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Floating gardening in Bangladesh: a sustainable income generating activity in wetland areas

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A B S T R A C T

Floating gardening acts as a fruitful climate-change adaptation strategy in different wetland areas of Bangladesh. The study accomplished to examine the profitability of floating gardening in Gopalgonj district of Bangladesh in 2018. A total of 100 floating gardeners were interviewed to achieve the objectives. Descriptive statistics and Cobb-Douglas production function were used to investigate the factors influencing yield of floating gardening. The findings reveal that, small and marginal farmers were more involved in floating gardening. Around sixty-five percent of the production costs was contributed by human labour. Floating gardeners of the study area earned a net return of BDT 457,901 per hectare per year. Human labour, fertilizers and support materials significantly affected the yield. More training and improved marketing system could further enhance the profitability.

Keywords: Adaptation strategy, Climate change, Cobb-Douglas production function, Income, Profitability.

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Introduction

Climate change bring up a significant change in the agricultural practices of the low laying and flood prone areas of Bangladesh (Ahmed, 2006; Brouwer *et al.,* 2007; Awal, 2014; Islam *et al.,* 2015b). Due to these changes, some parts of the country remain waterlogged for a prolonged period. To overcome this problem, farmers in these areas are adopting alternative cultivation techniques (Sen and Zaid, 2010; Pavel *et al.,* 2013; Hoque *et al.*, 2016; Chowdhury and Moore, 2017; Islam *et al.*, 2019; Kabir *et al.*, 2019; Kabir *et al.,* 2020). Floating gardening is one of the techniques where plants are grown on a bio-land or floating bed of water hyacinth, algae or plant residues (Winterborne, 2005; Saha, 2010; Alam and Chowdhury, 2018; Islam *et al.*, 2019). It is being practiced in southern floodplains of Bangladesh, particularly in the Barishal, Gopalganj and Pirojpur district (Haq and Nawaz, 2009; Chowdhury and Moore, 2017; Islam *et al.*, 2019). Irfanullah *et al.* (2011) studied the contribution of this practice to rebuild life after devastating flood in northern Bangladesh and found its positive impacts on nutritional security, household income and land-use capacity. Chowdhury and Moore (2017) also investigated the possibilities of this practice as a technique for climate change adaptation. Several other studies also recorded the success of this practice in coastal areas as well as wetland areas of the country (Byomkesh *et al.*, 2008; IUCN, 2008; Saha, 2010; Irfanullah, 2013; Hasan *et al.*, 2017). Kabir *et al.* (2019) studied the cost-benefit of seedling production on floating beds in Pirojpur district of Bangladesh and found a positive income with BCR 1.43. Islam *et al.* (2019) identified the constraints of floating gardening in wetland (haor) area of the country. However, financial profitability studies are very limited. Adoption of any new technology depends on its profitability. Profitability, factors affecting yield and constraints of this practice were investigated in this study. The adverse effect of climate change forces the policy maker to take newer production approaches to ensure food security for the marginalized people. Result of this study will be a handy tool to the policy maker, agricultural extension worker and development worker to take necessary steps for ensuring sustainable agricultural production.

Methodology

Data sources

The study was conducted in Gopalgonj district of southern Bangladesh due to availability of floating gardens. A list of floating gardeners of the district was prepared, which served as sampling framework of the work. A total of 100 floating gardeners were selected randomly from the list for face-to-face interview. Respondents were then grouped into marginal (0.02 – 0.20 hectare), small (0.20 – 1.00 hectare), and medium (1.00 – 3.00 hectare) farmer category based on the classification of DAE (1999). Data on the characteristics of the respondent, floating gardening activities, input use pattern, cost of inputs, output price, and constraint of floating gardening were collected using pre-tested interview schedule during January to June 2018.

Analytical techniques

Collected data were analyzed by using both descriptive and inferential statistics. Descriptive statistics like mean, and percentage were used to investigate socio-economic status of the floating gardeners. Profitability of floating gardening was estimated by using following formula as like Sujan *et al.*, 2017a & b:

$$GR_i = \sum_{i=1}^{n} Q_{ij} P_{ij}$$

Where, GR_i= Gross return of i[th] gardener; Q_{ij}= Quantity of j[th] product of i[th] gardener; P_{ij}= Price of j[th] product of i[th] gardener; i = 1,2,3 .... n.

Net return was calculated by deducting all costs from the gross return. To estimate the net return of floating gardening following formula was used:

$$\pi_i = GR_i - \sum_{i=1}^{n} P_{ij}X_{ij} - TFC_i$$

Where, π_i = Net return of i[th] gardener; GR_i= Gross return of i[th] gardener; P_{ij} = Price of j[th] input of i[th] gardener; X_{ij} = Quantity of j[th] input of i[th] gardener; TFC_i = Total fixed cost of i[th] gardener; i = 1,2,3, ...n.

Inferential statistics was applied to explore the factors affecting the yield of floating gardening. Cobb-Douglas production function was used to estimate these factors' influence. This function was used because of its mathematical properties, ease of interpretation and conceptual simplicity. It is the most widely used model for fitting agricultural production data (Heady and Dillon, 1961). It is also relatively easy to estimate because in logarithmic form it is linear and parsimonious (Beattie and Taylor, 1985). The functional form of the Cobb-Douglas production function was as follows:

$$Y = AX_1^{\beta_1} X_2^{\beta_2} \text{-------------------------------} X_n^{\beta_n} e^{ui}$$

The empirical production function for this research was the following:

$$\ln Y = \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + U_i$$

Where, Y = Yield (kg ha^{-1}); X_1 = Human Labor (man-days ha^{-1}); X_2 = Seed (kg ha^{-1}); X_3 = Fertilizer (kg ha^{-1}); X_4 = Insecticides & Pesticides (kg ha^{-1}); X_5 = Support material (BDT ha^{-1}); α = Intercept; β_1, β_2 ---- β_5 = Coefficients of the respective variables to be estimated; and U_i = Error term.

Results and Discussion

Socio-economic profile of farmers

Demographic statistics (Table 1) reveals that about 54% of the floating gardeners were middle aged (35-50). Similar to the findings of Pavel *et al.* (2014) and Kabir *et al.* (2019), about 68% of the respondents was found literate. It indicates that floating gardeners were educated. Middle aged and literate people's greater tendency to adopt with unconventional technologies might be the reason behind their more involvement in this practice. Average marginal, small and medium farm size was 0.16, 0.73 and 1.27 hectare, respectively. More involvement of marginal (21%) and small farmers (56%) in floating gardening signifies the importance of this practice as an alternative source of income to them (Alam and Chowdhury, 2018; Kabir *et al.*, 2019). Analysis of the housing pattern also reveals a typical scenario of resource poor people (Irfanullah, 2009). Though sanitation facilities were satisfactory, concerns about taking nutritious food were not up to the mark (Chowdhury and Moore, 2017). A majority (69%) of the respondent opined that their household income from floating gardening was about BDT 0.5 to BDT 1.0 lac per year. It also reveals the poor condition of the people engaged with floating gardening. Pavel *et al.* (2014) found an incremental income of the floating gardeners in Sunamganj haor of Bangladesh. In the study area, fifty-eight percent respondents use their own fund for floating gardening whereas 34%

collect loan from bank and NGOs. This result is in the line with the result found by MoEF (2005) and Hasan *et al.* (2017). Requirement of lower investment for floating gardening might be the responsible factor for that pattern of resource allocation.

Table 1. Socio-economic profile of the floating gardeners of the study area.

Attributes	Unit	Categories	Percentage (%)
Age of respondent	Year	Young age (<35 years)	20
		Middle age (35-50 years)	54
		Old age (>50 years)	26
Educational status	Year	Illiterate (<1 years)	32
		Primary (1-5 years)	37
		Secondary (6-10 years)	17
		Higher secondary (11-12 years)	10
		Above higher secondary (>12 years)	4
Land ownership status	Hectare[a]	Marginal farmer (0.02-0.20 hectare)	21
		Small farmer (0.20-1.00 hectare)	56
		Medium farmer (1.00-3.00 hectare)	23
		Large farmer (> 3.00 hectare)	0
Pattern of housing	-	Tin shade/mud made	24
		Semi pukka	44
		Pukka	32
Perception regarding food intake	-	Not worried about nutrition	15
		Poor nutritious	2
		Partial-nutritious	31
		Nutritious	52
Sanitation status	-	Use of open space	0
		Use of healthy toilet	79
		Use of modern toilet	21
Perceived income from floating gardening	BDT[b]	Less than 0.5 lac	17
		From 0.5 to 1.0 lac	69
		Greater than 1.0 lac	14
Sources of capital for gardening	-	Own fund	58
		Bank loan	12
		NGO loan	22
		Money lender	8

[a] 1 hectare = 247 decimal; [b] 1 USD = 85 BDT

Input use pattern in floating gardening

Human labour requirement per hectare was 932 man-days per year (Table 2) of which around 61 percent was family supplied. Smaller farm size and poor people's greater involvement might be the reason for higher employment of family labour in this practice. Average cost of seed or seedling was BDT 10,964 per hectare. Per hectare average cost for support materials was BDT 94,795. These support materials were used during the preparation of floating beds. That's why a significant portion (16.5%) of the required resource goes to manage support materials for floating gardening (Table 3).

Table 2. Input use pattern in floating gardening practices (per year).

Items	Units	Marginal farmer	Small farmer	Medium farmer	Average
Human labour	Man-days ha^{-1}	880	939	964	932
Family labour	Man-days ha^{-1}	606	568	519	565
Hired labour	Man-days ha^{-1}	274	371	445	367
Seed or Seedling	BDT ha^{-1}	10,378	11,120	11,120	10,964
Fertilizers	Kg ha^{-1}	267	284	297	284
Insecticides & Pesticides	Bottles ha^{-1}	30	27	32	30
Support materials	BDT ha^{-1}	90,809	95,134	97,605	94,795

Average use of fertilizers was 284 kg ha^{-1}. The proportional investment on seed/seedling, fertilizers and insecticides & pesticides were very low (Islam and Atkins, 2007; Irfanullah, 2009; Chowdhury and Moore, 2017) although Hasan *et al.* (2017) and Islam *et al.* (2019) claimed about no use of chemical fertilizers for floating gardening. The smart use of different organic matters and required essential nutrients for the plants during floating beds preparation might confirm the expected growth of the plants. That's why farmers might be reluctant to use additional chemical fertilizers.

Cost of production on floating gardening practices

Maximum proportion (around 65%) of costs for human labour indicates the labour intensive nature of this practice and implies that smallholder or marginalized people can manage their own work by engaging themselves in floating gardening (MoEF, 2005; Irfanullah *et al.*, 2007; Islam and Atkins, 2007; Irfanullah *et al.*, 2011). Incremental allocation of family labour with the decreasing amount of land ownership also signifies the importance of this practice as an income-generating source to the landless or marginal people (Pavel *et al.*, 2014; Chowdhury and Moore, 2017). About 87% of the total costs of production were contributed by variable costs of which 16.5% of the costs was incurred for the preparation of support materials. Greater involvement of family supplied and higher lanour and lower necessity of fixed investment in this practice might be the reason for higher requirement of variable costs.

Table 3. Cost of production on floating gardening practices (per year).

Items	Marginal farmer (BDT ha^{-1})	Small farmer (BDT ha^{-1})	Medium farmer (BDT ha^{-1})	Average
A. Variable cost	474,407 (86.8)	502,601 (87.0)	517,551 (87.1)	500,118 (87.0)
Human labour	351,870 (64.4)	375,592 (65.0)	385,476 (64.9)	372,883 (64.9)
Hired labour	109,712 (20.1)	148,260 (25.7)	177,912 (30.0)	146,985 (25.6)
Family labour	242,158 (44.3)	227,332 (39.4)	207,564 (34.9)	225,899 (39.3)
Seed or Seedling	10,378 (1.9)	10,872 (1.9)	11,120 (1.9)	10,825 (1.9)
Fertilizers	8,006 (1.5)	8,525 (1.5)	8,896 (1.5)	8,501 (1.5)
Insecticides & Pesticides	13,343 (2.4)	12,479 (2.2)	14,455 (2.4)	13,115 (2.3)
Support materials	90,809 (16.6)	95,134 (16.5)	97,605 (16.4)	94,794 (16.5)
B. Fixed cost	72,151 (13.2)	74,970 (13.0)	76,465 (12.9)	74,722 (13.0)
Land use	24,710 (4.5)	24,710 (4.3)	24,710 (4.2)	24,710 (4.3)
IOC (10%)	47,441 (8.7)	50,260 (8.7)	51,755 (8.7)	50,012 (8.7)
Total cost (A+B)	546,558 (100)	577,572 (100)	594,016 (100)	574,841 (100)

Note: Figures in the parenthesis indicates respective percentages.

Profitability of floating gardening

Floating gardeners mainly cultivate different types of vegetables like red-amaranth, lady's finger, cabbage, bottle gourd, papaya, chili and vegetable seedlings etc. (Pavel *et al.*, 2014; Kabir *et al.* 2019). The main source of income of this cultivation is the return from these produces. Yearly average gross return of this gardening was BDT 1,032,742 per hectare (Table 4). Study also reveals that the yearly average total variable cost and total cost of floating gardening in the study area as BDT 500,118 and BDT 574,841 per hectare. Thus, the gross margin and net return of the practice were BDT 532,624 and BDT 457,901 per hectare (Table 4). Requirement of lower fixed costs for floating gardening were the reason for lower difference between gross margin and net return of this practice. Among different groups of farmer, marginal farmers reap higher gross and net return from this practice. Better management possibilities of smaller farm and greater devotion to income generation from this practice might be the reason behind their higher income generating capacity. Overall benefit cost ratio (BCR) was 1.80, which was higher than that of land-based agriculture (Islam and Atkins, 2007; Hoque *et al.*, 2016). Islam *et al.* (2015a) also found a range of BCR from 1.6 to 2.6 for different floating vegetable cultivation in some southern districts of Bangladesh. For this higher income generating capacity, landless or marginal people of wetland areas tend to start floating gardening with a lower capital in their hands. This income earning agricultural activity helps the farmers to manage their livelihoods even in adverse situations. Thus, the result indicates the importance of this practice as an alternative source of income that may contribute to ensure food security for the respondent farmers.

Table 4. Profitability analysis of floating gardening (yearly per hectare).

Particulars	Formula	Marginal farmer	Small farmer	Medium farmer	Average
Gross return (BDT)	GR	1,048,940	1,020,523	1,047,704	1,032,742
Total variable cost (BDT)	TVC	474,407	502,601	517,551	500,118
Total cost (BDT)	TC	546,558	577,572	594,016	574,841
Gross margin (BDT)	GR-TVC	574,532	517,922	530,153	532,624
Net Return (BDT)	GR-TC	502,381	442,951	453,688	457,901
Benefit cost ratio (BCR)	GR÷TC	1.92	1.77	1.76	1.80

Factors affecting the yield of floating gardening

The value of R^2 of the model (0.69) indicates that about sixty-nine percent of the variation in yield of floating gardening was explained by the explanatory variables included in the model. Significant F-value (19.76***) implying that all the independent variables included in the model were important for explaining the variations of yield.

Cobb-Douglas production function was used to assess the factors influencing the yield of floating gardening. The estimated values of the coefficient and their related statistics have been presented in Table 5. Coefficient of human labour, fertilizers and support materials were positive and significant at 1% level. The coefficient of insecticides & pesticides was positive and significant at 5% level. The results imply that on an average, 10% increase in human labour, fertilizers, insecticides & pesticides and support materials, remaining other factors constant, would increase the yield of floating gardening by 0.10, 0.43, 0.57 and 0.54 percent, respectively. Achieving optimality might be the reason behind the smaller increase in yield with the incremental use of human labour in this practice.

Table 5. Estimated coefficients and their related statistics of production function for floating gardening.

Explanatory variables	Parameters	Co-efficient	t-value
Intercept	β_0	12.640***	3.38
Human labour (X_1)	β_1	0.010***	4.05
Seed or Seedling (X_2)	β_2	0.001	0.65
Fertilizers (X_3)	β_3	0.043***	2.62
Insecticides & Pesticides (X_4)	β_4	0.057**	2.45
Support materials (X_5)	β_5	0.054***	3.58
R^2		0.690	
F-value		19.76***	

*Note: *** and ** indicate significant at 1% and 5% level.*

Problems encountered by the floating gardeners

To identify the constraints encountered by the floating gardener of the study area, gardeners were asked to mention the problems they faced during their cultivation practices. A detail of the problems associated with this practice has been presented in Table 6. The entire problems mentioned by the gardeners were recorded and grouped into economic, technical and marketing categories and ranked based on their frequency of mentioning.

Table 6. Problem encountered by the floating gardeners.

Name of the problem	Faced by the % of floating gardener	Rank
Economic problem		
Lower farm gate price	44	1
Higher input price	19	5
Technical problem		
Lack of scientific knowledge	39	3
Pest infestation	27	4
Marketing problem		
Poor bargaining capacity	41	2
Transportation problem	18	6

Lower farm gate price, poor bargaining capacity, lack of scientific knowledge, insufficient credit facilities, pest infestation and higher input price were the mostly mentioned problems. Unfavourable economic condition of the floating gardeners might be responsible for their poor bargaining capacity as well as having lower farm gate price of their produces. Hasan *et al.* (2017) and Islam *et al.* (2019) also identified the shortage of technical knowledge as the most encountered problem in floating gardening and suggested for arranging more training to overcome the problems.

Conclusions

Floating gardening was profitable and mostly adopted by small and marginal farmers to fight against the harsh effect of climate change. Moreover, it can serve as an income generating activity in wetlands. Sensible use of human labour, fertilizers and support materials can further increase that income. Additional arrangement of training and smooth vegetable marketing system could be some crucial measures for further development.

References

Ahmed, A.U. 2006. Bangladesh climate change impacts and vulnerability: A synthesis. *In:* Comprehensive Disaster Management Programme, Climate Change Cell, Department of Environment, Government of the People's Republic of Bangladesh. 42p.

Alam, K. and Chowdhury, M.A.T. 2018. Floating Vegetable Gardening (FVG) as a Sustainable Agricultural System in Bangladesh: Prospects for Kaptai Lake, Rangamati, Chittagong Hill-Tracts. *OIDA Int. J. Sust. Dev.* 11(3): 43-58.

Awal, M.A. 2014. Water logging in southwestern coastal region of Bangladesh: Local adaptation and policy options. *Science Postprint*. 1(1): e00038. https://doi.org/10.14340/spp.2014.12A0001

Beattie, B.R. and Taylor, C.R. 1985. The Economics of Production. Montana State University, John Wiley and Sons, New York, USA. pp. 179-222.

Brouwer, R., Akter, S., Brander, L. and Haque, E. 2007. Socioeconomic vulnerability and adaptation to environmental risk: A case study of climate change and flooding in Bangladesh. *Risk Anal.* 7: 313-326. https://doi.org/10.1111/j.1539-6924.2007.00884.x

Byomkesh, T., Nakagoshi, N. and Shahedu, M.R. 2008. State and Management of Wetlands in Bangladesh, *Landscape Ecol. Eng.* 5: 81. https://doi.org/10.1007/s11355-008-0052-5

Chowdhury, R.B. and Moore, G.A. 2017. Floating agriculture: A potential cleaner production technique for climate change adaptation and sustainable community development in Bangladesh. *J. Cleaner Prod.* 150: 371-389. https://doi.org/10.1016/j.jclepro.2015.10.060

DAE. 1999. Agricultural Extension Manual. Department of Agricultural Extension, Ministry of Agriculture. Government of the People's Republic of Bangladesh. 11p.

Haq, A.H.M.R. and Nawaz, K.W. 2009. Soil-less agriculture gains ground. *LEISA*. 25: 34-35.

Hasan, S.S., Mohammad, A., Ghosh, M.K. and Khalil, M.I. 2017. Assessing of farmers' opinion towards floating agriculture as a means of cleaner production: A case of Barisal district, Bangladesh. *British J. Appl. Sci. Tech.* 20(6): 1-14. https://doi.org/10.9734/BJAST/2017/33635

Heady, E.O. and Dillon, J.L. 1961. Agricultural production functions. Iowa State University Press, Ames. 8p.

Hoque, M.Z., Haque, M.E., Afrad, M.S.I. and Islam, M.N. 2016. Effectiveness of floating agriculture for adapting climate change in southern Bangladesh. *Int. J. Econ. Theory Appl.* 3(1): 14-25.

Irfanullah, H.M. 2009. Floating gardening in Bangladesh: Already affected by climate variability? pp. 7-14. *In:* Biodiversity conservation and response to climate variability at community level, IUCN, UNEP, UNU, Dhaka, Bangladesh.

Irfanullah, H.M. 2013. Floating gardening: A local lad becoming a climate celebrity? *Clean Slate.* 88: 26–27.

Irfanullah, H.M., Adrika, A., Ghani, A. and Khan, Z.A. 2007. Introduction of floating gardening in the north-eastern wetlands of Bangladesh for nutritional security and sustainable livelihood. *Renewable Agric. Food Syst.* 23(2): 89–96. https://doi.org/10.1017/S1742170507002074

Irfanullah, H.M., Azad, M.A.K., Kamruzzaman, M. and Wahed, M.A. 2011. Floating gardening in Bangladesh: A means to rebuild life after devastating flood. *Indian J. Tradi. Knowl.* 10(1): 31-38.

Islam, M.A., Kamruzzaman, M., Akter, A. and Roy, P.C. 2015a. Perception of Haor farmers about the innovative features of floating farming. *Int. J. Nat. Soc. Sci.* 2(4): 52-58. https://www.aascit.org/journal/archive2.

Islam, M.A., Khandoker, M.S.A. and Choudhury, S. 2019. Constraints of floating farming in haor area of Bangladesh. *Int. J. Agril. Sci.* 9(9): 001-005.

Islam, M.A., Shitangsu, P.K. and Hassan, M.Z. 2015b. Agricultural vulnerability in Bangladesh to climate change induced sea level rise and options for adaptation: a study of a coastal Upazila. *J. Agric. Environ. Int. Dev.* 109(1): 19-39. https://doi.org/10.12895/jaeid.20151.218

Islam, T. and Atkins, P. 2007. Indigenous Floating Cultivation: a Sustainable Agricultural Practice in the Wetlands of Bangladesh. *Dev. in Prac.* 4(1): 130–136. https://doi.org/10.1080/09614520601092733

IUCN. 2008. Bangladesh Baira: The Floating Garden for Sustainable Livelihood. www.apan-gan.net › Projects.

Kabir, A., Hasan, M.M., Ahmed, B. and Islam, S. 2020. Climate change perception and adaptation strategies of southwest coastal Bangladesh. *American Sci. Res. J. Eng. Tech. Sci.* 66(1): 47-68.

Kabir, M.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. Agril. Stud.* 7(2): 75-86. https://doi.org/10.5296/jas.v7i2.14788

MoEF. 2005. National Adaptation Programme of Action (NAPA). Final Report, Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh. 38p.

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. *Int. J. Environ. Stud.* 71(3): 261-269. https://doi.org/10.1080/00207233.2014.911406

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. Agron. Plant Prod.* 4: 745–752.

Saha, S.K. 2010. Soilless cultivation for landless people: An alternative livelihood practice through indigenous hydroponic agriculture in flood-prone Bangladesh. *Ritsumeikan J. Asia Pacific Stud.* 27: 139-152. Retrieved at www.apu.ac.jp/rcaps/uploads/fckeditor/.../RJAPS_V27_Saha.pdf

Sen, S. and Zaid, F.A. 2010. Communities cope with flooding situation with Gaota. *LEISA*. 12: 22-23.

Sujan, H.K., Islam, F., Kazal, M.H. and Mondal, R.K. 2017a. Profitability and resource use efficiency of potato cultivation in Munshiganj district of Bangladesh. *SAARC J. Agric.* 15(2): 193-206. https://doi.org/10.3329/sja.v15i2.35151

Sujan, M.H.K., Islam, F., Azad, M.J. and Rayhan, S.J. 2017b. Financial profitability and resource use efficiency of boro rice cultivation in some selected area of Bangladesh. *African J. Agric. Res.* 12(29): 2404-2411. https://doi.org/10.5897/AJAR2017.12443

Winterborne, J. 2005. *Hydroponics: Indoor Horticulture*. Pukka Press Ltd., UK. 258p.