water hyacinth thickness) × 5 m length × 1 m width.

3.4. Treatments of the experiment

Three different treatments along with four replications were used to desired objectives.

The treatments were as follows:

T_1- Control (without organic and inorganic fertilizer)

T_2- Organic fertilizer (Cow dung)

T_3-Recommended dose of inorganic fertilizer (NPK)

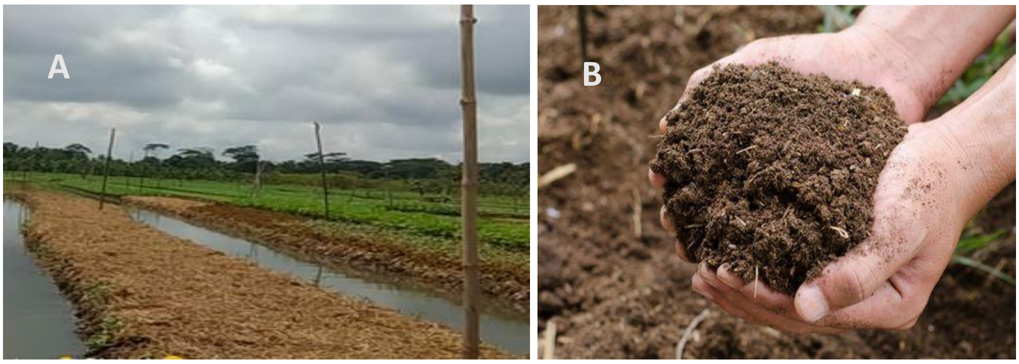

Figure 1. Treatments of the experiment

3.5. Design of the experiment

The experiment was conducted as a Randomized Complete Block Design (RCBD). The experiment included three treatments with four replications.

3.6. Floating Bed (dhap) Preparation

Healthy and matured water hyacinths were collected from the nearby river, canal and wetlands where it grows profusely. After collecting water hyacinths, a first layer was made with 1.7 m thickness, 1.0 m width and 5 m length. Water hyacinths were again dump on the first layer after 10/12 days later from the first dumping with 0.8 m thickness. So that required thickness was completed and then the bed was left for decomposition before planting of seedlings

3.7. Maintenance of floating bed

Mainly bamboos were used as anchorage of the floating beds to keep them fixed in place, and to prevent them from floating away by wind or water currents. The decomposed parts of the floating bed, as well as roots of water hyacinth were cut and placed underneath the seedlings, or they were put on chopped materials on the floating bed, 30 cm away from the edge of the bed. Thus, the seedlings received nutrients and grew healthy. A small country-boat was used for monitoring and maintaining the floating beds.

3.8. Raising of seedlings

A small ball was made with decomposed water hyacinth. The ball is locally called "Tema". After two-three days, the seeds of okra and cucumber germinated and were placed inside the Tema. Two sprouted seeds were put in each Tema which, in turn, was placed on the seedbed. The seedbed was shaded by polythene for protection against heavy rainfall.

3.9. Seedlings Transplanting on Floating Bed

Before transplanting, a hole or pit was made on the floating bed. A plant spacing of 50 cm × 50 cm for okra planted on two rows. Cucumber was planted at 80 cm × 80 cm spacing also in two rows of the seed bed. The seedlings at 14 day old were transplanted in a hole placing in the both edge site on two rows of the floating bed. Three treatments were then distributed randomly among each block so as to all treatments were placed once in each block.

Plate 1. Floating Bed (dhap) Preparation

Plate 2. Prepared "Tema"

Plate 3. Maintenance of floating bed

Plate 4. Raising of seedlings

Plate 5. Seedlings Transplanting on Floating Bed

Plate 6. Intercultural Operations

3.10. Application of Manure and Fertilizer

Manure and fertilizers were applied according to the treatments considering the recommended fertilizer dose on the basis of decomposed water hyacinth test value for respective crops (Fertilizer Recommendation Guide-2018). Cow dung, Urea, TSP, MoP and Gypsum were applied @ 3.71, 24.12, 18.56, 14.85 and 12.99 g/Floating bed for okra and 3.71, 16.70, 14.84, 12.06 and 12.99 g/Floating bed for cucumber.

3.11. Intercultural Operations

Irrigation, weeding and plant protection were carried out as and when needed, especially at the primary stage of seedling establishment. Fungicide ‘Thiovit’ and insecticide ‘Diazinon’ were used to control powdery mildew in cucumber, and to control shoot/fruit borers in okra, respectively.

3.12. Cost Return Analysis

The cost and return analysis of a crop grown in a particular year may not represent exactly, the same with the crop grown in another year. The cost and return analysis was performed based on the crop yield as well as factors such as cost of inputs, labor and market price of harvested material, which may vary from year to year. However, economic analysis was done to find out the most economic treatment applying the recommended dose of NPK fertilizers on floating bed condition.

All input *i.e*. seed, bamboo, dulalilata, tepapana, net, cow dung, fertilizers, boat rent and labor cost were considered for calculating cost of production. But the cost of water hyacinth was not considered. The cost and return analysis was done in details according to the procedure of (Iqbal *et al*., 1989).

$$\text{Net return} \equiv \text{Gross return} - \text{Total cost of production}$$

$$\text{Benefit cost ratio (BCR)} = \text{Gross return} \div \text{Total cost of production}$$

3.13 Data Collection

Four plants were selected randomly from each unit of the plot and the parameters were recorded at 15-day intervals.

3.13.1. Data collection in case of okra

The measurable factors included plant height (cm), number of leaves, branches and fruits per plant, length and diameter of fruit (cm), individual fruit weight (g), weight of harvested fruits per plant and fruit yield per hectare were measured and put down during the cultivation and after harvesting of okra.

3.13.1.1. Plant height at 65 DAT and matured stage

First parameter for okra data collection was plant height and data was recorded in cm.

3.13.1.2. Number of leaves at 65 DAT and matured stage

Number of leaves was counted in 15 days interval.

3.13.1.3. Branches and fruits plant^{-1}

Number of branches and number of fruits was recorded.

3.13.1.4. Length and diameter of fruit

Fruit length and the diameter of the fruits was measured in cm and put down for analysis.

3.13.1.5. Individual fruit weight

Single fruit wt of okra was recorded in gm when the fruit was matured.

3.13.1.6. Weight of harvested fruits plant^{-1}

After harvesting per plant fruit weight measured in gm and was recorded for analysis procedure.

3.13.1.7. Fruit yield hectare^{-1}

Finally Material, non-material and over head costs including harvesting of okra were recorded for all treatments on unit bed basis and converted to per hectare.

Plate 7. Vegetative Stage of Okra

Plate 8. Flowering Stage of Okra

Plate 9.Data Collection

3.13.2. Data collection in case of cucumber

The measurable factors included main stem length (cm), number of leaves, branches and fruits plant^{-1}, length and diameter of fruit (cm), individual fruit weight (g), weight of harvested fruits plant^{-1} and fruit yield per hectare were measured and put down during the cultivation and after harvesting of cucumber.

3.13.2.1. Main stem/vine length at 65 DAT and matured stage

First parameter for cucumber data collection was main stem length and data was recorded in cm.

3.13.2.2. Number of leaves at 65 DAT and matured stage

Number of leaves was counted in 15 days interval and recorded.

3.13.2.3. Branches and fruits plant^{-1}

Number of branches and number of fruits was recorded.

3.13.2.4. Length and diameter of fruit

Fruit length and the diameter of the fruits was measured in cm and put down for analysis.

3.13.2.5. Individual fruit weight

Single fruit wt of cucumber was recorded in gm when the fruit was matured.

3.13.2.6. Weight of harvested fruits plant^{-1}

After harvesting per plant fruit weight measured in kg and was recorded for analysis procedure.

3.13.2.7. Fruit yield hectare^{-1}

Finally Material, non-material and over head costs including harvesting of okra were recorded for all treatments on unit bed basis and converted to per hectare.

Plate 10. Initial growing stage of cucumber after transplanting

Plate 11. Vegetative stage of cucumber

3.14. Analysis of data

Recorded data were analyzed statistically with the help of computer package program MSTAT-C and the mean differences were adjudged by DUNCAN'S NEW MULTIPLE RANGE TEST (DMRT) at 5% level of probability for interpretation of the results (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

4.1. Effects on Growth Parameters of Okra

4.1.1. Plant height of Okra

4.1.1.1. Plant height at 65 DAT

Plant height is the first growth parameter of okra. The height of the okra plant influenced by different treatments which are called control, cow dung and NPK fertilizer. At the 65 DAT the okra plant showed the highest output (136.40) which was recorded from T_3 (Recommended dose of NPK) while the lowest height (101.30) was recorded from T_1 (without organic and inorganic fertilizers).

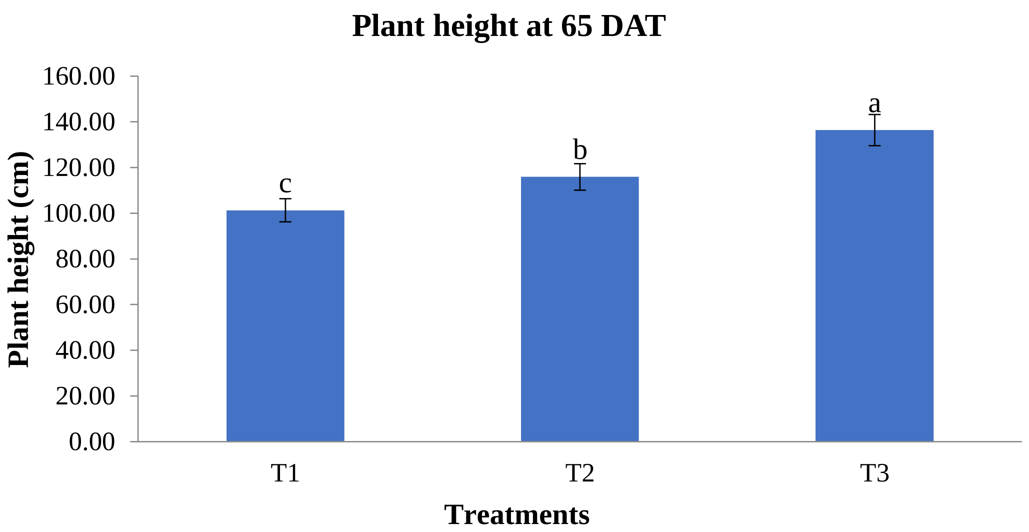

Figure 2. Effects of different treatments on plant height of okra at 65 DAT with CV% = 1.74 and $LSD_{(0.05)}$ =3.19
[T_1- Control; T_2- Cow dung; T_3- Recommended dose of NPK].

4.1.1.2. Plant height at matured stage

Plant height of kra varied significantly ($P \leq 0.05$) due to application of organic manure and inorganic fertilizers (**Table 1**). During the cultivation of the experiment, the highest plant height (156.90 cm), were found in receiving the recommended dose of NPK remarked as T_3. These results were significantly greater than those of the treatments T_1 (124.11 cm) and T_2 (133.30 cm). The lowest output was recorded from the control in all treatments.

Table 1. Plant height of okra at matured stage as influenced by organic and inorganic fertilizer in floating bed cultivation

Treatments	Plant height (cm)
T_1	124.11c
T_2	133.30b
T_3	156.90a
CV(%)	**1.56**
LSD (0.05)	**3.36**

Data figures in a column having common letter(s) do not differ significantly ($P \leq 0.05$).
Here, T_1: Control, T_2: Cow dung, T_3: Recommended dose of NPK.

Chatto *et al.* (2011) found similar output in their experiment with plant height where they reported that combination of individual organic sources with inorganic fertilizer in equal proportion (50:50), exhibited a beneficial response in plant height.

The nutrients in the compost usually do not leach out by rainwater and almost all of the nutrients remain available for the plants (Vidya and Girish, 2014).

This result might be found due to the combined impact of recommended dose of fertilizers, cow dung and decomposed water hyacinth as organic matter. Usually, the decomposed water hyacinth and cow dung release the nutrients slowly and steadily into the system and enables the plant to absorb nutrients.

During the cultivation of the experiment in 2014 and 2015 the highest plant height (171.73 cm and 164.03 cm), number of branches (5.67 and 5.67) and number of leaves (60.33 and 69.67) were found in receiving the recommended dose of NPK denoted as T_3 followed by T_4 treatment *i.e*. 50% cow dung + 50% recommended dose of NPK.However, the obtaining results exposed that there were no identical differences among all the parameters in between the treatments T_3 and T_4 (Mondal *et al.*, 2013).

4.1.2. Number of branches plant^{-1}

4.1.2.1 Number of primary branches plant^{-1}

Non-significant variation in respect of number of primary branches plant^{-1} was recorded from the three treatments. The highest number of primary branches per plant (3.00) followed by T_3 (Recommended dose of NPK) , next one (2.75) for T_2 and the lowest no. of primary branches plant^{-1} (1.50) was recorded for T_1 treatment.

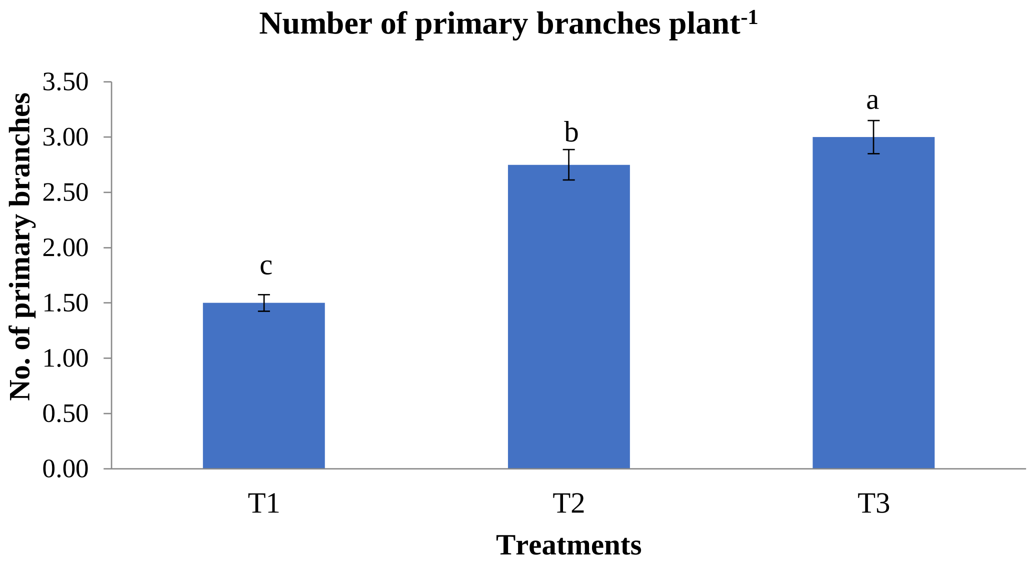

Figure 3. Effects of different treatments on number of primary branches plant^{-1} of Okra [T_1- Control; T_2- Cow dung; T_3- Recommended dose of NPK]

There was an agreement with these results in getting the highest number of branches worked out by (Malik *et al*., 2011) adapting the integrated application of organic and inorganic fertilizers.

4.1.2.2. Number of branches plant^{-1} at matured stage

Number of branches plant^{-1} of okravaried significantly ($P \leq 0.05$) due to application of organic manure and inorganic fertilizers (**Table 2**). During the cultivation of the experiment,the highest number of branches (5.50) showed by T_3 This result was significantly greater than those of the treatments T_1 (4.00) and T_2 (4.75). The lowest output was recorded from the control in all treatments.

Table 2. Number of branches plant−1 of okra at matured stage as influenced by organic and inorganic fertilizer in floating bed cultivation

Treatments	Number of branches plant^{-1}
T_1	4.00b
T_2	4.75ab
T_3	5.50a
CV(%)	**10.53**
LSD $_{(0.05)}$	**0.78**

Data figurs in a column having common letter(s) do not differ significantly ($P \leq 0.05$). [Here, T_1: Control, T_2: Cow dung, T_3: Recommended dose of NPK.]

4.1.3. Number of leaves plant^{-1}

4.1.3.1. Number of leaves plant^{-1} at 65 DAT

Significant variation in respect of number of leaves plant^{-1} among the three treatments were found. The maximum number of leaves plant^{-1} was produced by T_3 (Recommended dose of NPK) (37.50). It was followed by T_2 (27.25) and the minimum number of leaves plant^{-1} (21.50) was recorded in T_1 (Control).

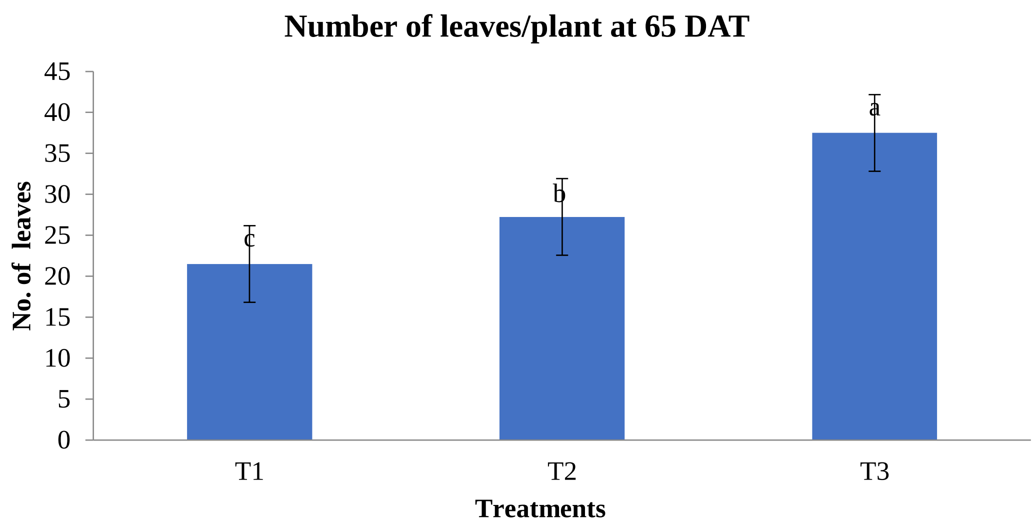

Figure 4. Effects of different treatments on number of leaves plant^{-1} at 65 DAT with CV%=3.43 and $LSD_{(0.05)}$ =1.53
[T_1- Control; T_2- Cow dung; T_3- Recommended dose of NPK]

Same trend of findings regarding more number of leaf in fluted pumpkin were reported by (Idem *et al.*, 2012) under similar condition.

4.1.3.2. Number of leaves plant^{-1} at matured stage

Number of leaves plant^{-1} of okra varied significantly ($P \leq 0.05$) due to application of organic manure and inorganic fertilizers (**Table 3**). During the cultivation of the experiment, the highest number of leaves (55.75) found in receiving the recommended dose of NPK denoted as T_3. This result was significantly greater than those of the treatments T_1 (32.75) and T_2 (42.00). The lowest output was recorded from the control in all treatments.

Table 3. Number of leaves plant^{-1} of okra at matured stage as influenced by organic and inorganic fertilizer in floating bed cultivation

Treatments	Number of leaves plant^{-1}
T_1	32.75c
T_2	42.00b
T_3	55.75a
CV(%)	**5.56**
LSD $_{(0.05)}$	**3.75**

Figures in a column having common letter(s) do not differ significantly ($P \leq 0.05$). Here, [T_1: Control, T_2: Cow dung, T_3: Recommended dose of NPK]

4.2. Effects on yield components of Okra

In the second phase, the cultivation results showed in (**Table 4**) that the number of fruits plant^{-1} varied from 14.75 to 22.00, fruit length varied from 13.50 cm to 16.38 cm and fruit diameter varied from 5.00 cm to 6.48 cm respectively.

Also, it was observed that all yield parameters under the treatments T_3 was significantly greater than those in getting with the other treatments T_1 and T_2. The control treatment T_1 showed the lowest yield.

There were no identical difference between the treatments T_3 (recommended dose of NPK) and T_4 (50% cow dung + 50% recommended dose of NPK) for all the yield containing parameters in okra cultivation (Mandal *et al.*, 2013).

The increase in yield of okra could be attributed to the fact that plant nutrients were more readily available by applying recommended dose of NPK on floating bed with decomposed water hyacinth as organic matter. Among the yield contributing characteristics number of fruits plant^{-1} is the most important fact that indicates total yield plant^{-1} there by determines economic return from each plant. Fruit size is another important factor that quantifies the yield of the crop.

Table 4. Yield and yield contributing characters (number of fruits plant^{-1}, fruit length and fruit diameter) of okra as influenced by organic and inorganic fertilizers in floating bed cultivation

Treatments	Fruits plant^{-1} (No.)	Fruit length (cm)	Fruit diameter (cm)
T_1	14.75c	13.50c	5.00c
T_2	17.75b	14.88b	5.75b
T_3	22.00a	16.38a	6.48a
CV (%)	**4.77**	**3.83**	**5.45**
LSD $_{(0.05)}$	**1.35**	**0.88**	**0.49**

Data in a column having common letter(s) do not differ significantly ($P \leq 0.05$). [T_1: Control, T_2: Cow dung, T_3: Recommended dose of NPK]

However, in the case of okra, the fruit should be left unplucked to the plant up to a definite size depending upon variety.

Attigah *et al.* (2013) indicated similar findings where they found the maximum fruit length and diameter in combined application of organic and inorganic fertilizer.

Ferreira *et al.* (2002) reported that the use of organic and mineral fertilizer significantly increased the yield of okra with the increasing rate of manure and mineral fertilizers.

Further, the cultivation results showed (**Table 5**) that individual fruit weight varied from 16.40 to 21.67 g, weight of fresh fruit plant^{-1} varied from 365.90 g to 602.80 g while yield varied from 6.11 to 12.12 t·ha^{-1}.

It was also observed that all yield parameters under the treatments T_3 was significantly greater than those in getting with the other treatments T_1 and T_2. The highest yield (12.12 t·ha^{-1}) and other yield contributing attributes in the cultivation year were obtained in receiving the treatment T_3. The control treatment T_1 showed the lowest yield.

Table 5. Yield and yield contributing characters (Individual fruit weight, fruit length and yield) of okra as influenced by organic and inorganic fertilizers in floating bed cultivation

Treatments	Individual fruit weight (g)	Fruits weight plant^{-1} (g)	Yield (t.ha^{-1})
T_1	16.40c	365.90c	6.11c
T_2	18.63b	462.90b	8.43b
T_3	21.67a	602.80a	12.12a
CV (%)	**5.06**	**2.19**	**7.21**
LSD (0.05)	**1.49**	**16.24**	**0.99**

Data in a column having common letter(s) do not differ significantly ($P \leq 0.05$). [T_1: Control, T_2: Cow dung, T_3: Recommended dose of NPK]

4.3. Economic analysis of Okra

The detailed economic analysis of okra production have been shown in **Table 6.** The total variable cost of production ranged from Tk. 263,712.00 to 399,075.00 among the treatments. The highest cost of production (Tk. 399,075.00) was found in T_3 : recommended dose of NPK fertilizers followed by T_2: cow dung (Tk. 309425.00), and the lowest (Tk. 263,712.00) was in control. The value of gross return from different treatments ranged from Tk. 276,262.00 to 426,137.00 and net return ranged from Tk. 12,550.00 to 27,060.00 per hectare obtained from the total income by selling okra @ Tk. 32,000.00 – 35,000 per ton.

Factor of the economic analysis shown that the treatment T_3 gave the highest net return worth Tk. 27,060.00 followed by T_2 (Tk. 18,090.00) whereas, the lowest (Tk. 12,550.00) was found from the control. In case of results, significant variations in respect of the benefit cost ratio (BCR) were found among the treatments. The highest value of BCR (1.07) was recorded from the treatment T_3 which was significantly different from the other treatments and the lowest BCR (1.03) was found in control. So, there were significant differences in BCR values among the treatments T_1, T_2 and T_3.

Mondal *et al.* (2013) stated that significant variations in respect of the benefit cost ratio (BCR) were found among the treatments. The highest value of BCR (1.17) was recorded from the treatment T_4 which was significantly different from the other treatments and the lowest BCR (1.03) was found in control. There were no significant differences in BCR values among the treatments T_1, T_2 and T_3. However, results revealed that T_4 treatment *i.e*. 50% cow dung + 50% recommended dose of NPK was found to be suitable for higher economic return from okra under the climatic conditions of Gopalganj.

Table 6. Cost and return analysis of okra production due to application of organic and inorganic fertilizers in floating bed cultivation

Treatments	Marketable yield ($t.ha^{-1}$)	Total cost of production Tk ($t.ha^{-1}$)	Gross return Tk ($t.ha^{-1}$)	Net return Tk ($t.ha^{-1}$)	Benefit cost ratio (BCR)
T_1	5.88c	263712.00c	276262.00c	12550.00b	1.04c
T_2	8.29b	309425.00b	327512.00b	18090.00b	1.05b
T_3	11.86a	399075.00a	426137.00a	27060.00a	1.07a
CV (%)	7.82	1.23	1.52	6.69	0.42
Level of significance	*	*	*	*	*

*= Significant at 5% level. Means followed by common letter(s) in a column do not differ significantly by DMRT. Here, T_1 = Control, T_2 = Cow dung, T_3 = Recommended dose of NPK.

In the context of economic consideration, the highest mean cost of production of okra was observed in T_3 treatment followed by T_2. T_3 (recommended dose of NPK) resulted in the highest mean net return and mean BCR value, followed by T_2 (cow dung).

4.4. Effects on Growth Parameters of Cucumber

4.4.1. Main stem/vine length

4.4.1.1. Main stem/vine length of cucumber at 65 DAT

Main stem/vine length is the first growth parameter of cucumber. Significant variation in respect of vine length among the three treatments were found. The highest vine length was recorded by T_3 (Recommended dose of NPK) (207.90) at 65 DAT. It was followed by T_2 (156.30) and the lowest main vine length (127.90) was recorded in T_1 (Control).

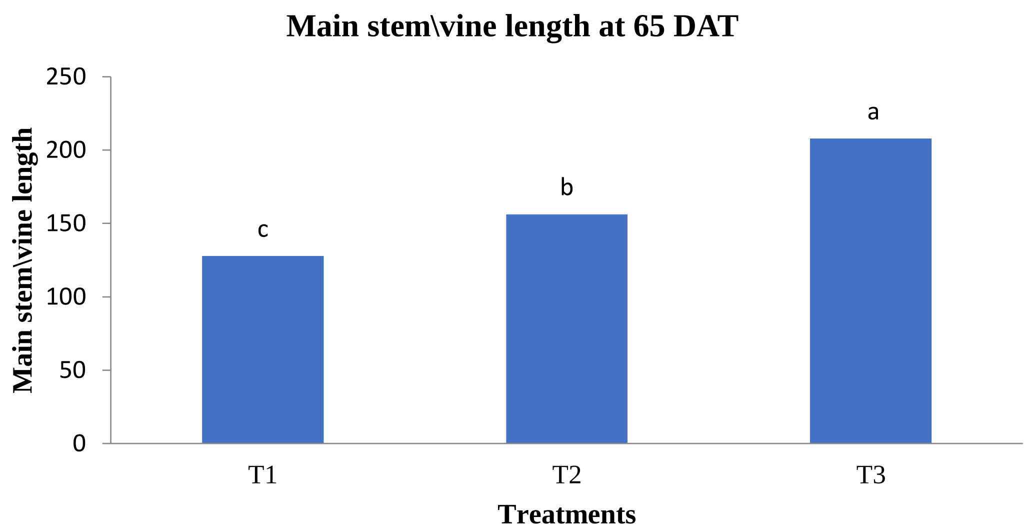

Figure 5. Effects of different treatments on main stem/vine length of cucumber at 65 DAT with CV%= 1.84 and $LSD_{(0.05)}$ =4.69
[T_1- Control; T_2- Cow dung; T_3- Recommended dose of NPK]

These results were supported by the work done by (Ahmed *et al.*, 2007) and (Abdel-Mawgoud *et al.*, 2005) who reported an increase in cucumber vine length with an increase in nitrogen application.

4.4.1.2. Main stem/vine length at matured stage

Results of vine length showed a significant variation ($P \leq 0.05$) among different treatments (**Table 7.**). The longest vine length 242.54 cm was obtained from recommended dose of NPK (T_3) while the lowest 149.17 cm was from the control and 188.19 cm from the T_2 treatment.

Table 7. Main stem/vine length of cucumber at matured stage as influenced by organic and inorganic fertilizers under floating bed cultivation

Treatments	Main stem/vine length (cm)
T_1	149.17c
T_2	188.19b
T_3	242.54a
CV(%)	**1.12**
LSD $_{(0.05)}$	**3.37**

Data figures in a column having common letter(s) do not differ significantly ($P \leq 0.05$). Here, T_1 = Control, T_2 = Cow dung, T_3 = Recommended dose of NPK.

The longest vine length 259.47 cm and 273.47 cm were obtained from recommended dose of NPK (T_3) while the lowest 148.10 cm and 177.60 cm were from the control in 2014 and 2015 respectively. No significant differences among growth parameters were found in between the treatments T_1 and T_2 and in between T_3 and T_4 (Mondal *et al.*, 2013).

4.4.2. Number of branches $plant^{-1}$ of Cucumber

4.4.2.1. Number of primary branches $plant^{-1}$

Non-significant variation in respect of number of primary branches $plant^{-1}$ of cucumber was recorded from the three treatments. The highest number of primary branches per plant (6.75) followed by T_3 (Recommended dose of NPK) , then (5.25) for T_2 and the lowest no. of primary branches $plant^{-1}$ (3.25) was recorded for T_1 treatment.

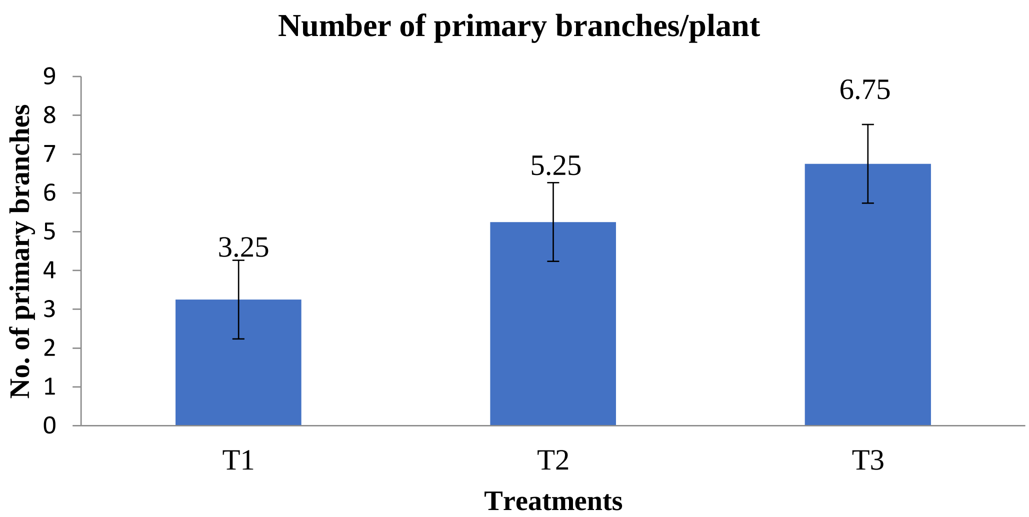

Figure 6. Effects of different treatments on number of primary branches $plant^{-1}$ of cucumber
[T_1- Control; T_2- Cow dung; T_3- Recommended dose of NPK]

In the case of cucumber primary branches, the parameters showed same significant improvements in response from T_1 to T_3 treatment, compared to okra.

4.4.2.2. Number of Branches plant^{-1}at matured stage

Results of number of branches plant^{-1} showed a significant variation ($P \leq 0.05$) among different treatments (**Table 8**). The highest number of branches (11.00) per plant were recorded in receiving the treatment T_3 (recommended dose of NPK) and the lowest number of branches (5.75) and leaves (49.25) per plant were from the control. There is significant differences among growth parameters were found in between the treatments T_1 and T_2.

Table 8. Number of Branches plant^{-1}of cucumber at matured stage as influenced by organic and inorganic fertilizers under floating bed cultivation

Treatments	No. of Branches plant^{-1}
T_1	5.75c
T_2	8.00b
T_3	11.00a
CV(%)	**11.25**
LSD $_{(0.05)}$	**1.44**

Data figures in a column having common letter(s) do not differ significantly ($P \leq 0.05$). Here, T_1 = Control, T_2 = Cow dung, T_3 = Recommended dose of NPK.

The highest number of branches (12.33 and 12.00) per plant were recorded in receiving the treatment T_4 (50% cow dung + 50% recommended dose of NPK) and the lowest number of branches (6.33 and 5.67) per plant were from the control in the same growing years respectively. No significant differences among growth parameters were found in between the treatments T_1 and T_2 and in between T_3 and T_4 (Mondal *et al.,* 2013).

4.4.3. Number of leaves plant^{-1}

4.4.3.1. Number of leaves plant^{-1} at 65 DAT

There was significant variation in terms of number of leaves plant^{-1} of cucumber was recorded from the three treatments. The highest number of leaves per plant (51.50) followed by T_3 (Recommended dose of NPK), 2nd height number of leaves plant^{-1} indicated 43.75 leaves by T_2 and the lowest number of leaves plant^{-1} (36.00) was recorded for T_1 (Control) treatment.

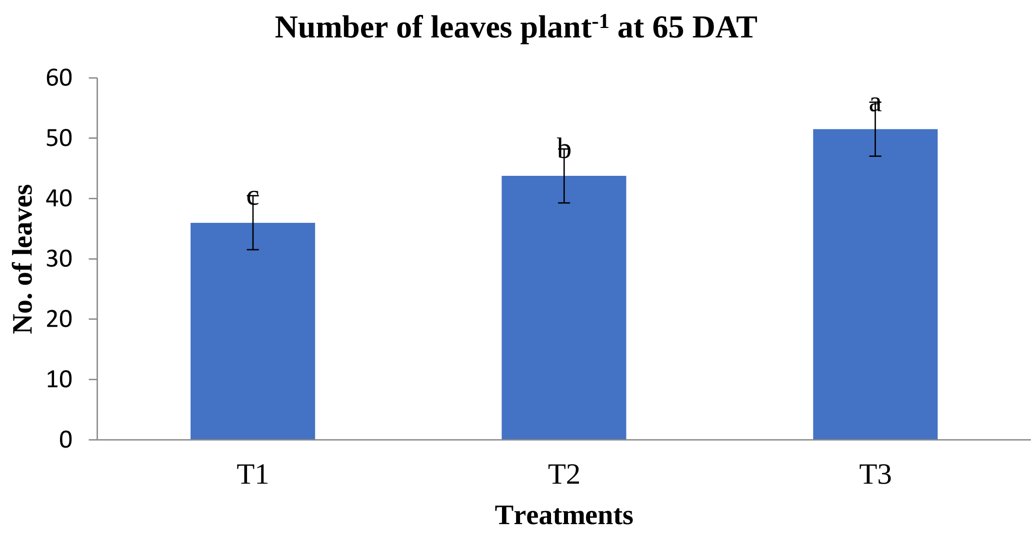

Figure 7. Effects of different treatments on number of leaves plant^{-1} of cucumber at 65 DAT with CV%= 4.46 and $LSD_{(0.05)}$ =3.04

[T_1- Control; T_2- Cow dung; T_3- Recommended dose of NPK]

4.4.3.2. Number of leaves plant^{-1} at matured stage

Results of number of leaves plant^{-1} showed a significant variation ($P \leq 0.05$) among different treatments (**Table 9**). The highest number of leaves (65.25) per plant was recorded in receiving the treatment T_3 (recommended dose of NPK), T_2 resulted 2nd height number of leaves (57.25) per plant and the lowest number of leaves (49.25) per plant were from the control. There is significant differences among growth parameters were found in between the treatments T_1 and T_2.

Table 9. Number of leaves plant^{-1} of cucumber at matured stage as influenced by organic and inorganic fertilizers under floating bed cultivation

Treatments	Leaves plant^{-1} (No.)
T_1	49.25c
T_2	57.25b
T_3	65.25a
CV(%)	**1.84**
LSD $_{(0.05)}$	**1.64**

Data figures in a column having common letter(s) do not differ significantly ($P \leq 0.05$). Here, T_1 = Control, T_2 = Cow dung, T_3 = Recommended dose of NPK.

The highest number of leaves (66.00 and 74.43) per plant were recorded in receiving the treatment T_4 (50% cow dung + 50% recommended dose of NPK) and the lowest number of leaves (48.67 and 57.00) per plant were from the control in the same growing years respectively. No significant differences among growth parameters were found in between the treatments T_1 and T_2 and in between T_3 and T_4 (Mondal *et al.,* 2013)

4.5. Effects on yield components of Cucumber

Yield and yield components e.g. fruit number, length and diameter of fruit of cucumber varied significantly with the addition of organic and inorganic fertilizers (**Table 10**). Among the yield contributing characteristics number of fruits plant^{-1} is most important that indicates total yield plant^{-1} there by determines economic return from each plant. Fruit size is another important factor that determines the yield of the crop. The cultivation resulted that number of fruits plant^{-1} varied from 9.25 to 21.50 while number of fruits (14.25) plant^{-1} attained from T_2. Fruit length varied from 14.59 to 18.21 cm while fruit diameter varied from 14.10 to 16.72 cm.

Table 10. Yield and yield contributing characters (No. of Fruits plant^{-1}, Fruit length and Fruit diameter) of cucumber as influenced by organic and inorganic fertilizers in floating bed cultivation

Treatments	No. of Fruits plant^{-1}	Fruit length(cm)	Fruit diameter (cm)
T_1	9.25c	14.59c	14.10c
T_2	14.25b	16.24b	15.83b
T_3	21.50a	18.21a	16.72a
CV(%)	**7.62**	**6.09**	**2.92**
LSD $_{(0.05)}$	**1.78**	**1.55**	**0.70**

Data figures in a column having common letter(s) do not differ significantly ($P \leq 0.05$).
[Here, T_1 = Control, T_2 = Cow dung, T_3 = Recommended dose of NPK.]

Choudhari and More, (2002) also observed that 150:90:90 kg NPK ha^{-1} produced maximum fruit weight (g) in cucumber plant.

Proper nutrients promote vigorous growth of cucumber plant, which ultimately increase the number of fruits per plant confirming the observation of (Waseem *et al.*, 2008) for cucumber when 80 kg N ha^{-1} was applied.

Fuchs *et al*. (1970) reported that nutrients from mineral fertilizers enhanced the establishment of crops through the mineralization of organic matter promoted yield by using the combination of manures and fertilizers.

The fresh yield per plant also followed the similar trend of increment. It was observed that there was no significant differences among different yield attributes of cucumber in the treatments between T_3 (recommended dose of NPK) and T_4 (50% recommended dose of NPK + 50% cow dung)(AB Mandal*et al.*, 2013).

The yield and yield contributing characters of cucumber were mostly influenced by T_3 treatment followed by T_2. This result is supported by the previous findings of (Ahmed *et al.*, 2007) who also reported that fruit weight of cucumber increased linearly with an increase in Nitrogen fertilizer rate.

These results emanate from the fact that recommended dose of NPK supply more plant nutrients for growth and yield.

Yield and yield components e.g. individual fruit weight, fruit weight per $plant^{-1}$ and yield of cucumber varied significantly with the addition of organic and inorganic fertilizers (**Table 11**). The cultivation resulted that individual fruit weight varied from 136.12 to 213.21 g. The highest fruit weight (4.24 kg) derived from the recommended dose of NPK (T_3), T_2 showed 2^{nd} highest (3.62 kg) result and control was the lowest. The highest yield 25.09 $t \cdot ha^{-1}$ was obtained from the recommended dose of NPK (T_3) followed by T_2 and T_1. The lowest yield 18.77 $t \cdot ha^{-1}$ was recorded in control (T_1).

Table 11. Yield and yield contributing characters (Individual fruit weight, Fruits weight plant^{-1} and Yield) of cucumber as influenced by organic and inorganic fertilizers in floating bed cultivation

Treatments	Individual fruit weight (g)	Fruits weight plant^{-1}(kg)	Yield (t·ha^{-1})
T_1	136.12c	3.35c	18.77c
T_2	161.68b	3.62b	22.68b
T_3	213.21a	4.24a	25.09a
CV(%)	**1.17**	**1.94**	**2.37**
LSD $_{(0.05)}$	**3.10**	**0.11**	**0.82**

Figures in a column having common letter(s) do not differ significantly ($P \leq 0.05$). [Here, T_1 = Control, T_2 = Cow dung, T_3 = Recommended dose of NPK.]

4.6. Economic analysis of Cucumber

The economic analysis for cucumber considering material, non-material and over head costs including harvesting of cucumber were recorded for all treatments on unit bed basis and converted to per hectare have been shown in **Table 12**.

The total cost of production ranged from Tk. 313,252.50 to 373,280.00 among the treatments. Due to different input costs along with the variable cost of organic and inorganic fertilizers the variation was occured. The highest cost of production (Tk. 373,280.00) was required for the treatment T_3 (recommended dose of NPK) followed by T_2 (Tk. 350,932.50) whereas, the lowest (Tk. 313,252.50) was found from the control. The gross return from different treatments ranged from Tk. 475,437.50 to Tk. 608,653.00 per hectare. Gross returns were obtained from the total income through selling cucumber @ Tk. 25,000.00 per ton(approximately)

It was found from the economic analysis that the treatment T_3 (recommended dose of NPK) gave the highest net return of Tk. 235373.00 followed by cow dung only (Tk. 193,137.50), and the lowest (Tk. 162,585.00) was observed from the control.

In case of results, significant variations in respect of the benefit cost ratio (BCR) were found among the treatments. The highest value of BCR (1.63) was recorded from the treatment T_3 which was significantly different from the other treatments and the lowest BCR (1.52) was found in control. So, there were significant differences in BCR values among the treatments T_1, T_2 and T_3.

Table 12. Cost and return analysis of cucumber production due to application of organic and inorganic fertilizers in floating bed

Treatments	Marketable yield ($t.ha^{-1}$)	Total cost of production Tk ($t.ha^{-1}$)	Gross return Tk ($t.ha^{-1}$)	Net return Tk ($t.ha^{-1}$)	Benefit cost ratio (BCR)
T_1	18.72c	313,252.50c	475,837.50c	162,585.00c	1.52c
T_2	22.62b	350,932.50b	544,070.00b	193,137.50b	1.55b
T_3	25.01a	373,280.00a	608,653.00a	235,373.00a	1.63a
CV(%)	**2.40**	**0.71**	**1.13**	**1.90**	**0.38**
Level of significance	*	*	*	*	*

*= Significant at 5% level. Means followed by common letter(s) in a column do not differ significantly by DMRT.
[Here, T_1 = Control, T_2 = Cow dung, T_3 = Recommended dose of NPK.]

Significant variations were found among the treatments in respect of the benefit cost ratio (BCR). The treatment T_4 (50% cow dung + 50% recommended dose of NPK) gave the significantly highest BCR (1.71) value among all other treatments, and the second highest BCR (1.64) value was found in T_3 treatment. The lowest BCR (1.52) value was recorded in the control. Therefore, results exposed that the treatment T_4 combined with organic and inorganic fertilizers *i.e*. 50% cow dung + 50% recommended dose of NPK was found to be suitable for greater economic return in cultivating cucumber with the climatic conditions of Gopalganj (Mondal*et al.*, 2013).

CHAPTER V

SUMMARY AND CONCLUSION

SUMMARY

The present experiment was conducted in Nazirpur Upazila to evaluate the overall parameter of okra and cucumber from the growth contributing characters to the benefit cost ratio under the treatments of T_1 (control), T_2 (cow dung) and T_3 (recommended dose of NPK) over the floating seedbed. Almost all features acquired the highest values when the plants established on floating bed with T_3 treatment. Nonetheless, there was significant difference between the T_2 and T_1 treatments in the floating beds. The lowest output in all cases was recorded from the control in all treatments.

Both organic and inorganic fertilizers exhibited positive influence on the performance of okra and cucumber in floating bed cultivation. At matured stage plant height (156.90cm), number of branches plant^{-1} (5.50) and number of leaves plant^{-1} (55.75) of okra grown in 2020 were found maximum in the treatment T_3, and the yield attributes viz. number of fruits (22.00), fruits size, individual fruit weight (21.67g) were significantly higher in receiving the same treatment. Significant differences were also observed between T_1 and T_2 among all growth and yield parameters, the lowest output was recorded in control for all growth and yield attributes.

Similar growth and yield trend were also observed during the cultivation of cucumber under the same treatment conditions. However, results obtained from the growing season 2020 applying the recommended dose of NPK assigned as the treatment T_3 was superior than others. At maturity, main stem/vine length (242.54cm), number of branches plant^{-1} (11.00) and number of leaves plant^{-1} (65.25) of cucumber grown in

2020 were found maximum in the treatment T_3, and the yield attributes viz. number of fruits (21.50), fruits length (18.21cm), fruit diameter (16.72cm), individual fruit weight (213.21g), fruit weight plant^{-1} (4.24kg) were significantly higher in receiving the same treatment. In the economic context, the treatment T_3 was exposed to be more feasible and suitable as cost-effective for the growth and yield of okra and cucumber in floating bed cultivation of that southern experimental region.

Floating vegetable gardening contributes significantly in total income and thus, improve the income, education, sanitation, and consumption expenditure of the farmers. In my study area lack of capital was the 1st most severe problem and lack of awareness of farmers was the last problem of the farmers.

CONCLUSION

Based on the experimental results, it may be concluded that-

- Floating seedbed is an effective monsoon cultivation techniques for the local people with minimum cost of production.
- Better yield was exposed in case of okra and cucumber in floating seedbed with recommended dose of NPK compared to without organic and inorganic fertilizers and cow dung.

CHAPTER VI

REFERENCES

Abdel-Mawgoud, A.M.R., El-Desuki, M., Salman, S.R. and Hussein, S.D.A. (2005) Performance of Some Snap Bean Varieties as Affected by Different Levels of Mineral Fertilizers. *J. of Agro.*4**,** 242-2 https://doi.org/10.3923/ja.2005.242.247

Adams, P. (2002). Nutritional control in hydroponics. In: Hydroponic Production of Vegetables and Ornamentals, Savvas, D. and Passam, H.C. (Eds.)., Embryo Publications, Athens, ISBN: 9608002125, pp. 211–261.

Adegunloye, D.V., Adetuyi, F.C., Akinyosoye, F.A. and Doyeni, M.O. (2007). Microbial Analysis of Compost Using Cowdung as Booster. *Pakistan J. of Nutrition*. **65**: 06-510. https://doi.org/10.3923/pjn.2007.506.510

AghayeNoroozlo Y, Souri, M.K., Delshad, M. (2019). Effects of foliar application of glycine and glutamine amino acids on growth and quality of sweet basil. *Advances in Hort. Sci*., **33**(4): 495-501.

Ahmed, N., Baloch, M.H., Haleem, A., Ejaz, M. and Ahmed, N. (2007). Effect of Different Levels of Nitrogen on the Growth and Production of Cucumber. *Life Sci. of Int. J.***1**, 99-102.

Alam k, Chowdhury MAT (2018). Floating Vegetable Gardening (FVG) as a Sustainable Agricultural System in Bangladesh: Prospects for kaptai Lake, Rangamati, Chittagong Hill-Tracts. *OIDA Int. J. of Sustainable Development.***11**(03): 43-58.

Ali, A. (1996). Vulnerability of Bangladesh to climate change and sea level rise through tropical cyclones and storm surges. Water, Air and Soil Pollution, **92**, 171–179.

Ali, M.Y. (1990). ‘Open water fisheries and environmental changes’, in Rahman, A.A., Huq, S. and Conway, G.R. (eds.) Environmental Aspects of Surface Water Systems of Bangladesh, Dhaka: University Press Ltd.

Aneja, K.R., Kumar P., Sharma, C (2014). A new strain of *Alternariaalternata*(AL-14) on water hyacinth from India. *J. of Innovative Biology.***1**(2): 117–121.

Anik, S.I., Khan, M (2012). Climate change adaptation through local knowledge in the north eastern region of Bangladesh. Mitigation and Adaptation Strategies for Global Change, 17, 879–896.

APEIS. (2014). Asia-Pacific Environmental Innovation Strategies; Floating Agriculture is not a New Practice in Bangladesh; https://www. researchgate.net/.../233762713_Indigenous_Floating_Cultivation_a_Sustain in Bangladesh.

APEIS and RIPSO. (2004). Floating Agriculture in the flood one or submerged areas in Bangladesh (Southern regions of Bangladesh). Bangladesh: APEIS and RIPSO.http://enviroscope.iges.or.jp/contents/APEIS/RISPO/inventory/db/pdf/0146.pdf [Accessed: 22/07/10].

Asaduzzaman, M. (2004). Floating Agriculture in the flood-prone or submerged areas in Bangladesh (Southern regions of Bangladesh) Asia-Pacific Environmental Innovation Strategies (APEIS), Research on Innovative and Strategic Policy Options (RIPSO), Good Practice Inventory.

Attigah, A.S., Asiedu, E.K., Agyarko, K. and Dapaah, H.K. (2013). Growth and Yield of Okra (Abelmochusesculentus L. Moench). As Affected by Organic and Inorganic Fertilizers. *ARPN J. of Agri. and Biological Sci*. **8**, 766-770.

Bangladesh Agricultural Research Council (BARC) (2018) Fertilizer Recommendation Guide 2018.

Bala, H., Ghosh, A. K., Kazal, M. M. H., Rahman, M. S., Sultana, M., and Sujan, M. H. K. (2020). Floating gardening in Bangladesh: a sustainable income generating activity in wetland areas. *Int. J. of Agri. Res. Innovation and Tech.* **10**(1): 87-93.

Bala, H. (2018). Study on Floating garden in some selective area of Gopalganj District: a tool for income generating farm practice (Doctoral dissertation), Department ofDevelopment and Poverty Studies, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207

BCCTF. (2017). Floating Gardens of Bangladesh: A Community Based Adaptation for Combating Climate Change in Wetland Area.

Bernzen, A., Jenkins, C., Braun, B (2019). Climate Change-Induced Migration in Coastal Bangladesh? A Critical Assessment of Migration Drivers in Rural Households under Economic and Environmental Stress. Geo-sciences, **9** (51), 1–21.

Bernas, S. M. (2010). Potential Of Floating Horticulture System On Swampland In South Sumatra.

Bhuiya, A. A. H., and Karim, M. S. A.(2002). Prospects of Hydroponics in Bangladesh: Lessons from Nesarabad, Pirojpur.

Brammer, H., Asaduzzaman M., and Sultana P. (1996). Effects of Climate and Sea-Level Changes on the Natural Resources of Bangladesh, Dhaka: Bangladesh UnnayanParisad.

Brouwer, J. and Powell, J.M. (1998). Micro-Topography, Water Balance, Millet Yield and Nutrient Leaching in a Manuring Experiment on Sandy Soil in South-West Niger. In: Renard, G., Neef, A., Becker, K. and von Oppen, M., Eds., Soil Fertility Management in West African Land Use Systems, Margraf, Weikersheim, 349-360.

Brouwer, J. and Powell, J.M. (1995). Soil Aspects of Nutrient Cycling in Manure Experiment in Niger. In: Powell, J.M., FernandezRivera, S., Williams, T.O. and Renard, C., Eds., Livestock and Sustainable Nutrient Cycling in Mixed

Farming Systems of Sub-Saharan Africa, ILCA, Addis Ababa, 211-226.

CARE, (2011). Understanding Vulnerability to Climate Change. Retieve from https://www.google.com

Castine, S. A., Sellamuttu, S. S., Cohen, P., Chandrabalan, D., and Phillips, M. (2013). Increasing productivity and improving livelihoods in aquatic agricultural systems: A review of interventions.

Chattoo, M.A., Ahmed, N., Wani, M.H., Mir, S.A., Khan, S.H. and Jabeen, N. (2011). Effect of Organic Manures and Inorganic Fertilizers on Growth, Yield and Quality of Okra (*Abelmochusesculentus* L. Moench). Vegetable Science, **38**, 135-139.

Chowdhury RB, Moore GA (2015). Floating Agriculture: A Potential Cleaner Production Technique for Climate Change Adaptation and Sustainable Community Development in Bangladesh, *J. of Cleaner Production*. doi:10.1016/j.jclepro.2015.10.060.Http://www.sciencedirect.com/science/article/pii/S0959652615015279,accessed November 27, 2015.

Chowdhury, K.R. (2004). ‘A Glimmer of Hope for Victims of Climate Change’, the Independent (Dhaka).

Chowdhury, A.M.R., Bhuyia, A.U., Choudhury, A.Y. and Sen, R. (1993). The Bangladesh cyclone of 1991: Why so many people died. Disasters, **17**, 291–304.

Choudhari, S.M. and More, T.A. (2002). Fertigation, Fertilizer and Spacing Requirement of Tropical Gynoecious Cucumber Hybrids. ActaHort,588,233-240. https://doi.org/10.17660/ActaHortic.2002.588.36

Dasgupta, S, Huq, M, Wheeler, D. (2016) Drinking water salinity and infant mortality in coastal Bangladesh. Water Economics and Policy, **2**(1). 1650003. https://Doi.org/10.1142/S2382624X1650003X

Dhali, M. Z. H., Sen, S., Emran, D. M. A., and Biswas, S. A. (2014). Effect Of Floating Agriculture On Socio-Economic Condition And Bio-Diversity.

Duyne, J.E. (2004). Local Initiatives: Collective Water Management in Rural Bangladesh, New Delhi: D.K. Printworld Ltd.

FAO (2017). Floating Garden Agricultural Practices in Bangladesh: A Proposal for Globally Important Agricultural Heritage System (GIAHS).Rome, Italy.

FAO. (2008). Floating Garden Agricultural Practices in Bangladesh; www.fao .org/ 3/a-bp777e.pdf.

Ferdous, M. M. (2016). Study On The Adaptation Capacity And Practices Of The Villagers In The Water Logged Area Of Satkhira, Bangladesh.

Ferreira, J.M., Santos, L.C., Andrade, W.E.B., Valentini, L., Ribeiro, L.J., Silva, M.V. and Silva, M.V. (2002) Organic and Mineral Fertilizers of Okra in North Rio de Janeiro Region. Technical Communication Agricultural Research Company of the State of Rio de Janeiro, No. 280.

Fuchs, W., Rauch, K. and Wiche, H.J. (1970). Effect of Organic Fertilizers and Organo Mineral Fertilizing on Development and Yield of Cereals. Albrecht Thaer Arch, 14, 359-366.

Germanwatch Nord-SiidInitiativeV. Ntanos, D. A, Koutroubas, S. D. (2002). Dry matter and N accumulation and translocation for indica and japonica rice under Mediterranean conditions. Field Crops Science. **4**: 93-101.

Giménez, A., Fernández, J. A., Pascual, J. A., Ros, M., Saez-Tovar, J., Martinez-Sabater, E., and Egea-Gilabert, C. (2020). Promising composts as growing media for the production of baby leaf lettuce in a floating system. *Agronomy*, ***10***(10): 1540.

Gomez, K. A, Gomez, A. A. 1984. Statistical Procedure for Agricultural Research (2nd edn.) Int. Rice Res. Inst., Willey Inter Science Publ., pp. 28-192.

Haq, A.H.M.R., Ghosal, T.K. and Ghosh, P. (2004). Cultivating Wetlands in Bangladesh. Leisa Magazine. 20: 18-20.

Haq, A.H.M.R., Ghosal, T.K. and Ghosh, P. (2004). Cultivating wetlands in Bangladesh. India: LEISA. Available from: http://bit.ly/c3Ah0o [Accessed: 05/08/10].

Haque, M.M. (2014). Conduct an Innovation in Fish and Vegetable Production for Shaded Ponds in Bangladesh-NC-ND License.

Hasan, M. K., Desiere, S., D'Haese, M., and Kumar, L. (2018). Impact of climate-smart agriculture adoption on the food security of coastal farmers in Bangladesh. *Food Security*. ***10***(4): 1073-1088.

Hoque, M. Z., and Haque, M. E. (2016). Impact of climate change on crop production and adaptation practices in coastal saline areas of Bangladesh. *Int. J. Appl. Res*. **2**(1): 10-19.

Hoozemans, F.M.J., and Hulsbergen C.H. (1995). 'Sea-level Rise: A World-Wide Assessment of Risk and Protection Costs', in Eisma, D. (ed.). Climate Change: Impact on Coastal Habitation, London: Lewis Publishers.

Hossain, M.A. (2014). Floating cultivation: An indigenous technology for adapting to water logging situation towards sustainable livelihood security in the low lying areas of Bangladesh. *J. of Bioscience and Agri. Res.* **1**: 54- 58.

Hossain, M. L., and Hossain, M. K. (2012). Climate change, sea level rise and coastal vulnerabilities of Bangladesh with adaptation options.

Huq, S., Ahmed, A.U. and Koudstaal, R. (1996). Vulnerability of Bangladesh to Climate Change and Sea Level Rise. In: Downing, T.E., Ed., Climate Change and World Food Security, NATO ASI Series, Vol. 37. pp. 347-379. https://doi.org/10.1007/978-3-642-61086-8_14//

Idem, N.U.A., Ikeh, A.O., Asikpo, N.S. and Udoh, E.I. (2012). Effect of Organic and Inorganic Fertilizer on Growth and Yield of Fluted Pumpkin (Telfaria occidentialis, hook f.). In Uyo, Akwa Ibom State, Nigeria. J. of Agri. and Social Res (JASR). 12, 74-84.

Infanullah, M.H., Azad, M.A.K., Kamruzzaman, M. and Wahed, M.A. (2007). Floating gardening in Bangladesh (IUCN, UNFP, UNU, Dhaka, Bangladesh).

Infanullah, M.H., Azad, M.A.K., Kamruzzaman, M. and Wahed, M.A. (2009). Floating gardening in Bangladesh (IUCN, UNFP, UNU, Dhaka, Bangladesh).

IPCC. (2015). Intergovernmental Panel on Climate Change; Climate Change and Bangladesh; The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for assessment of Published.

Iqbal, T.M.T., Alam, M.S., Amin, M.S., and Gaffer, M.A. (1989) Management of Agriculture Farm (in Bengali). 2nd Edition, S. Alam, Dhaka, 41-48.

Irfanullah HM, Azad MAK, Kamruzzaman M, Wahed M A (2011). Floating gardening in Bangladesh: a means to rebuild life after devastating flood. *Indian J. of Traditional Knowledge* **10**(1): 31-38.

Islam T, Atkins P, (2007). Indigenous floating cultivation: A sustainable agricultural practice in the wetlands of Bangladesh. Development in Practice **4**(1):130–13

Islam, S.T. and Atkins, P.J. (2005). Indigenous Floating Cultivation: A Sustainable Agricultural Practice in the Wetlands of Bangladesh. Ph.D. Thesis, Department of Geography, Jahangirnagar University, Savar Union.

Ivanova, D. T., Manusheva, B. H., and Dimov, A. B. (2016). Effect of vermicompost and system of cultivation on tomatoes seedlings. Eurasian Union of Scientists , (3-3 (24)), 100-104.

Kabir. A., Moniruzzaman. M., Jahan, K. and Shahjahan, M. (2019). Cost-benefit Analysis of Seedling Production on Floating Beds in a Few Selected Areas of Bangladesh. *J. of Agri. Studies.***7**: 75-86.

Kates, R.W. (2000). Cautionary tales: adaptation and the global poor. Climatic Change. **45**: 5-17.

Khan, A.A. (1993). 'Freshwater Wetlands in Bangladesh: Opportunities and Options', in Nishat, A. Hussain, Z., Roy, M.K., and Karim, A. (eds.) Freshwater Wetlands in Bangladesh – Issues and Approaches for Management. Dhaka: IUCN, the World Conservation Union.

Kreft, S, Eckstein, D, Melchior, I. (2016). Global Climate Risk Index 2017: Who Suffers Most from Extreme Weather Events? Weather-related Loss Events in 2015 and 1996 to 2015.

Mandal, K.K., Rajak, A., Debnath, S.W. and Hasan, M.A. (2013) Integrated Nutrient Management in Aonlacv A-7in the Red Laterite Region of West Bengal. *J. of Crop and Weed*. **9**: 121-123.

Mahtab, F. (1989). Effect of Climate Change and Sea Level Rise on Bangladesh (for Export Group on Climate Change and Sea Level Rise). Commonwealth Secretariat, London.

Mondal, A. B., Azad, A. K., Ahmed, M. B., Mannan, A., Hossain, M., and Eaton, T. E. (2022). Influence of Organic and Inorganic Fertilizers on Floating Bed Cultivation of Okra and Cucumber during Summer Season in Southern Part of Bangladesh. *American J. of Plant Sci.**13***(5): 600-612.

Mondal, A. B., Ahmed, M. B., and Mannan, M. A. (2022). Impact of Thickness of Floating Bed on the Performance of Select Summer Vegetables. *Int. J. Hort. Sci. and Tec*h. ***10***(3): 115-124.

Mohsin, K. F. (2019). Role Of Floating Cultivation On Rural Livelihood Practice Of Coastal Bangladesh.

M. Z. H. Dhali, S. Sen, D.M.A. Emran and Syed Ali Biswas (2014). Effect of Floating Agriculture on Socio-economic Condition and Bio-diversity. *Int. J. Bus. Soc. Sci. Res.* **2**(2): 173-177. Retrieve from http://www.ijbssr.com/currentissueview/14013071a

Nicholls, R.J. and Mimura, N. (1998). Regional Issues Raised by and Their Policy Implications, Climate Research, Vol.11, pp. 5-18.

Nicholls, R.J., Hoozemans, F.M.J. and Marchand, M. (1999). Increasing Flood Risk and Wetland Losses due to Global Sea-Level Rise: Regional and Global Analyses, Global Environmental Change, Vol. 9, pp. 69-87.

Nyong, A., Adesina, F. and Elasha, B.O.(2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. Mitigation and Adaptation Strategies for Global Change. **12**: 787-797.

Öztekin, G. B., Uludağ, T., and Tüzel, Y. (2018). Growing spinach (*Spinaciaoleracea* L.) in a floating system with different concentrations of nutrient solution. *Appl. Ecol. Environ. Res*, *16*, 3333-3350.

Pavel, M.A., Chowdhury, M.A. and Mamun, M.M.A. (2014). An Economic Evaluation of the Floating Garden as a Means of Adapting to Climate Change in Bangladesh.

Pavel, M.A.A., Khan, M. A. S. A., Rahman, S. A. and Mamun, M.A.A. (2013). Climate change adaptation strategy for the folk communities: an approach to vegetable production in flood prone areas. *Int. J. of Agro. and Plant Production.* **4**: 745-752.

Pyka, L. M., Al-Maruf A., Shamsuzzoha, M., Jenkins, J.C. and Braun, B. (2020). Floating gardening in coastal Bangladesh: Evidence of sustainable farming for food security under climate change. *J. of Agri. Food and Environ.***1**(4): 161-168.

Rahman, A, Alam, M. (2003). Mainstreaming adaptation to climate change in least developed countries (LDC). Bangladesh Country Case Study.

Rahman, A. (2011). Floating Vegetable Bed Cultivation. *Climate of Coastal Cooperation*, 179-180.

Rana, M. s. (2018). Floating Vegetable Gardening in Bangladesh: A Way to Improve Income and Livelihood of the Farmers (Doctoral Dissertation, Department of Development and Poverty Studies, Sher-e-Bangla Agricultural University, Dhaka-1207).

Rashid, M.H. (1981). Bangladesh District Gazetteers: Bakerganj, Dhaka: Bangladesh Government Press.

Saha, SK (2010). Soilless Cultivation for Landless People: An Alternative Livelihood Practice through Indigenous Hydroponic Agriculture in Flood-prone Bangladesh. Ritsumeikan Asia Pacific University. Available: www.apu.ac.jp/rcaps/uploads/fckeditor/ …/RJAPS.

Sharma, N., Acharya, S., Kumar, K., Singh, N., and Chaurasia, O. P. (2018). Hydroponics as an advanced technique for vegetable production: An overview. *J. of Soil and Water Cons*. **17**(4): 364-371.

Singh, N. P., S. Bantilan, M. C., Kumar, A. A., Janila, P., and R. Hassan, A. W. (2011). Climate Change Impact in Agriculture: Vulnerability and adaptation concerns of semiarid tropics in Asia. *Crop adaptation to climate change*, 107-130.

Soil Resources Development Institute (2001). Soil Guideline: Nesarabad Thana Dhaka: Ministry of Agriculture.

Souri, M.K., Yaghoubi Sooaki, F. (2019). Benefits of organic fertilizers spray on growth quality of chili pepper seedlings under cool temperature. *J. of Plant Nutrition*, **42**(6): 650-656.

Tareq, S. M. (2016). Environmental management of waterlogging problem in south-west coastal region of Bangladesh.

Vidya, S, Girish, L. (2014). Water Hyacinth as a Green Manure for Organic Farming. *Indian J. of Agro*. **2**(6): 65-72.

Warrick, R.A., Oerlemans, J., Woodworth, P.L., Meier M.F. and Provost C.L. (1996). 'Changes in Sea-level', in Houghton, J.T., MeiraFilho, L.G., and Callander, B.A. (eds.) Climate Change 1995: The Science of Climate Change, Cambridge: Cambridge University Press.

Waseem, K., Kamran, Q.M., and Jilani, M.S. (2008) Effect of Different Levels of Nitrogen on the Growth and Yield of Cucumber (*Cucumissativus* L.). *J. of Agri. Research.***46**, 259-266.

Warrick, R.A. and Ahmed, Q.K. (1996) The Implication of Climate and Sea-Level Change for Bangladesh. Kluwer Academic Publishers, Dordrecht; Boston; London.

Warrick, R.A., J. Oerlemans, P.L. Woodworth, M.F. Meier, and C. Le Provost (1996). 'Changes in sea-level', in Houghton, J.T., MeiraFilho, L.G., and Callander, B.A. (eds.)

Wilken, G.C. (1985). 'A note of buoyancy and other dubious characteristics of the 'floating' chinampas of Mexico', in Farrington, I.S. (ed.) Prehistoric Intensive Agriculture in the Tropics, British Archaeological Reports, International Series 232.

Wilken, G.C. (1987). Good Farmers: Traditional Agricultural Resource Management in Mexico and Central America, Berkeley: University of California Press.

Yellin, J. (2013). Showed Floating Gardens were an effective habitat solution in urban rivers. https://www.kickstarter.com/projects/wildmile/floatinggardens-in-the-chicago-river.

Yoshini, M.A. and Merabtene, K. (2007). Flood at Lowland Spreading Across the Middle of the Meghna River Basin in Bangladesh.

CHAPTER VII

APPENDICES

Appendix 1. Geographical Characteristics of My Study Area

Study Area/Location	Mugarjhor, Matibhanga, Nazirpur, Pirojpur.
AEZ	13 and 14, Pirojpur
Soil Type	Medium Highland
Soil pH	In general most of the topsoil's are acidic and subsoil's are neutral to slightly alkaline.
Topography	Moderate plain soil.

Appendix 2. ANOVA Table for Okra measuring parameters

Appendix of plant height at 65 DAT

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	2.267	0.756	0.1795	
Treatment	2	2491.332	1245.666	296.0190	0.0000
Error	6	25.248	4.208		

Appendix of plant height at matured stage

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	7.32	2.441	0.5238	
Treatment	2	2299.29	1149.646	246.6902	0.0000
Error	6	287.93	4.660		

Appendix of primary branches of Okra

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	0.250	0.083	0.1429	
Treatment	2	5.167	2.583	4.4286	0.0659
Error	6	3.500	0.583		

Appendix of branches of Okra at matured stage

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	2.25	0.75	3.00	0.117
Treatment	2	4.5	2.25	9.00	0.0156
Error	6	1.5	0.25		

Appendix of leaves at 65 DAT

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	20.917	6.972	7.1714	0.0207
Treatment	2	525.500	262.750	270.2571	0.00000
Error	6	5.833	0.972		

Appendix of leaves at matured stage

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	14.667	4.889	0.8421	
Treatment	2	1115.167	557.583	96.0431	0.00000
Error	6	34.833	5.806		

Appendix of no. of fruits

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	3.000	1.000	1.3333	0.3486
Treatment	2	106.167	53.083	70.7778	0.0001
Error	6	4.500	0.750		

Appendix of fruits length

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	8.917	2.972	9.1064	0.0119
Treatment	2	16.542	8.271	25.3404	0.0012
Error	6	1.958	0.326		

Appendix of fruit diameter

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	2.349	0.783	7.9858	0.0162
Treatment	2	4.352	2.176	22.1898	0.0017
Error	6	0.588	0.098		

Appendix of individual fruit weight

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	34.087	11.362	12.4215	0.0055
Treatment	2	56.105	28.052	30.6678	0.0007
Error	6	5.488	0.915		

Appendix of fruit weight/plant

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	603.370	201.123	1.8463	0.2394
Treatment	2	113495.269	56747.635	520.9343	0.0000
Error	6	653.606	108.934		

Appendix of yield

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	6.093	2.031	4.9504	0.0461
Treatment	2	73.400	36.700	89.4469	0.0000
Error	6	2.462	0.410		

Appendix of marketable yield

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	6.300	2.100	4.5619	0.0544
Treatment	2	72.458	36.229	78.7073	0.0000
Error	6	2.762	0.460		

Appendix of total cost of production

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	335143958.333	111714652.778	7.0421	0.0216
Treatment	2	37933015416.667	18966507708.333	1195.5827	0.0000
Error	6	95182916.667	15863819.444		

Appendix of gross return

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	460232291.667	153410763.889	5.6173	0.0355
Treatment	2	46421291666.667	23210645833.333	849.8782	0.0000
Error	6	163863333.333	27310555.556		

Appendix of net return

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	9951666.667	3317222.222	2.0029	0.2151
Treatment	2	429102916.667	214551458.333	129.5459	0.0000
Error	6	9937083.333	1656180.556		

Appendix of benefit cost ratio

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	0.000	0.000	0.5714	
Treatment	2	0.001	0.001	26.1431	0.0011
Error	6	0.000	0.000		

Appendix 3. ANOVA Table for Cucumber measuring parameters

Appendix of vine length at 65 DAT

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	2.376	0.792	0.0871	
Treatment	2	13183.612	6591.806	725.1482	0.0000
Error	6	54.542	9.090		

Appendix of vine length at matured stage

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	135.059	45.020	9.5967	0.0105
Treatment	2	17593.673	8796.836	1875.1961	0.0000
Error	6	28.147	4.691		

Appendix of primary branches

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	0.917	0.306	0.2500	
Treatment	2	24.667	12.333	10.0909	0.0120
Error	6	7.333	1.222		

Appendix of no. of branches at matured stage

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	3.583	1.194	1.3871	0.3345
Treatment	2	55.500	27.750	32.2258	0.0006
Error	6	5.167	0.861		

Appendix of no. of leaves at 65 DAT

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	4.917	1.639	0.4307	
Treatment	2	480.500	240.250	63.1314	0.0001
Error	6	22.833	3.806		

Appendix of no. of leaves at matured stage

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	23.583	7.861	7.0750	0.0214
Treatment	2	512.000	256.000	230.4000	0.0000
Error	6	6.667	1.111		

Appendix of no. of fruits plant^{-1}

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	2.667	0.889	0.6809	
Treatment	2	303.500	151.750	116.2340	0.0000
Error	6	7.833	1.306		

Appendix of fruit length

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	0.090	0.030	0.0303	
Treatment	2	26.242	13.121	13.2446	0.0063
Error	6	5.944	0.991		

Appendix of fruit diameter

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	1.468	0.489	2.3920	0.1673
Treatment	2	13.855	6.927	33.8701	0.0005
Error	6	1.227	0.205		

Appendix of individual fruit weight

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	5.404	1.801	0.4554	
Treatment	2	12336.733	6168.366	1559.5562	0.0000
Error	6	23.731	3.955		

Appendix of fruit/plant

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	0.059	0.020	3.7655	0.0785
Treatment	2	1.678	0.839	159.5864	0.0000
Error	6	0.032	0.005		

Appendix of yield

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	6.878	2.293	8.2641	0.0150
Treatment	2	81.443	40.722	146.7752	0.0000
Error	6	1.665	0.277		

Appendix of marketable yield

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	7.059	2.353	8.3566	0.0146
Treatment	2	80.668	40.334	143.2551	0.0000
Error	6	1.689	0.282		

Appendix of total cost of production

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	161219100.000	53739700.000	8.9505	0.0124
Treatment	2	7363325216.667	3681662608.333	613.1906	0.0000
Error	6	36024650.000	6004108.333		

Appendix of gross return

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	501430387.667	167143462.556	4.4801	0.0563
Treatment	2	35288793314.000	17644396657.000	472.9428	0.0000
Error	6	223846075.333	37307679.222		

Appendix of net return

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	100321787.667	33440595.889	2.3951	0.1669
Treatment	2	10687180880.667	5343590440.333	382.7271	0.0000
Error	6	83771295.333	13961882.556		

Appendix of benefit cost ratio

Source	Degrees of Freedom	Sum of Squares	Mean Square	F value	P
Replication	3	0.000	0.000	1.2308	0.3776
Treatment	2	0.028	0.014	389.3086	0.0000
Error	6	0.000	0.000		