FACTORS AFFECTING ADOPTION OF COMMERCIAL VEGETABLE CULTIVATION IN SOME AREAS OF BANGLADESH

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*This is to certify that thesis entitled, "**FACTORS AFFECTING ADOPTION OF COMMERCIAL VEGETABLE CULTIVATION IN SOME AREAS OF BANGLADESH**" submitted to the Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **AGRIBUSINESS AND MARKETING**, embodies the result of a piece of bona fide research work carried out by **MD. MAZHARUL HOQUE BHUIYAN**, Registration No. **14-06033** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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.

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“**God will exalt those of you who believe and**

those who have knowledge to high degrees”

- Surah Al-Mujdalah:11 (Al Quran)

Gratitude to those beloved people

who have meant and continue to mean so much to me but

no longer exist of this world

LIST OF ACRONYMS AND ABBREVIATIONS

AEZ	Agro-Ecological Zone
AVDRC	Asian Vegetable Research and Development Center
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
BFVAPEA	Bangladesh Fruit, Vegetable and Allied Products Exporters' Association
CIAT	International Center for Tropical Agriculture
CCR	Correct Classification Rate
DAE	Department of Agricultural Extension
DAM	Department of Agricultural Marketing
DFID	Department for International Development
GDP	Gross Domestic Product
GSP	Generalized System of Preferences
Ha	Hectare
HVAPs	High value Agricultural Products
ICARDA	International Center for Agriculture Research in the Dry Areas
IPM	Integrated Pest Management
M.sing	Mymensing
SDSN	Sustainable Development Solutions Network
UN	United Nations
UNRISD	United Nations Research Institute on Social Development

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Md. Mazharul Hoque Bhuiyan

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FACTORS AFFECTING ADOPTION OF COMMERCIAL VEGETABLE CULTIVATION IN SOME AREAS OF BANGLADESH

ABSTRACT

Responding to climate amicable global summons, Bangladesh attempts to exalt UN-SDSN principles focusing 'International Fruit and Vegetable Year-2021'. Nation's horticultural welfare-oriented planning stimulates farmers swap to sustainable vegetable cultivation. This study illustrated the factors influencing vegetable commercialization from grain crop. A dichotomous logistic regression analysis was conducted using statistical package program (comprising Hosmer-Lemeshow, R^2cox-snell and R^2Nagelkerke tests) and enumerating marginal effect co-efficient value. 120 local participants from four districts of Madhupur tract (purposive sampling) were queried thirteen quantitative responses. Research revealed age, IPM consciousness, women participation, crop selling market and grain crop independence were statistically significant corresponding with marginal effect co-efficient. Moreover, study depicted that 73.3% of farmers was stimulated by extension department, with 80% willingness to extend arable vegetable land over 46% than before. Furthermore, almost 80% respondents confronted incentives with having 73% significant impact on livelihood and social security. Finally, some perplexities were distinguished along with compatible suggestions to mobilize country's self-complacent in vegetable.

Keywords: vegetable commercialization, Madhupur tract, cultivation swap, vegetable profitability, cultivation perplexities.

CHAPTER 01

INTRODUCTION

1.1. **Background of the study**

Bangladesh, a land area of 1,47,610 square km, is world's largest delta with mostly flat fertile topography famed by the mutable amount of rainwater (BBS, 2020). Most of its inhabitants over 40% of the entire labor force directly or indirectly are involved in agrarian actions for livelihood and contribute up to 13.47% of the country's GDP (BER, 2021). Vesting with an exceptional six season climates, more than 150 vegetables (including 35 key vegetables), 70 fruits and 60 spices are produced on this ground (Terry, 2011; MoA, 2018). These auspicious crops led Bangladesh to hold the third position after China and India in terms of producing vegetables (FAO, 2020).

Vegetables may be entitled as patrons in exalting human health that deliver a promising economic convenience for fastening women engagement as well as financial security in Bangladesh (Alam, 2017). Currently, due to its response toward climate amicable global call by meeting responsible consumption and production, Bangladesh is presented 'SDG Progress Award (SDSN, 2021). Accordingly, nations around the world are now stirring diversified futuristic actions to meet up the existing horticultural crop demand with sustainable progressive technology and innovative marketing techniques. Moreover, the UN declaration on the 'International Year of Fruits & Vegetables 2021' motto accelerates enthusiasm toward climate affable global ecosystems (Grünwald, 2021).

Horticultural crops comprise various crops including vegetables, tuber crops, fruits, flowers, healing and aromatic plants, mushrooms and spices (Sonah *et al.*, 2011). Vegetables are immense sources of vital vitamins including A, C, niacin, thiamin, riboflavin and minerals that form accessible dietary fiber compulsory for digestion and cure nutritional disorders (Terry, 2011). Additionally, these crops have become a boon for the developing countries like Bangladesh thanks to its relatively higher sustainable yield and higher lucrative return than other crops (Hasan *et al.*, 2020). Therefore, to cope up targets with both economic and nutritional aspects, vegetable production has seen tremendous growth (almost doubled) in the last decade in Bangladesh, generating new earning sources, increasing trade and income and advancing toward self-complacent SDG targets fulfillment (MoA, 2018).

Bangladesh by birth possesses fertile land with 535 agroecological units under 30 Agro Economical Zones (BBS, 2017). Out of 30 AEZs, the Madhupur tract, drained by the Brahmaputra-Jamuna river system, supersedes other tracts due to its terrestrial position supremacy, contingent nature of climate and soil, convenient marketing feasibility (Hoq *et al.*, 2012; BARC, 2013; BBS, 2017). This tract comprises of 4,244 sq. km ranges from Dhaka, Gazipur, Mymensingh, Narsingdi, Tangail, Kishorhonj (Islam, 2012).

Madhupur tract region, situated at north-central part of Bangladesh, for its deep brownish well-drained acidic terrace soil conducive to horticultural crop cultivation and year-round or two seasons crop could be easily purveyed (BBS, 2017; Nasim *et al.*, 2018). The most general vegetable containing cropping pattern was Vegetable-Vegetable-Vegetable followed by Vegetable−Fallow−T. Aman (Nasim *et al.*, 2018).

Native peasants cultivate numerous vegetables on this vast tract like different gourds (bitter gourd, bottle gourd, pointed gourd and ridge gourd), long yard beans, eggplant, tomato, cucumber, cauliflower, pumpkin and aroids (BBS, 2020). Antecedently, most of the subsistence native farmers who resided on this tract had scanty marketable surplus (WB, 2014). However, latter-day commercial vegetable productions were getting momentum and cognized as well as skilled farmers are coming forward increasingly to meet up the potential market expansion. (Razzaque and Hossain, 2007; Karim *et al.*, 2011). These vegetables also get renowned across country border alongside homeland demand. According to Bangladesh Fruit, Vegetable and Allied Products Exporters' Association (BFVAPEA), this country is currently exporting 50 varieties of vegetables in 118 nations including the Kingdom of Saudi Arabia, UAE, Malaysia, Hong Kong, and UK were the leading importers (MoA, 2018). Most importantly, foremost of the shipped vegetables are grown in this tract (Hoq *et al.*, 2012).

Due to such a promising economic point of assessment, peasants are more enthusing in the agrarian decision based on the role of several economic as well as non-economic livelihood factors (Begum *et al.* 2011; Khandoker *et al.* 2014; Hasan *et al.* 2020). Thus, an effort has been made to study some of the background factors such as age structure, arable land size, IPM practicing consciousness, women participation, market locations and grain crop requirement at households that

stimulate the peasants shifting into vegetable production in detail. However, this cultivation swapping confronts some perplexities that interrupt to attain a broad range conclusion (Khandoker et al. 2017; Hasan et al. 2020).

1.2. **Research questions**

A good research question acts as a lighthouse that pinpoints the entire research task focused, relevant and feasible. Following specific and reasonable questions are illustrated to conduct the present study.

1. What livelihood standard do the research area farmers belong to?

2. How much margin purvey from vegetable farming comparing with other crops?

3. Which factors stimulate the farmers most to swap the cultivation?

4. Which complexities cost more and how to overcome those barriers?

This paper is aggrandized with a chronological step to expose the current queries with relevant and reasonable scenarios.

1.3. **Objectives of the study**

From the above viewpoints, the current study takes an effort to depict the following objectives in accordance with the research enquires:

1. To identify the socio-economic profile of vegetable farmer;

2. To measure the profitability of different vegetable comparing with cereal-grain crops;

3. To examine the factors influence on vegetable farming in survey area;

4. To analyze the constraints confronted at vegetable commercialization.

1.4. **Justification of the study**

Nations around the world are currently passing through global summons under the SDG formula keeping climate safeguards and efficient resource allocation in the limelight. In Bangladesh, vegetables play charismatic sustainable roles in economic and social compass for ameliorating income and nutritional status, food and financial security.

Madhupur tract, enriched with climate and soil lushness conducive to horticultural crop production, prompt to be seen as a prominent agrarian hub of this country. Most importantly, such cultivation pattern stimulates climate amiable horticulture, women involvement and overall livelihood advancement. A comprehensive cultivation swap is observed at the rural end. This notion procreates the current research theme to uncover the cabalistic factors associated with swap. Meanwhile, several crucial constraints remedial outline would assist in reaching the nation's food self-sufficiency.

Finally, the outcomes purveyed from this research are anticipated to be convenient to the apprentices, academic researchers and extension policy makers of different associations to promote strategies and approaches for effective expansion actions with the pastoral peasants, specifically with the rural women.

1.5. **Research framework**

This study comprises five major chapters. Chapter 1 designates the introduction of the study. It is decorated with a preliminary overview and objectives pertinent to research questions. Next, chapter 2 deals with literature review that will demonstrate the antecedent study with purveyed outcomes and deficiencies. Following that, the materials and methods section in chapter 3 will display the roadmap of the entire study including data collection method, regression model construction and pertinent variable illustration, study validity, ethical issues and limitations. Chapter 4, representing results and discussion, will be incorporated with research outcomes and description. Finally, chapter 5, the conclusion and summary will enwrap up the research and depict the key findings. Additionally, compatible suggestions, study limitations and avenues for farther research will be set out.

CHAPTER 02

REVIEW OF LITERATURE

Attempts had been made to accumulate secondary data for constructing a comprehensive systematic review (presented in appendix IV) from numerous sources keeping relevant with research purposes.

2.1. **Vegetable commercialization prospect**

Diversified crisis including extreme natural food-chain exploitation as well as COVID-19 pandemic caused the world to confront perplexities in food production and distribution as well as complexities in environmental issues maintenance. To feed the fast-growing world population, United Nations formulated a diversified scheme under which the 'International year of fruit and vegetable 2021' proposal outlined a climate amiable global food production strategy (Grünwald, 2021). Cultivating vegetables under these differentiated climatic features may be acted as an idyllic prospect for the general in flourishing nations to promote their revenue and meet their nutrition aspect spontaneously (Bhardwaj, 2012). Muriithi and Matz (2015) pointed out a positive connection between vegetable commercialization and household welfare enrichment. More entree to national, neighbor and global markets for vegetables could afford more income incentives and more surplus to the underprivileged individuals (Muriithi and Matz, 2015; Grünwald, 2021). Response to universal call, under Bangladesh welfare-oriented planning, the nation's vegetable-oriented land uplifted by almost 29%, almost 1.25 million hectares in 2018-19 fiscal period only 0.98 million hectares in 2013-14 (BBS, 2020). Additionally, country's vegetable production around 26.7 million tons had seen a significant rise of 37.63% in five years (BBS, 2020). Just before the initiation of twenty first century, Mahmud et al. (1994) expressed that under non-irrigated or semi-irrigated conditions in Bangladesh, varietal agrarian practices relevant to non- grain crops would be more lucrative and could drive to crop diversification as a fruitful aspect for the sustainability of national agriculture.

Ameliorating national as well as global vegetable production and distribution in sustainable manner would ensure an efficacious food economy and restore climate lushness (BBS, 2020; Bhardwaj, 2012; Grünwald, 2021; Mahmud et al., 1994; Muriithi and Matz, 2015)

2.2. **Physiography of Madhupur tract and vegetable cultivation pattern**

Bangladesh by birth possesses very fertile land with 535 agroecological units under 30 Agro Ecological Zones (BBS, 2017). Out of 30 AEZs, the Madhupur tract, drained by the Brahmaputra-Jamuna river system, comprises of 4,244 sq. km ranges from Dhaka, Gazipur, Mymensing, Narsingdi, Tangail majorly and some portions leftovers in Kishorgonj and Narayangonj (Islam, 2012).

The northern climate of the Madhupur tract is comparatively cooler than south in winter. Usual temperatures varied from 10o to 20oC in winter as well as 28oC to 32oC in summer and precipitation ranged between 1,000 to 1,500 mm per year that is conducive to vegetable cultivation (Islam, 2012). The alluvial pH is highly acidic to slightly acidic entailed in red-brownish soil mostly silty clay loam in nature (Begum et al., 2009; Lira et al., 2014). Meanwhile, Maynard et al. (2007) stated that green & colored vegetables could be raised pleasingly in acidic soil by keeping pH values 4.5 to 6.8. Therefore, it can be exemplified that this tract supersedes other tracts due to its terrestrial position supremacy, contingent nature of climate and soil, convenient marketing feasibility (BARC, 2013; BBS, 2017; Hoq et al., 2012).

Both alluvial supremacy and geological position accelerate vegetable cultivation (BARC, 2013; Begum et al., 2009; Hoq et al., 2012; Islam, 2012; Maynard et al., 2007)

2.3. **Comparative advantages in vegetable over grain crops cultivation**

Antecedently, most farmers were at the subsistence level (which means major portions of production were gone to restrain his family members' appetite) thus the marketable surplus rate was scanty (WB, 2014). However, latter-day commercial productions are getting momentum and farmers with proper knowledge as well as profit incentive motive are grabbing the opportunity to meet up the potential market expansion (Karim et al., 2011; Razzaque and Hossain, 2007).

Bisbis et al. (2018) pointed out that vegetables provide utmost output and more incentive per unit area of land to small-scale growers, particularly when equated to

cereals under various weather scenario. Moreover, Fatema (2006) researched that crops were lucrative because of labor intensive cash harvests and relatively short production cycles than staple crops and less risky as compared than pulses and mustard like field crops. Additionally, peasants who are engaged in the production of vegetables often earn higher earnings than those involved in the production of cereal crops alone (Begum et al., 2011; Chandra et al., 2020; Chowdhuri et al., 2014; Hasan et al., 2020; Parvin, 2008; Weinberger and Lumpkin, 2005). However, some traditional farmers purveyed more incentive in cereal substances mainly rice crop to build better living standard (Rasha et al., 2018).

Vegetable production proven out incentive and short time span compared with cereal cultivation although few upheld their ancestors' cereal preferences (Bisbis et al., 2018; Begum et al., 2011; Chandra et al., 2020; Chowdhuri et al., 2014; Hasan et al., 2020; Karim et al., 2011; Parvin, 2008; Rasha et al., 2018; Razzaque and Hossain, 2007; Weinberger and Lumpkin, 2005).

2.4. **Earning source swapping from one source to another**

From the cradle of human civilization, individuals swapped one earning source to another for better incentives and attaining livelihood. El-Solh et al. (2009) identified that commercialization enables farmers to shift their inclination to a market-oriented production from the conventional farming scheme and generating more earning sources oriented for women and women-headed families. Altering earning sources improved farm income, brought new bases of employment and altered gender roles as well as relations (Gurung et al., 2016). Khandoker et al. (2014) demonstrated that farming area changed in favor of horticultural harvest from cereal crop had been proposed as a viable option not only to stabilize and promote farm earning but also to enhance agricultural growth and employment chances. Generally, such altering decisions are influenced by the sources closer to the farmer including neighbor, extension individuals or electronic media (Khandoker et al. 2017).

Cognized farmers desire to move onto vegetable production rather than cultivation traditional grain crops in light of commercial profitability and enhance livelihood (El-Solh et al., 2009; Gurung et al., 2016; Khandoker et al. 2014; Khandoker et al. 2017)

2.5. **Factors influencing farmer's decision towards commercial vegetable cultivation**

Some studies demonstrated the key influencers including age (Akter, 2009; Ali *et al.*, 2001; Battese and Coelli, 1995; Farid *et al*., 2015; Kabir and Rainis, 2015), farm size (Andrew and Anna, 2005; Farid *et al*, 2015), IPM practice consciousness (Kabir and Rainis, 2015), women participation (Akhter, 2010; Kabir and Sarker, 2015; Rahman, 2000; Sobhan and Khondokar, 2001), product selling market (location of market) (Muamba, 2011; Rabirou *et al*., 2009; Rahman, 2020), grain crop requirements at home (Khandoker *et al.*, 2014; Mahmud *et al.,* 1994) are brought into light that decorate farmer agrarian activity decisions.

2.5.1. **Age distribution**

Commonly, active aged young communal individuals show more enthusiasm in vegetable growing (Akter, 2009; Battese and Coelli, 1995; Kabir and Rainis, 2015). However, Ali *et al.* (2001) and Farid *et al*. (2015) found no cabalistic relationship with age factor in deciding cultivation.

2.5.2. **Arable farm size**

Andrew and Anna (2005) demonstrated that small vegetable plots have privileged with respect to labor deployment, pests and disease management. Meanwhile, Farid *et al.* (2015) found more intention of large farm cultivars toward vegetable farming.

2.5.3. **IPM consciousness**

Kabir and Rainis (2015) found that IPM cognized farmers made comparatively more profit and inclined to enhance the existing farm size further.

2.5.4. **Women participation/assistance**

Kabir and Sarker (2015) stated the dynamism of women participation in horticulture wing specifically in homestead vegetable farming (Sobhan and Khondokar, 2001). About 14-48% of entire agricultural female labor were engaged in non-cereal (Rahman, 2000) who exercised most of their time in pre-harvesting actions including fencing (53%), fertilizing (52%), watering (65%) and weeding (56%) (Akhter, 2010). Share of women's labor increases overtime with comparatively less wage required the demand for hired female labor as anticipated while declining the

demand for hired male labor (Akhter, 2010) which ultimately denoted a wide extent of young and middle-aged women involvement (Kabir and Sarker, 2015).

2.5.5. **Crop selling market (Location of market)**

Muamba (2011) showed that wider market participation promoted the alteration of the farmers' economic position from subsistent or semi-subsistent to specialization where they cultivate crops for a proportional advantage. Rahman (2020) further added that farmers who receive immediate payment at harvest and can introduce the potential customers with their forthcoming production. Therefore, a convenient marketing system may accelerate cultivation spontaneously. However, Rabirou *et al*. (2009) stated that farmer would expand their farming arena with their experience and capacity not with farm distance from market notion.

2.5.6. **Grain crop independence**

Mahmud *et al.* (1994) identified an acute struggle for land among Boro season rice and non-rice due to irrigation inconveniences. Additionally, Khandoker *et al*. (2014) exposed that cereal food crop requirement had negative relation with the decision of altering cultivation. It meant that additional cereal food requirements at household inhibited the scope of crop swap decision of the peasants.

From these aforementioned factors impact on cultivation, it is apparent that adoption or alteration or apathy are much more influenced by these certain factors.

2.6. **Major vegetable cultivation and marketing perplexities**

Major difficulties were identified including insect and disease infestation, lack of acquaintance on modern technology, middle men outrage, environmental stress variety, lack of capital and labor crisis (Chandra *et al.,* 2020). Hasan *et al*. (2020) added two more problems counting price fluctuations at market and lack of extension authority supervision. Meanwhile, Missanga and Rubanza (2018) put more emphasis on quality seed deficiency and climate as well as environmental stress aspects.

2.7. **Antecedent study gaps**

Several empirical evidence and significant researches had been observed to enumerate earning source swap pattern along with the land superiority and crop profitability in light of climate fluctuation. However, most of them are in a scrappy pattern and conducted in dissimilar alluvial tracts. Cumulative studies were found absent in any other locations that expressed the aforementioned contextual factors behind commercial vegetable cultivation swap. Therefore, an attempt has been made to study the aforementioned background factors that influence the land cultivars towards vegetable production. On the contrary, cabalistic constraints need to be outlined with time compatible actions to grasp vegetable commercialization efficiently.

CHAPTER 03

MATERIALS AND METHODS

The methodology used in leading research need very careful deliberation. The Questionnaire with valid information (including most of the quantitative data) has played the role of roadmap for the comprehensive study. The methods and procedures followed in directing this research are being described beneath:

3.1. **The Conceptual framework of the Study**

In technical study, selection and measurement of variables found a vital task. The conceptual framework of Rosenberg and Hoveland (1960) was reserved in mind while edging the formative layout for the dependent and independent variables which is presented in Figure 01. This present study is attempted to focus on two insight: the first, the certain aspects of producer end and the second, intuition of producer/farmer toward vegetable crop and benefits as well as constraints confronted due to such cultivation.

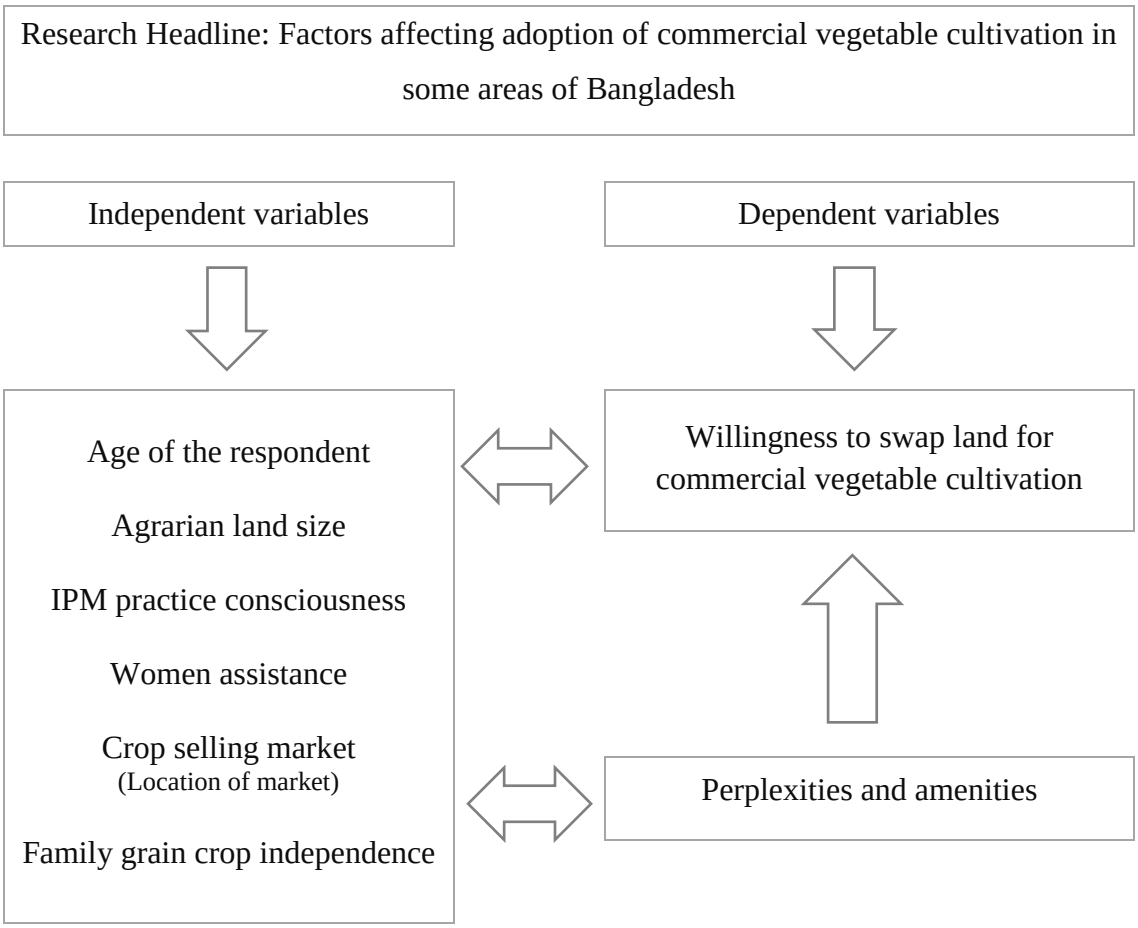


Figure 01: Conceptual framework of research study

(Source: Researcher's own design, 2021)

3.2. **Locale of this Study**

According to Yang (1962) the extent to which an agrarian survey is to be completed depends on the particular study purpose and the plausible farmers cooperation. Experimental site has been exposed in the Map of AEZ of Bangladesh. The study was operated in five vegetable arable areas under Dhaka, Gazipur, Mymensingh and Narsingdi districts. The explored areas belong to the Agro-Ecological Zone (AEZ) of "The Madhupur Tract", AEZ-28. In this study region almost 56% of the working population is involved in agriculture (BBS 2020).

Figure 02: Survey locations of Madhupur Tract (AEZ-28) at North-Central Region

3.3. **Sampling Technique and Sample Size**

A purposive sampling design was pursued to assemble sample farmers for this study. At the beginning stage, four districts were selected according to the highest concentration of vegetable production. Madhupur tract mainly expanded in Dhaka, Gazipur, Mymensingh, Narsingdi and Tangail district (BBS, 2017), although sample survey was done excluding Tangail due to time as well as economy deficiency and Kishorgonj as well as Narayangonj districts were discounted as small portions of tract remaining there (Islam, 2012).

Table 01. Area and production of vegetables in study area districts as a whole with respect to entire Bangladesh for FY 2019-20.

Crops	Area (acres)		%	Production (Metric Ton)		%
	Survey site	Bangladesh		Survey site	Bangladesh	
Okra	2,456	28,515	09	4,491	55,905	08
Cucumber	2,547	24,413	12	11,614	82,963	14
Bitter gourd	2,431	27,484	09	6,862	59,371	12
Bottle gourd	7,566	49,096	15	49,916	250,613	20
Broccoli & Cauliflower	4,354	54,205	08	34,015	283,157	12
Ridge gourd	2,418	25,085	10	4,249	52,575	09
Snake gourd	2,781	19,778	14	7,429	42,938	17
Tomato	3,665	70,460	05	20,666	415,494	05
Bean	5,435	61,628	09	24,855	169,735	15
Average			10.1			12.5

Source: (BBS, 2020)

Since area soil under survey is comparatively more fruitful than other districts production attitude, therefore survey zone selection was feasible and relevant indeed.

Finally, a total of 120 farmers including 30 farmers from each district were randomly selected for interview in terms of data availability, ease of data collection, accessibility and logistic supports.

Table 02: Sampling framework of the vegetable grower in the study area

District	Upazila	No of vegetable farmers (district wise)		Women-led farm
		Full-time grower	Partial grower	
Dhaka	Savar	23	7	4
Gazipur	Kapasia	14	1	2
	Sreepur	13	2	1
Mymensingh	Gafargaon	22	8	6
Narsingdi	Shibpur	22	8	5

(Source: Field study, 2021)

3.4. **Period of Study**

Effective time management allows the researcher to affix the research productivity (Chase *et al.* 2012). Thus, an exquisite time schedule was structured to get the relevant info. The data collection period was November 2020 to March 2021.

3.5. **Preparation of Survey questionnaire**

A structured sample survey is the primary determining instrument in survey research (Cheung, 2014). A set of comprehensive structured sample questionnaire was set to collect fixed scheme information relevance with the objectives of the study (Marsden and Wright, 2010). Eventuality, open and close-ended enquiries were applied according to the purpose of the survey (Roopa and Rani, 2012). The necessary adjustments were made for a final survey outline.

3.6. **Collection of Data**

The primary data were composed by face-to-face interviewing the categorized respondents according to survey nature (Kabir, 2016; Khandoker, 2017) both at the home and farm side of the respondents. It was inconvenient to collect precise data since farmers did not retain any records of their farm activities in black and white. To overcome this labyrinth, all possible efforts were made by the researcher to confirm the precise info collection. Before beginning the interview, each respondent was provided a brief sign about the nature and purpose of the study and they were persuaded that it was merely for academic study purposes. Responses were chronicled and will be used only to serve the purpose of Master's research project.

3.7. **Processing of Data**

Actions were occupied during the data collection period to lessen the possible errors. The composed data were manually revised and coded. After that, all the collected data were shortened and examined prudently. Data were processed to transfer to facilitating tabulation to meet the study's objectives. Moreover, data entry was provided in computer and analyses were done using the concerned software Stata. It may be noted here that data were composed initially in local units. After obligatory checking it was converted into standard worldwide units including hectare, metric ton.

3.8. **Categorization of data**

For describing the diverse characteristics, the respondents were classified into several categories. These categories were settled by considering the data distribution nature, general thoughtful prevailing in the social system and possible observed scoring system.

3.9. **Analytical Technique**

To meet particular study objectives, several analytical methods were employed in the present study (Parvin, 2008; Khandoker *et al.,* 2014; Hasan *et al.,* 2020).

3.9.1. **Descriptive analysis**

Tabular and graphical analysis strategies were commonly used to expose the socio-demographic profile of the respondent and to demark the profitability of vegetable farmers along with their grain crop respectively.

Chronicle and descriptive techniques were followed to evaluate the complied data by using software named Stata.

Benefit-cost ratio (BCR)

It is an exponent presenting the association between the relative costs and benefits of a proposed crop in accordance with another crop, expressed in numeric term. If a scheme has a BCR greater than 1.0, the undertaking production scheme is projected to deliver a positive net return value to a farm and vice-versa.

3.9.2. **Functional technique**

3.9.2.1. **Hypothesis statement**

Research regression need to have hypothesis for acknowledging the significance.

Null hypothesis, H_o = Farmers socio-economic factors had no influence on willingness towards vegetable commercialization,

Alternative hypothesis, H_1 = Farmers socio-economic factors had significant level influence on willingness towards vegetable commercialization.

3.9.2.2. **Regression model expression**

A mathematical concept of logistic regression may be expressed to weigh the factors affecting the level of changing pattern by the peasants through constructing an association between outcome variable and predictor variables (independent variable) in terms of logit: the natural logarithm of odds (Abedin et al., 2016). Let's consider as simple case where Y is a dichotomous outcome variable categorized as "1" and "0". Logistic regression facilitates the situation by logit transformation on the outcome variable Y. The simplest form of regression model may be entitled as:

$$\mathbf{Y = Logit(P) = ln\ (P\ /\ 1\text{-}P) = \alpha + \beta_1 X}$$

Hereby, P is the probability of occurring outcome Y and P/1-P is the odd of willingness. But, if more than one explanatory variable exists, then the multiple logistic regression model becomes as follows:

$$\ln (P / 1\text{-}P) = \alpha + \beta_j X_{ij} \text{ Since: } i = 1,2, \ldots \ldots, n, j = 1,2, \ldots\ldots, J$$

In this experiment, the expanded equation is as:

$$\mathbf{Y = Logit(P) = ln\ (P\ /\ 1\text{-}P) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 D_6 + e}$$

Where,

Y = '1' denotes interests and '0' denotes reluctance in vegetable commercialization

X_1 = Age distribution (years)

X_2 = Farm size (ha)

X_3 = IPM practicing knowledge (scale score)

X_4 = Women assistance/participation (scale score)

X_5 = Marketing reach capacity (scale score)

D_6 = Grain crop independence (binary score)

α = Intercept

β_1, β_2 --------- β_6 = Regression coefficients of the respective variables to be estimated

e = Random error

By taking antilog of both sides of equation, the probability of the occurrence of outcome Y for a given value of predictor X:

$$P = P(Y \mid X = X)$$

$$= e^{\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6} / 1 + e^{\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6D6}$$

$$= 1 / 1 + (e^{\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7D7})^{-1}$$

Thus, the probability of the response variable (y) taking the value (1) is

$$P(Y=1 \mid x) = 1 / 1 + (e^{\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6D6})^{-1}$$

And the probability that the response variable (y) takes the value (0) is

$$P(Y=0 \mid x) = 1 / 1 + e^{\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6D6}$$

Statistical significance of co-efficient can be proved via Hosmer-Lemeshow test and pseudo R^2 test (Abedin et al., 2016; Bairmani and Ismael, 2021). After that logit model co-efficient and marginal effect co-efficient will be estimated to delineate significance of the variables.

The **first method** is the examining statistical significance of regression equation:

A. **Hosmer-Lemeshow test**

The Homger-Lemeshow test is used for evaluating the estimated model fitness (Hosmer and Lemeshow, 2013). If (calculated value of HL > the tabular value Chi-square) at a level of 5% significance, the model would be identical to the observation data (Bairmani and Ismael, 2021).

B. **$R^2_{cox\text{-}snell}$ and $R^2_{Nagelkerke}$ tests**

The Cox & Snell R Square and the Nagelkerke R Square values provide an indication of the amount of variation in the dependent variable explained by the model (from a minimum value of 0 to a maximum of approximately 1).

The **second method** is the observing statistical significance of independent variable through Logit model and marginal effect co-efficient:

C. **Logit model co-efficient**

The logistic regression coefficient β associated with a predictor X is the expected change in log odds of having the outcome per unit change in X. So increasing the predictor by 1 unit (or going from 1 level to the next) multiplies the odds of having the outcome by e^{β}.

D. **Marginal effect co-efficient**

Marginal effects are a useful way to describe the average effect of changes in explanatory variables on the change in the probability of outcomes in logistic regression.

3.10. **Measurement of independent variables**

Independent variables under this study were six selected features, namely: age, farm size under cultivation, IPM consciousness, women participation, crop selling market, grain crop requirements at home. The depiction of the independent variables is given below:

3.10.1. **Age distribution**

Time length that a person has lived (Séguy et al. 2019); is measured on year unit.

3.10.2. **Farm Size**

Farm size denotes to the total arable area either owned by a farmer or obtained from others on share cropping system or taken from others as mortgage/lease where s/he used to do his/her farming operations during the period of this study (Rahman and Norton, 2019). The farm size of the respondent was calculated by using the following formula:

Farm size = (Own land + Rented in + Leased in + Mortgaged in)

– (Rented out + Leased out + Mortgaged out)

10.3. **Integrated pest management (IPM) practicing consciousness**

According to Food and Agricultural Organization (FAO, 2017), IPM is a well-defined pest management system including all suitable methods and techniques in a compatible manner to uphold the pest populations below economic injury level.

A three-point assessment scale was used to rank the consciousness of recommended 10 IPM practices by the vegetable growers. The respondents indicated their adoption of ten IPM practices by choosing a suitable answer from three options, including "frequently," "occasionally" and "rarely or never". Then an index was settled to fulfill this objective using the following formula:

$$\mathbf{IPM_{PA} = N_1 \times 2 + N_2 \times 1 + N_3 \times 0}$$

Where, IPM_{PA} = IPM Practice index, N_1 = No. of used IPM practices frequently, N_2 = No. of used IPM practices occasionally, N_3 = No. of used IPM practices rarely or never.

IPM practice could range from 0-20. Whereby, Low adoption (up to 8), Medium adoption (8-12), High adoption (above 12).

10 IPM practices are mentioned including practice of weed management (uprooting), crop rotation, cultivation of resistant variety, pheromone trap/yellow sticky trap, pesticides made at home manually (soap / neem oil / salt spray), soil amendment using poultry refuse/ farmyard manure, vermi-compost, natural enemy / parasitoids, hand picking of insect, wearing protection (dress, gloves, goggles).

3.10.4**. Women assistance/participation**

In the present study, rural women participation score was computed in three points rating scale manner for involvement in each agrarian practice. Participation level was categorized into three major categories: crop cultivation and take care, crop harvest and sorting out, finally crop marketing. The respondents indicated by choosing a suitable answer from three options, including "frequently," "occasionally" and

"rarely or never". An index was developed to fulfill this objective using the following formula:

$$\mathbf{WM_{PA} = N_1 \times 2 + N_2 \times 1 + N_3 \times 0}$$

Where, WM_{PA} = Women participation index, N_1 =Number of participations frequently, N_2 =Number of participations occasionally, N_3 =Number of participations rarely/never.

Women participation could range from 0-6. Whereby, low participation (up to 2), medium involvement (3-4), high involvement (above 4).

3.10.5. **Crop selling market** (location of market)

Agricultural market generally means an open place or large building where actual trade occurs (Myers *et al.* 2010). It may range to a locality, village town, region or a country according to the demand of a commodity. On the basis of location, we may organize agricultural markets into three broader groups. Whereby, each of them is assigned with ascending scale score based on potential high commodity price gained by the seller.

Table 03: Market classification and assigned score

Existed market	Characteristics	Assigned score
Local market / village market	Markets located in minor towns and at farmer convenient places (even at their farm end)	1
Primary market	Markets held in the open place or at roadside stands in centrally situated areas (such as haat- held once/twice a week on particular days)	2
Secondary market	Regular wholesale markets or permanent places for daily transaction. These markets (such as upazila/district level market) also have grading, warehousing, transportation and banking facilities.	3

(Source: Researcher questionnaire, 2021)

3.10.6. **Grain crop independence at home**

In Bangladesh, rice still accounts for 70-75 percent of calorie intake and about 367 grams of parboiled rice is eaten by common people at least twice a day (HIES, 2016). Thus, in this cabalistic scenario, farmer's family food intake nature and ancestral cultivation behavior flings to cultivate cereal crop in their field. Finally, the family size s/he leads and family earning member play as the crucial factor to enumerate the cereal crop requirement. However, commercial production of vegetables is also gaining momentum and cognized farmers are increasingly coming forward to undertake this venture. (Karim *et al*., 2011).

Table 04: Farmers classification by grain crop independence at home

Types of farmer	Assigned score
Always depended for meeting family grain food from own production	0
Not having much dependence on own production	1

3.11. **Study variability and reliability**

The study was 120 farmers oriented; 30 from each four districts. 18 female functioned farms were marked off. However, ten of them were accompanied with their husband for facile agrarian operation. Since farmer hardly kept written records, cabalistic range was composed. Market survey as well as discussion with sub assistant agricultural officers were made for precise estimation. Information purveyed from these later two sources were 90% similar the collected data from farmers. Therefore, data accuracy and reliability can be legitimately ensured. Moreover, researcher made consistency with the seasonal and communal agrarian aspects for better data compilation.

3.12. **Ethical consideration of research study**

Researcher attempted to follow the ethical aspects pertinent to the study. Appointments were conceded before farmer interviews and each respondent was well informed about the nature and purpose of the study. No exaggerated or misleading questions were asked which might violate the confidentiality or privacy

aspects. In some instances, age-old farmer mislaid with their babble and researcher averted that tactfully. Transparent responses were chronicled and farmers consent were occupied with serving merely the purpose of the Master's research project. Most importantly, words were designed considering the rank and file perception.

3.13. **Limitations in data compilation**

The primary constraints were the time boundary. Moreover, ceaseless expedition was not plausible during Covid-19 pandemic situation. Additionally, unexpected interference from the side-talkers while accumulating data from the target individuals. Therefore, the researcher attempted to rely on the data furnished by the respondent limited within the heads of farm families with their remembrance during interview.

CHAPTER 04

RESULTS AND DISCUSSION

This chapter includes the socio-economic circumstance, behavior and impacts analysis, land amount changed into vegetable cultivation, key vegetable and grain crop cultivation with benefit-cost ratio, factors influencing cropping pattern change and the opportunities as well as constraints behind this shifting schedule.

4.1 **Socio-economic circumstances and behavior of respondents**

The socio-economic profile was essential to have a general idea about the present farm activities and farm enhancement possibility. Therefore, info regarding respondents age structure, gender, cultivated land size, occupation nature, IPM practicing consciousness, women participation, crop selling market, grain crop dependency at home were recorded as discussed below:

4.1.1 **Age distribution**

Farmers were grouped into three major clusters. The majority of farmers (72.5%) were in the age group of 35-50 years followed by the age group greater than 50 years. Low percent was 16.7% under the age group up to 35 years (Table 05).

Table 05: Age distribution of respondents in study area

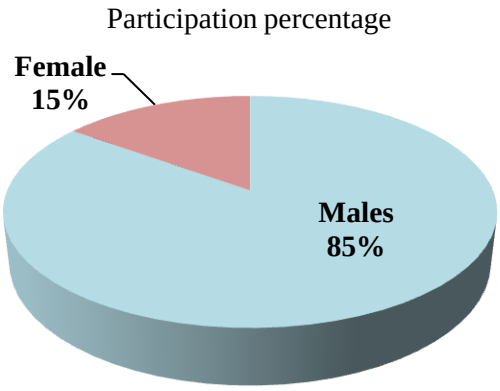
Categories (years)	Responded farmers						Mean	SD
	Dhaka	Gazipur	Mymensingh	Narsingdi	Total	% in total		
Young aged (up to 35)	3	6	7	3	19	15.8	44.05	8.246
Middle aged (35-50)	20	21	19	16	76	63.4		
Old (above 50)	7	3	4	11	25	20.8		

(Source: Field study, 2021)

4.1.2. **Gender**

In this study male-dominated agrarian activities were seen widely with respect to women headed cultivation scarcity. The undermentioned (Figure: 03) demonstrated the comparison in the number of male-female dominancy.

Figure 03: Gender ratio participated in agrarian activities



(Source: Field survey, 2021)

4.1.3. **Occupation nature**

Considering their household revenue sources, the respondents were classified into four sorts: farming one kind vegetable and/not grain crop, farming diversified crops, providing labor along with farming land and doing business along with farming land which are shown in Table 06. Table data revealed that the highest proportion of the respondent (53.3%) had income from cultivating diversified crop while 9.2% had to earn livelihood through agrarian activities as well as providing labor.

Table 06: Earning source of respondents in study area

Categories	Responded farmers					
	Dhaka	Gazipur	Mymensingh	Narsingdi	Total	% in total
Farming only vegetable in one season and grain crop in other season	5	8	8	5	26	21.7
Farming diversified crops in a season	14	19	14	17	64	53.3
Providing labor as well as farming land	2	3	3	3	11	9.2
Doing business as well as farming land	9	0	5	5	19	15.8

(Source: Field survey, 2021)

4.1.4. **Cultivated land size**

In this present exploration the land under vegetable growing farmers were classified into different categories. It is evident from the Table 7 that 10% farmers had medium, 87.5% had small and 2.5% were marginal in words. In study areas, large farmers were found absent.

Table 07: Agrarian farm size held by respondents in study area

Categories (hectare)	Responded farmers						Mean	SD
	Dhaka	Gazipur	Mymensingh	Narsingdi	Total	% in total		
Marginal (0.05-0.5)	1	0	1	1	3	2.5	0.63	0.248
Small (0.51-1)	27	26	26	26	105	87.5		
Medium (1.01-2.0)	2	4	3	3	12	10.0		
Large (above 2.0)	0	0	0	0	0	0.0		

(Source: Field survey, 2021)

4.1.5. **IPM practicing consciousness**

The study areas exposed that farmers were little bit more conscious about natural conservation. Therefore, farmers were adopting IPM for environmental and economic point of view. Additionally, mediocratic level consciousness topped with 75% followed by 13.3% high level IPM practicing consciousness.

This denotes the SDG target no. 15 (life on earth) completion underway. Such sustainable management would reduce the loss of natural habitats and biodiversity that support national food and water security, soil non-deterioration further.

Table 08: IPM consciousness of respondents in study area

Categories (score)	Responded farmers						Mean	SD
	Dhaka	Gazipur	Mymensingh	Narsingdi	Total	% in total		
Low adoption (< 8)	3	1	7	3	14	11.7	10.88 ≈ 11	1.839
Medium adoption (8-12)	22	25	19	24	90	75.0		
High adoption (> 12)	5	4	4	3	16	13.3		

(Source: Field survey, 2021)

4.1.6. **Women participation/assistance**

Women participation was found significantly in labor sources under the survey zones. Along with women entrepreneurship, a lot of them were engaged with field labor as well as post-harvest practices and these proportionate were enriching day by day in contrast with male dominancy. Overall medium level participation rate was higher (55%) in this area.

Table 09: Women participation at agrarian activities

Categories (score)	Responded farmers						Mean	SD
	Dhaka	Gazipur	Mymensingh	Narsingdi	Total	% in total		
Low participation (< 3)	11	9	9	11	40	33.3	3.15 ≈ 3	1.418
Medium participation (3-4)	15	19	17	15	66	55.0		
High participation (> 4)	4	2	4	4	14	11.7		

(Source: Field survey, 2021)

High women assistance feasibility depicted less labor cost in other sense and met up SDG target five (gender equality performance) ultimately. Survey delineated that providing women and girl access to this ancient task led to farm expenditure reduction and structured management than before.

4.1.7. **Crop selling market**

As vegetables were more perishable and bulkiness, marketing approach needed to be more clarified. As this tract area was closer to the heart of this country, farmers intended to reach the center market but most of them prefer primary market.

17.5% of farmer wanted to market their product at the local village market. Meanwhile, 23.3% desired to sell their vegetable in the secondary market with viable intermediaries. Among them, primary market seekers were the most in percentage and that is 59.2%.

Table 10: Crop market responded by the participants in study area

Categories	Responded farmers					
	Dhaka	Gazipur	Mymensingh	Narsingdi	Total	% in total
Local market	3	7	5	6	21	17.5
Primary market	19	15	18	19	71	59.2
Secondary market	8	8	7	5	28	23.3

(Source: Field survey, 2021)

4.1.8. **Grain crop independence at home**

It is observed that two patterns mainly dependent on own cultivation and purchase from market dictate the vegetable growing motive. Besides, some of growers showed neutrality own cultivation and purchase from market as it seemed almost same economic efficiency. About 65.8% farmers purchase the grain crop from market with

the help of cash generated from open end vegetable cultivation. Middle farmers confronted nothing barrier in vegetable along with or not with grain crop on their field. And the remaining portions have to manage their grain food source from own land which ultimately create shackle in vegetable production enhancement.

Table 11: Dependence of respondents family on own cultivation

Categories (score)	Responded farmers					
	Dhaka	Gazipur	Mymen singh	Narsingdi	Total	% in total
Dependent on own crop	9	10	8	14	41	34.2
Non-dependency	21	20	22	16	79	65.8

(Source: Field survey, 2021)

4.2 **Impact on respondent's socio-economic position**

Vegetable cultivation has created marvelous impact to many of the respondent farmers in these study areas. Survey results exposed that 90.8% respondent farmers opined that changing pattern to vegetable cultivation brought them significant impacts to some extent on nutritious food intake (Table 12). More than 65.8% farmers obtained household improvement. Adaptation of hygiene and sanitation were also increased to the responded households by 58.3%. Additionally, 51.7 % farmers had their recreation and social security facilities. Over 73% farmers household confronted a significant impact and most of them are leading a completely changed life with three-time meals a day.

Table 12: Impact on food consumption, household and social security

Items	% of vegetable growers responded				All areas
	Dhaka	Gazipur	Mymensingh	Narsingdi	
Significant impact	70.0	80.0	76.7	66.7	73.3
Not any significant impact	16.7	10.0	13.3	23.3	15.8
No impact	13.3	10.0	10.0	10.0	10.9

(Source: Field survey, 2021)

Items	% of vegetable growers responded				All areas
	Dhaka	Gazipur	Mymensingh	Narsingdi	
Diurnal food consumption (Nutritious food intake)	93.3	96.7	93.3	80.0	90.8
Household improvement	53.3	70.0	73.3	66.7	65.8
Hygiene and sanitation	80.0	73.3	43.3	36.7	58.3
Recreation and social security	56.7	53.3	46.7	50.0	51.7

(Source: Field survey, 2021)

4.3. **Area changed for vegetable cultivation over time**

Farmers were questioned how much land they changed for vegetable cultivation from grain crops. On an average, the farmers changed 69.89% land in proportionate their farm size which was higher in Narsingdi district (85.49%) followed by Gazipur district (78.79%) (Table 13). Meanwhile, 46.46% lands were increased for vegetable cultivation than five years ago period in the study area which was also the highest in Narsingdi district (58.29%) and the lowest in Dhaka district (31.8%).

Table 13: Percentage area changed into vegetable cultivation

Particulars	Dhaka	Gazipur	Mymensingh	Narsingdi	Average
Average land increased (%)	31.80	47.22	48.54	58.29	46.46
Average land changed (%)	47.41	78.79	67.87	85.49	69.89

(Source: Field survey, 2021)

4.4. **Sources of inspiration for vegetable commercialization**

The sample farmers mentioned various sources that influenced or inspired them to turn towards vegetable cultivation. The highly reported source was extension department (73.3%) (Table 14). About 71% farmers opined that they were influenced by family members to cultivate vegetable. In contrast, some farmers (17%) reported that they were influenced by neighbor and relatives. Again, 32.5% farmers were inspired by the traders and 30.8% influenced by village association.

Table 14: Source of inspiration for vegetables commercialization

Medium	% of vegetable growers responded				All areas	Rank order
	Dhaka	Gazipur	Mymensingh	Narsingdi		
Own desire & Family members	83.3	73.3	66.7	63.3	71.1	2
Neighbors & Relatives	33.3	13.3	53.3	63.3	40.8	3
Radio / TV / Newspaper	43.3	33.3	56.7	33.3	36.7	4
Extension department (Government stimulus)	66.7	90.0	80.3	80.0	73.3	1
Businessman	26.7	30.0	26.7	46.7	32.5	5
Village association	36.7	36.7	23.3	26.7	30.8	6

(Source: Field survey, 2021)

4.5. **Predominantly commercialized vegetable**

Diversified valuable vegetables are grown to meet the demand of public consumption. Vegetables which are commercialized widespread inside the sample area are under-mentioned. Total land is covered 17.5% by Bottle gourd, 14.17% by Papaya, 13.3% by Eggplant, 7.5% by Bitter gourd, 4.17% by Leafy vegetables and 42.83% by others.

Table 15: Salient commercialized vegetables (per season)

Sl. No	Name of the crops	Vegetable growers		Sl. No.	Name of the crops	Vegetable growers	
		% of response	Rank down			% of response	Rank down
1.	Eggplant	13.33	3	11.	Bean	5.00	6
2.	Bitter gourd	7.5	5	12.	Capsicum	1.67	15
3.	Bottle gourd	17.5	1	13.	Tomato	2.5	12

Sl. No	Name of the crops	Vegetable growers		Sl. No.	Name of the crops	Vegetable growers	
		% of response	Rank down			% of response	Rank down
4.	Ridge gourd	4.17	7	14.	Radish	.83	18
5.	Ribbed gourd	2.5	14	15.	Leafy vegetables	4.17	8
6.	Snake gourd	3.33	9				
7.	Arum	1.67	16	16.	Wax gourd	3.33	10
8.	Cauliflower	1.67	17	17.	Yard long bean	2.5	13
9.	Papaya	14.17	2				
10.	Cucumber	3.33	11	18.	Others	10.87	4

(Source: Field survey, 2021)

4.6. **Farmers' perception about profitability of vegetable**

Farmers in the study areas were much interested in vegetable cultivation that symbolized profitability perception. Table 16 demonstrates that a large portion of the respondent farmers (60.83%) told that vegetable was slightly profitable crop compared to other. Meanwhile, 17.5% farmers exposed that profitability of vegetable cultivation was higher than other crops. Meanwhile, very small percentage of farmers (15%) pointed out that profitability of vegetable cultivation was almost equal to other crops and some 6.67% confronted comparative loss.

Table 16: Farmers' perception on profit of vegetable compare to other crops

Items	% of vegetable growers responded				All areas
	Dhaka	Gazipur	Mymensingh	Narsingdi	
Highly profitable	16.67	20	16.67	16.67	17.5
Slightly profitable	63.33	56.67	56.67	66.67	60.83
No profit/loss	16.67	16.67	16.67	10	15
Comparatively loss	3.33	6.67	10	6.67	6.67

(Source: Field survey, 2021)

4.7. **Comparative profitability analysis of vegetable and grain crops**

Participants were inquired about their key crop's variable as well as fixed cost and gross return. Their responses are chronicled at Table 17.

Table 17: Comparative production and profitability analysis of vegetable items in response to grain crop (BDT per hectare)

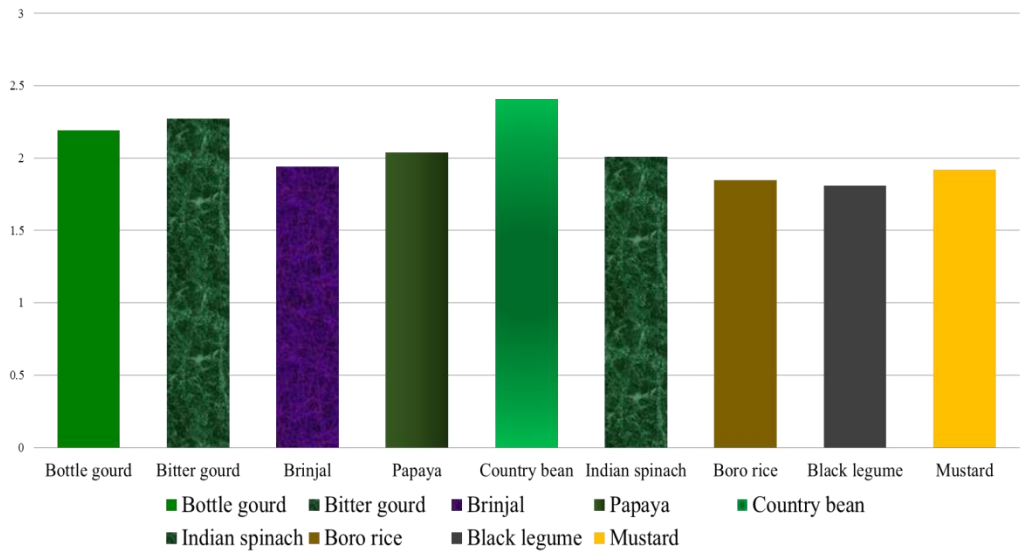
Items		Bottle gourd	Bitter gourd	Eggplant	Papaya	Country Bean	Indian spinach	Boro Rice	Black legume	Mustard
i.	Land preparation	15,900	12,300	15,000	16,500	16,800	10,000	16,500	14,000	15,000
ii.	Human labor	128,000	120,500	138,000	144,000	145,000	120,000	86,500	85,000	80,500
iii.	Seed/Sapling	8,500	16,700	3,000	15,500	3,500	9,500	3,000	2,800	2,100
iv.	Fertilizer and manure	38,300	35,000	38,500	40,500	35,000	31,500	26,600	25,500	22,300
v.	Macha / Structure	45,000	46,000	24,500	20,000	41,000	0	0	0	0
vi.	Irrigation charge	11,000	12,500	15,400	12,500	13,000	11,000	14,000	13,500	14,000
vii.	Pesticides	28,400	29,800	34,400	31,000	28,700	25,500	21,800	24,600	22,400
viii	Other cost	11,500	13,000	14,000	10,000	12,000	11,000	15,000	13,000	13,500
ix.	Interest on capital	14,300	14,500	14,100	14,500	14,500	10,900	9,100	8,900	8,500
x.	Land rent	60,000	60,000	60,000	60,000	60,000	55,000	55,000	60,000	55,000
A.	Total cost	361,000	363,000	296,900	364,500	372,000	284,400	247,500	247,300	233,300
B.	Gross return	788,000	825,000	576,000	743,500	896,000	571,600	457,800	445,000	447,900
C.	Net margin (B-A)	427,000	462,000	280,000	379,000	524,000	287,200	210,300	197,700	214,600
D.	**Benefit Cost Ratio**	**2.19**	**2.27**	**1.94**	**2.04**	**2.41**	**2.01**	**1.85**	**1.81**	**1.92**

(Source: Field study, 2021)

Here, Benefit-cost ratios of several salient crops are presented with bar chart.

Apparently, BCR of vegetable superseded the BCR of grain crop all the times. Country bean (2.41) was found with most enriched BCR following by bitter gourd (2.27). Meanwhile, mustard (1.92) was the most valued grain crop with comparative BCR followed by boro rice (1.85).

Figure 04: Comparative BCR analysis of vegetable and grain crop



(Source: Field survey, 2021)

Therefore, this point of aspect ensouled farmers towards vegetable farming. They prefer to cultivate commercial profit-making vegetable farming than grain crop.

4.8. **Factors influencing farmers for vegetable commercialization**

4.8.1. **Measuring worth of the model**

Statistics have been proposed for weighing the worth of a logistic regression model. This table contains pseudo R^2 values highlighting Cox & Snell R^2 and Nagelkerke R^2 values. The explained variation in the dependent variable ranges from 37.4% to 58.3%, based on the reference Cox & Snell R^2 or Nagelkerke R^2 methods. Moreover, in the Hosmer-Lemeshow test, a chi-square statistic was computed comparing the observed frequencies with those expected under the linear model. A nonsignificant chi-square (p-value is 0.863, which is above 0.05) indicates that the data fit the model well.

Table 18: Analysis for binary logistic regression model

Pseudo R^2 values		Hosmer and Lemeshow test		
Cox & Snell R Square	Nagelkerke R Square			
0.374	0.583	Chi-square	df	Sig.
		3.932	8	0.863

(Source: Field survey, 2021)

4.8.2. **Estimated values of regression function and interpretation**

Values of regression function variables are delineated with standard error.

Table 19: Factors influencing towards vegetable from grain crops cultivation

Variable	**Logit model coeffeciant** (Standard Error)	**Marginal Effect coeffeciant** (Standard Error)
Age_distr	**- 0.07903**** (0.03943)	**- 0.00692**** (0.00322)
Land_size	1.79036 (1.38285)	0.156831 (0.11891)
IPM_score	**0.59909*** (0.20953)	**0.05247*** (0.01598)
Women_score	**0.70310*** (0.24943)	**0.06159*** (0.01889)
Market_score_code		
Primary_market	**1.56946**** (0.72890)	**0.18078**** (0.08979)
Secondary_market	**3.13543*** (1.16042)	**0.28635*** (0.09261)
Grain_indpdn_code	**1.29885***** (0.71454)	**0.11378***** (0.05966)
_cons	**- 7.69099**** (3.78353)	-

*, **, *** represent significance difference at the 1%, 5%, 10% levels respectively; the values in parenthesis are standard deviation.

Local market and No grain crop dependence are taken as a base for Market_score_code and Grain_dpdn_code for statistical convenience.

(Source: Field survey, 2021)

Age of the farmer was found to have a negative association with probability of changing willingness at 5 percent significant level. With an increase of 1 unit in biological age, approximately 0.6 percent farmer's tendency was found decline toward cultivation swap. These meant farmers of older ages preferred less likely to change their ancient cultivation pattern than younger ones.

Farmer IPM consciousness was found to have a positive relationship with willingness swap probability at 1 percent significant level. Cognizant farmers who practiced IPM had 5.2% more interest mounting on vegetable cultivation with every level of IPM consciousness (mentioned at methodology) improvement.

Women participation was also found positive relationship with swap willingness probability at 1 percent significant level. Farmers who enhance women labor magnitude in every step at their field generally had 6.2% more interest in vegetable commercialization than before.

Crop selling market had a positive liaison with shifting will probability. Estimation demonstrated that farmers who sold their harvest in primary market had 18.07 % more interest in vegetable commercialization than who sold in local market. Besides, secondary market devoted farmers had 28.64% more interest than local market.

Finally, family grain crop dependence was found high impact on swap willingness. The independent farmers had 11.38% more tendency in moving toward vegetable commercialization uninterruptedly than family grain crop dependent participants.

In this way, this multiple dichotomous logistic regression model revealed that the key variables included in the model were individually or jointly accountable for the participant's willingness toward vegetable cultivation.

4.9. **Willingness or reluctance toward vegetable cultivation**

Respondent farmers were inquired to project the arable area of extension for vegetable cultivation in future. About 80% famers reported positive attitude (Table 20). Among all responded farmers, Narsingdi district showed the highest (83.3%) interest in increasing vegetable arable area.

Table 20: Willingness or reluctance for father vegetable farm enhancement

Items	% of participants responded				All areas
	Dhaka	Gazipur	Mymensingh	Narsingdi	
Willingness to increase	76.67	80	76.67	83.33	79.71
Reluctance	23.33	20	23.33	16.67	20.29

(Source: Field survey, 2021)

Table 21: Reasons for increasing/decreasing vegetable cultivation in the future time

Items	% of participants responded				All areas
	Dhaka	Gazipur	Mymensingh	Narsingdi	
A. Reasons for increasing					
Comparatively profitable	60.0	73.3	70.0	80.0	70.8
Relatively short production cycles	80.0	70.0	66.7	83.3	75.0
Easy cultivation process / Less troublesome	30.0	40.0	36.7	43.3	37.5
Needs less labor / Use family labor	46.7	60.0	40.0	53.3	50.0
Increasing market demand	90.0	96.7	83.3	93.3	90.8
B. Reasons for not increasing					
Lack of quality seeds and seedlings	60.0	46.7	53.3	33.3	48.3
Disease and insect infestation	80.0	80.0	60.0	73.3	73.3
Natural disasters and land complexity	93.3	83.3	76.7	70.0	80.8
Lack of access to credit	43.3	33.3	30.0	53.3	40.0
Lack of transport facilities	26.7	46.7	33.3	46.7	38.3
Ancestral grain crop production intention	30.0	43.3	53.3	57.3	46.0
Non-availability and higher price of labor	30.0	30.0	26.7	16.7	25.7
Market failure	73.3	60.0	63.3	70.0	66.7

(Source: Field survey, 2021)

Farmers sought to shift more arable vegetable area in subsequent years due to its comparative profitability (71%), cultivation easiness (37.5%) and relative short cycle (75%). About half of total respondents desired to increase area since cultivation required less hired labor. Few farmers (9%) also pointed out some reasons for not expanding their vegetable arable areas in following years and few (10.8%) were hung in the balance. The crucial reasons were disease as well as insect infestation (73.3%) and natural disasters as well as land complexity (81%). Moreover, lack of credit (40%), lack of proper transportation (38%), ancestral agrarian pattern (46%) and market failure (66.7%) were also mentioned that demotivated in vegetable cultivation.

4.10. **Major perplexities confronted by the farmers**

Although vegetable is a profitable crop in the study areas, some constraints are confronted at the farmer end. Major hinderances are undermentioned:

4.10.1 **Economic loss due to disease and pest infestation**

Harvests were valuable so a little careless may turn out into a huge loss. It was a matter of sorrow that farmers could not adopt preventive measures with addressing improper communication. Therefore, unrestrained damage was observed within some time period.

4.10.2. **Ruined market panic and warehousing non-feasibility**

Imported vegetables from the neighboring country made the market prospect very much uncertain. Therefore, even though the demand for new crops or vegetables grew across the country, the farmers were afraid to enhance production. Moreover, crumple and fragile performance of agricultural marketing system made the situation more labyrinths. Again, as vegetables are perishable nature, quick marketing is most important matter. There was lack of warehouse and transportation facilities which made difficult to store the product in the abundance situation.

4.10.3. **Monetary perplexity**

Vegetable farms required numerous expenditures throughout cultivation along with large initial investment. A rural end farmer often unable to meet that amount from

own pocket and had to look on money lending institutions or persons. Sometimes debt might not plausible in absence with proper mortgage or debt had to be borne with high interest. Subsequently, this excessive pressure entailed in forced sale and this influence in the ensuing farming tasks.

4.10.4. **Ancestral plowing pattern (Tradition and inertia)**

To some cultivars, paddy production was continuing ancestrally. Thus, several of them were reluctant to swap even if they were cognized with the advantage of vegetable farming. To keep the heredity, they easily foregone the intention of meeting new one.

4.11. Discussions

Madhupur tract vested with terrestrial position supremacy and contingent nature of climate as well as soil was under location preference. Researcher attempted to expose the features of farmers agrarian practices with their farther arable land enhancement keeping opportunities as well as perplexities in the lime light.

4.11.1. Characterizations of independent variable across survey area

Study found active age group ranged 31-50 years majorly up to 63.4% followed by the age group greater than 50 years. 85% male farmers were documented in entire survey arena. Most of farmers (53.3%) cultivated diversified crops whereby 21.7% farmers cultivated sole crop per season. Rest of others were engaged with labor livelihood and non-agricultural business alongside farming.

Research also revealed that 87.5% farm size was small in nature and 10% farmers had medium farm size. 75% farmers adopted medium level IPM. This ultimately drove the SDG target no. 15 (life on land) fulfillments more efficiently. Such sustainable and eco-friendly agro-management continuously reincarnates the soil fertility and biodiversity chain.

Women participation was found medium level regularly over 55%. Along with entrepreneurship, a lot of women were engaged with field labor as well as post-harvest practices and this scenario was enriching day by day. High women involvement feasibility depicted less labor cost and met up SDG target five (gender

equal performance) ultimately. Women community involvements are constantly accelerated which moving them to economic solvency and social stability.

Farmers under survey location had entrée to primary market most of time (59.2%). One-forth of entire farmer community had secondary market entrance scope. About 17.5% of farmer found convenience to market their product at the local village market.

More than 65% farmer purchased the grain crop from market with the help of cash generated from vegetable cultivation. Meanwhile, the remaining portions have to manage their family grain food calorie source from own land which ultimately create shackle in vegetable production enhancement.

4.11.2. Socio-economic advancement and arable land enhancement

After linked with vegetable farming, almost 75% household confronted a significant welfare and most of them led a reformed life with three-time meals a day. More than 65% farmers upgraded household and about 58% progressed in sanitation level. This found the similarity with Bhardwaj (2012) and BSS (2021) reports. Moreover, over 50% farmers had their recreation and social security facilities.

On an average, farmers changed about 70% land equivalent farm size which was higher in Narsingdi district (85.5%) followed by Gazipur (78.8%). Meanwhile, 46.46% lands were increased for vegetable cultivation than five years ago which was the highest in Narsingdi district (58.3%) and lowest in Dhaka district (31.8%).

Prominent vegetable crop such as bottle gourd, bitter gourd, cucumber, eggplant, beans and leafy vegetables were the most cultivated across tract land. Farmers in the study area about three quarter farmers reported extension department was opined to be as an important source. In contrast, 40.8% farmers were motivated by neighbor, 32.5% were inspired by the traders and 30.8% influenced by village association.

4.11.3. Comparative profitability analysis of vegetable and grain crop

With the advancement of time period, experienced farmers were more cognized with IPM practicing, women labor enforcement and crop selling market. These led 80% farmers on the incentive level and a silly portion about 7% confronted comparative

loss with respect to grain crop. Apparently, BCR of vegetable superseded the BCR of grain crop all the times. This results also parallel to the results operated by Bisbis *et al.* (2018), Begum *et al.* (2011), Chandra *et al*. (2020), Chowdhuri *et al.* (2014), Hasan *et al.* (2020), Karim *et al.* (2011), Parvin (2008), Razzaque and Hossain (2007) and Weinberger and Lumpkin (2005). Bitter gourd (2.45) was found with most enriched BCR followed by bottle gourd (2.17). Meanwhile, Boro rice (1.61) was the most valued grain crop with comparative BCR. Therefore, farmers were easily ensouled with vegetable farming and forego to cultivate the traditional grain crop.

4.11.4. Interpretation of regression function estimated values

After accumulating information, a dichotomous logistic regression was formulated. The values of Cox & Snell R^2 and Nagelkerke R^2 ranged from 37.4% to 58.3% which indicated the variance percentage explanation in the dependent variable with respect to independent ones. Additionally, Hosmer-Lemeshow tests was observed nonsignificant chi-square (p-value is 0.863, above 0.05) indicating the suitable data fitness of model.

Afterwards, marginal effect co-efficient were assessed to find the statistical significances of explanatory variables.

4.11.4.1. **Age structure and arable land size**

Respondents age was found to have a negative association with the probability of swap willingness meaning that farmers of older ages were less likely to change the cultivation pattern. Ultimately, the young aged were more enthused to vegetable commercialization. This negative significance had appreciation with Akter (2009), Battese and Coelli (1995), Kabir and Rainis (2015) although deviation from Ali *et al.* (2001) and Farid *et al.* (2015) researches.

However, the influence of arable land size over swap willingness was found insignificant. This result appeared odd as Andrew and Anna (2005) found a negative correlation and Farid *et al.* (2015) found positivity.

4.11.4.2. **IPM consciousness and women participation**

IPM consciousness and women participation at arable land were found positive related with probability of swap willingness towards vegetable commercialization at 1 percent significant level and had similarity with Kabir and Sarker (2015), Kabir and Rainis (2015), Sobhan and Khondokar (2001).

Mathematically, farmers who practiced IPM had 5.2% more interest mounting on vegetable cultivation with every level of IPM consciousness improvement. And farmers who enhance women labor magnitude in every step at their agrarian operation generally had 6.2% more interest in vegetable commercialization than before.

4.11.4.3. **Market location and grain crop independence at home**

The market location had a positive association with farmers' willingness probability. This research found the exact concept from Muamba (2011), Rabirou *et al.* (2009) and Rahman (2020). Current research demonstrated that farmers who sold their harvest in primary market had 18.07 % more interest in vegetable commercialization than who sold in local market. Besides, secondary market devoted farmers had 28.64% more interest than local market.

Finally, family grain crop independence was found high impact on the farmer's tendency toward vegetable cultivation. Alike Khandoker *et al.* (2014) report, this research carried out same inverse proportional relationship between grain crop requirement and farther commercialization willingness. The independent farmers had 11.38% more tendency in moving toward vegetable commercialization uninterruptedly than family grain crop dependent participants.

4.11.5. **Opportunities and perplexities throughout commercialization**

A set of considerable scope (including comparatively profitability, cultivation process easiness and relatively short cycle and market feasibility) apparently assessed to stir vegetable cultivars willingness. This outcome expressed as same as Chatterjee and Mukherjee (2019), Fatema (2006), Muriithi and Matz (2015), Khandoker *et al.* (2017) statement did.

Although these vegetables were rationally profitable, few farmers confronted setbacks during production. Economic damage due to pest infestation, warehouse infeasibility, market fluctuation, monetary perplexity and ancestral plowing outline were found major barriers in widespread expansion of vegetable revolution. These crucial barriers were also appeared as same constraints in Chandra *et al.* (2020), Hasan *et al.* (2020), Missanga and Rubanza (2018) studies.

If these perplexities could be diminished then a promising economic convenience would be attained for affixing comprehensive women engagement as well as assuaging rural poverty and ultimately SDG target would be accomplished with rampant headway.

CHAPTER 05

SUMMARY AND CONCLUSION

This is the compacted chapter of the entire paper. It is time to enwrap up the research and the study's key findings into concise. Section 5.1 presents a summary of the exclusive study. Compatible suggestions, conclusion, limitations of the study and farther research avenues are demonstrated in sections 5.2, 5.3, 5.4 and 5.5.

5.1. **Summary**

Delta-based climatic supremacy, cultivation pattern and achievements in horticulture were cited initially. Afterwards, an AEZ named Madhupur tract was introduced with its terrestrial position dominance followed by the contingent nature of climate as well as soil and marketing feasibility. Farmers resided at that tract now enthused onto commercial farming and made more turnover from domestic and global markets which was comparatively tough in case of traditional grain crop cultivation. Finally, stimulus factors that stirred peasants toward vegetables were mentioned along with perplexities and this chapter welcomed the following literature review section.

In literature review, systematic evaluation of vegetable prospect, physiography of Madhupur tract and horticulture pattern practiced at there, comparative advantage in vegetable and grain cultivation, swapping earning source impact, factors influencing farmers decision towards cultivation, vegetable cultivation and marketing perplexities were constructed by accumulating info from numerous sources.

In third chapter, roadmap for the entire study named materials and methods was revealed with consistent process. A dichotomous logistic regression was constructed with the abovementioned factors. Hosmer-Lemeshow test, $R^2_{\text{cox-snell}}$ and $R^2_{\text{Nagelkerke}}$ tests were kept in the limelight and stimulus factors (including age, farm size, IPM consciousness, women participation, crop selling market and grain crop independence) were characterized with labels including marginal effect co-efficient.

Finally, the results and discussion chapter captured the surveyed circumstances including active age group ranged 35-50 years and over fifty percent of them cultivated diversified crops. Additionally, 75% farmers adopted medium level IPM and women participation was found medium level. Farmers had entrée to primary market mostly and two-third of them purchased the grain crop from market with the help of cash generated from vegetable. 73.3% of farmers was stimulated by extension department, with arable vegetal land extends over 46% than before.

Almost 80% respondents confronted incentives with having 73% significant impact on livelihood and social security.

Age, IPM consciousness, women participation, crop selling market and grain crop independence were statistically significant corresponding with marginal effect co-efficient. Economic damage due to pest infestation, environmental stress, market fluctuation, monetary perplexity and ancestral plowing pattern were found major barriers in widespread expansion of vegetable revolution.

5.2. **Compatible suggestions**

On the basis of the findings of the study it is manifest that vegetable is profitable enterprises and this can generate more incentives and employment opportunity to the rural end. Therefore, undermentioned compatible strategies and tactics are put forwarded for ensuring more production willingness of vegetable in one hand and higher profit of the farmer on the other.

i. **Operating as a quadruple force to assist farmer in the production**

Research institutions, Academic organizations, extension authorities and merchant associations should support farmers as a quadruple dynamism. With regular intervention of extension activity, farmers will be cognized with sustainable farming profitability and highly encouraged to further horticultural crop cultivation.

ii. **More rigorous campaign to promote IPM technology**

Farmers in many areas (most of outlying area) are still using harmful pesticides in cultivation as these are easily available although more expensive than the pheromone technology. Country-wide campaign and advertising (including field manuals, extension leaflets) are required in order to motivate all farmers to lessen the use of chemicals for pest management and to adopt the use of IPM to produce safe vegetables. Respective authority may provide stimulus to adopt IPM technology.

iii. **Ensuring more involvement of women than before**

Empowering women is not only beneficial for their own socio-economic well-being but also imperative for sustainable livelihoods of communities. Agrarian activities including homestead gardening, nursery business, production and preservation of horticultural seeds are very suitable for women community. The extension personnel

should provide regular visit to build and strengthen the networks among women farmer community. Finally, socializing the concept of gender awareness by community and religious leaders will influence rampantly.

iv. **Enacting auspicious timely policy and certification**

The government should enact synergism strategy for the peasants, traders and consumers. Implementation of national agriculture policy for quality assurance following GSP strategy would do the business. Authorities should provide competent certification schemes to match standard qualifications and emphasis on policies concerning residue management. Finally, increase subsidies with exotic seeds and accessories as well as establish fair market price for the product will stabilize farmers' income and shrink the consumer end over-pressure.

5.3. **Conclusion**

On headway to prosperity marked by UN-SDSN agenda, sustainable horticulture can serve affordable nutritious food, strengthen livelihoods and assure women involvement revitalize rural landscapes as well as ultimately deliver inclusive national growth. From this sense, peasants from Madhupur tract currently are taking agrarian decision with economic efficient and climate safeguard mindset. A cognized farmer is easily influenced to vegetable commercialization because of viewing the landmark of IPM utilities, women participation, market solvency on crop return profitability except family grain crop dependent of own cultivation. Presence of extension services and family labor support lead eighty percent farmer to augment their arable land toward vegetable cultivation in future. Since vegetable returns more than the traditional cereal/grain crop both in economic and ecological point of views, cultivators can upgrade their living standard and environment can relieve from the monoculture devastation. Finally, eradicating cultivation perplexities with effective measures could facile more investment as well as production and ultimately lead toward self-complacent as well as mobilize welfare headway.

5.4. **Limitation of the study**

Considering the time, money and other obligatory resources accessible to the researcher, it was necessary to levy some boundaries as stated underneath:

i. The study was kept to thirty selected respondents of four specified districts.

ii. There were many bucolic farmers associated with vegetable cultivation in this tract but only 120 respondents were taking into account for this study.

iii. Only six features of vegetable growers were brought for exploration in this study.

iv. The researcher relied on the data furnished by the respondent limited within the heads of farm families with their memory during interview.

v. For some cases, the researcher confronted unexpected interference from the side-talkers while accumulating data from the target populations. However, the researcher tried to overcome the problem as far as possible with sufficient tact and skill.

vi. Various barriers during cultivations are likely to be faced by the rural end farmer. However, only eight complications had been reflected for investigation in this study.

5.5. **Avenue for farther research**

Original motive behind this research was to enumerate some premeditated factors affecting in the swap toward vegetable commercialization across country. However, considering the time, capital and other obligatory possessions inadequacy, it was not credible for the researcher to cover other Agro-economic zones along with diversified vegetable crop. Hence, only selected areas of four districts under Madhupur tract were brought under survey. Additionally, small sample survey from each of the mentioned areas were occupied during Covid-19 pandemic situation as ceaseless expedition was also challenging. Thus, this sketchy research finding does not generalize such swap activities as a whole in Bangladesh. Therefore, an enormous scope of further survey to estimate the association between other analogous factors and cultivation shifting on other AEZ region corresponding with this study area is plausible for generalizing the result.

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APPENDICES

Appendix I

AN ENGLISH VERSION OF THE INTERVIEW SCHEDULE

Department of Agribusiness and Marketing

Sher-e-Bangla Agricultural University, Dhaka- 1207

An Interview Schedule for a research study entitled

"**FACTORS AFFECTING ADOPTION OF COMMERCIAL VEGETABLE CULTIVATION IN SOME AREAS OF BANGLADESH**"

(Please response the following questions and put-check mark whenever application)

01**. Preliminary information of farmer**: Sample no:……

Name: …….. Village: ……..……..

Upazila/Thana: ……..… District …….

02. **Age:** How old are you? ..... Years.

03. **Farm Size**:

3.1. Please mention the area of land according to use

Sl. no.	Type of land	Land Area	
		Local Unit (Decimal)	Hectare
A.	Own land under own cultivation		
B.	Rented (in/out)		
C.	Leased (in/out)		
D.	Mortgaged (in/out)		
	Total = A + B + C + D		

3.2. Type of farm size: Marginal (0.05-0.5 ha) / Small (0.51-1.00 ha) / Medium (1.01-2.00 ha) / Large (Above 2 ha).

3.3. Crop land allocation throughout agricultural seasons:

Crop land (ha)	Year	Robi	Kharif-1	Kharif-2
Vegetable cultivated land	Current			
	5 years back			
Grain crop cultivated land	Current			
	5 years back			

04. **Farm Expenditure and Revenue**

4.1. Estimation of production cost in surveyed land (per ha):

Crop name	Seed cost	Labor cost	Hired machineries / animal cost	Irrigation	Fertilizer	Pesticides	Macha / Structure preparation	Harvests transportation	Others	Total
		No. of unit x Per unit cost x total day		No. of application x per application cost						
i.										
ii.										
iii.										
iv.										

4.2. A**.** Income from vegetable and grain crop sources (per ha):

Sl. No.	Name of the crops	Production (kg)	Market price at harvest (Tk.kg-1)	Sl. No.	Name of the crops	Production (kg)	Market price at harvest (Tk.kg-1)
1.				3.			
2.				4.			

B. Income from other sources:

Sl. No.	Sources of income		Sl. No.	Sources of income
01.	Another crop (if cultivated)	a.	02.	Day labor
		b.	03.	Business

4.3. Farmers' perception on profitability of vegetable crop (BCR):

4.4. Farmers' perception on profitability of grain crop (BCR):

4.5. Farmers' perception on profitability of vegetable with respect to grain crop:

4.6. Profitability perception: Higher profit / Slighter profit / No profit-loss / Comparatively loss

05. **Farming experience**:

5.1. Which is the key vegetable crop cultivated? ……

5.2. How many years are you associated with agrarian activities? ……

06. **IPM practicing frequency**

6.1 Did you participated in IPM learning seminar/workshop? Yes / No

6.2 Please remark how frequently do you use the following IPM technologies in your crop field (put-check mark the degree of practicing)

Sl no.	Technologies	Degree of practicing		
		Frequently (2)	Occasionally (1)	Never (0)
i.	Weed management (uprooting)			
ii.	Crop rotation			
iii.	Cultivation of resistant variety			
iv.	Pheromone trap / Yellow sticky trap			
v.	Pesticides made at home manually (Soap / Neem oil / Salt Spray)			
vi.	Soil amendment using poultry refuse/ farmyard manure			
vii.	Vermi-compost			
viii.	Natural enemy / parasitoids			
ix.	Hand picking of insect			
x.	Wearing protection (dress, gloves, goggles			

IPM practicing efficiency: Low (0-8), Medium (9-12) and High (greater than 12)

07. **Women participation**

7.1. Number of women participations: ……

7.2. Women participation score: (put-check mark the degree of participation)

Sl no.	Technologies	Degree of participation		
		Frequently (2)	Occasionally (1)	Never (0)
i.	Crop cultivation and take care			
ii.	Crop harvesting and sorting out			
iii.	Crop sale and marketing			

Women participation range: Low (0-2), Medium (3-4) and High (5-6)

08. **Grain food dependence by farmer family**:

8.1. Avg. meal is …. Times/day

8.2. How grain requirement fulfilled? dependent on own production / Not dependent

09. **Crop marketing strategy**

9.1. How you carried out the harvests onto the market? own self / van / auto / CNG / pickup van / others (mention please)

9.2. Farmers preference/efficiency to sell harvest:

Own farm land	Local village market	Haat / Highway adjacent market
District level market	Contractual marketing	Capital city market

Local market	**Primary market**	**Secondary market**

10. **Who encourages the farmer for vegetable cultivation**?

Own willingness	Neighbors & Relatives	Radio / TV / Newspaper	Businessman
Family members	Extension department		Village association

11. **Social-economic status moving after vegetable cultivation**:

Diurnal food consumption pattern (Nutritious food intake)		Household / Infrastructure improvement	
Adaptation of hygiene and sanitation		Recreation and social security	

12. Perplexities / opportunities confronted by farmer throughout production & marketing (put-check mark on the right side of the preferred options)

Key opportunities	Present	Absent	Key hindrances	Present	Absent
Comparatively profitable			Lack of quality seeds and seedlings		
Relatively short production cycles			Disease and insect infestation		
Easy cultivation process / Less troublesome			Natural disasters & Land complexity		
Needs less hired labor / Use family labor			Lack of access to credit		
Increasing market demand			Lack of transport facilities		
			Ancestral cereal crop pd^{n} intention		
			Non-availability and higher price of labor		
			Market failure		

13. **Farmer own perception / opinion / expectation**:

Willingness to (in future)-	Increase		Decrease	

……

……

Thank you for your kind co-operation

Date: .....

…… ……

Signature of Responded participant Signature of Interviewer

APPENDIX II

Madhupur tract topography pertinent to vegetable cultivation

Table A**:** Physiography of Madhupur Tract, Bangladesh

Physiographic Unit	Agro-Ecological Zone (AEZ)		Area excluding river beds (ha)	Texture, $p^H = p^H$, Organic Matter Status = O.M	Land Type					
	AEZ No.	General soil type			High	Medium High	Medium Low	Low	Very Low	Home stead + Water
Madhupur Tract	28	Red Brown Terrace Soil	424, 581	Type (%)	56	18	7	9	-	10
				Texture:	Loamy	Loamy	-	-	-	-
				p^H:	4.8-5.5	4.8-5.5	-	-	-	-
				O.M:	Low	Low	-	-	-	-

(Source: BBS, 2017)

Table B: Temperature in Madhupur tract and Temperature requires for winter vegetables

Vegetable crops	Need temperature ^oC	Madhupur temperature ^oC
Cauliflower	10-15	15-20
Carrot	13-17	
Lettuce	8-12	
Bean	10-15	
Radish	15-17	
Broccoli	10-13	
Eggplant	15-20	

Source: (BARC, 2013)

APPENDIX III

Prominent vegetables produced in four districts under Madhupur tract region in respect to whole Bangladesh

Vegetables	Districts	2017-18		2018-19		2019-20	
		Area (acres)	Pd^{n} (MT)	Area (acres)	Pd^{n} (MT)	Area (acres)	Pd^{n} (MT)
Okra	Dhaka	681	1153	678	1206	737	1326
	Gazipur	306	401	304	400	309	405
	Mymensingh	1104	2198	1102	2194	1087	2090
	Narsingdi	345	805	330	687	323	670
	Total	**2436**	**4557**	**2414**	**4487**	**2456**	**4491**
	Bangladesh	**28303**	**56145**	**28647**	**54183**	**28515**	**55905**
Cucumber	Dhaka	617	1642	639	1722	643	1552
	Gazipur	262	357	284	481	270	365
	Mymensingh	1220	4540	1270	7255	1280	7450
	Narsingdi	385	1100	367	1052	354	990
	Total	**2484**	**7639**	**2560**	**10510**	**2547**	**9957**
	Bangladesh	**23695**	**65499**	**24608**	**73220**	**24413**	**82963**
Broccoli & Cauli Flower	Dhaka	937	7983	939	7983	971	9379
	Gazipur	757	5353	761	5401	768	5509
	Mymensingh	1554	17816	1672	19474	2200	17500
	Narsingdi	425	1679	427	1671	415	1627
	Total	**3673**	**32831**	**3799**	**34529**	**4354**	**34015**
	Bangladesh	**48083**	**274297**	**49869**	**284327**	**54205**	**283157**
Bitter Gourd	Dhaka	391	347	422	856	447	847
	Gazipur	344	356	348	358	349	359
	Mymensingh	1152	2447	1160	2435	1317	5085
	Narsingdi	446	931	330	605	318	571
	Total	**2333**	**4081**	**2260**	**4254**	**2431**	**6862**
	Bangladesh	**26490**	**57908**	**26491**	**54443**	**27484**	**59371**

Bottle gourd	Dhaka	2241	19608	2209	19540	2225	23700
	Gazipur	2508	7368	2510	7393	2525	7451
	Mymensingh	1738	10834	1743	10960	1790	10701
	Narsingdi	1156	9903	1075	8573	1026	8064
	Total	**7643**	**48713**	**7537**	**46466**	**7566**	**49916**
	Bangladesh	**46059**	**222315**	**47391**	**236033**	**49096**	**250613**
Ridge gourd	Dhaka	658	648	678	1428	718	1161
	Gazipur	378	372	367	370	381	340
	Mymensingh	1083	2404	1052	2337	1031	2320
	Narsingdi	306	473	311	487	288	428
	Total	**2425**	**3897**	**2408**	**4622**	**2418**	**4249**
	Bangladesh	**18515**	**37342**	**18523**	**37613**	**19778**	**42938**
Snake gourd	Dhaka	834	1465	289	415	1009	3598
	Gazipur	332	535	340	547	349	561
	Mymensingh	696	1388	729	1626	1129	2671
	Narsingdi	288	605	294	619	294	599
	Total	**2150**	**3993**	**1652**	**2837**	**2781**	**7429**
	Bangladesh	**18515**	**37342**	**18523**	**37613**	**19778**	**42938**
Tomato	Dhaka	1097	5518	1097	5518	1279	5399
	Gazipur	648	1120	664	1683	936	6961
	Mymensingh	1979	17505	1979	17505	725	6051
	Narsingdi	784	2500	757	2388	725	2255
	Total	**4508**	**26643**	**4497**	**27094**	**3665**	**20666**
	Bangladesh	**69509**	**385038**	**69697**	**387653**	**70460**	**415494**
Bean	Dhaka	1432	4267	1432	4467	1487	4515
	Gazipur	474	645	462	618	1008	1726
	Mymensingh	2100	6119	2116	6118	2120	6285
	Narsingdi	2839	12801	2807	12622	2720	12329
	Total	**6845**	**23832**	**6817**	**23825**	**5435**	**24855**
	Bangladesh	**50888**	**134860**	**51578**	**144050**	**61628**	**169735**

APPENDIX IV

Systematic review of all relevant individual studies over current research issue

Table A: Systematic review on vegetable cultivation and marketing prospect

Author (Year)	Context/Sample	Title	Outcomes
Bhardwaj (2012)	Year wise agricultural statistics conducted by Directorate of Economics and Statistics in India	Challenges and opportunities of vegetable cultivation under changing climate scenario	Cultivating vegetables under diversified climatic features acted as an ideal prospect for the general in developing nations to surge their income spontaneously.
Grünwald (2021)	World Food and Agriculture Statistical Yearbook 2020	Entering the international year of fruits and vegetables: tradeoffs between food production and the environment	Vegetable cultivation illustrated sustainable responses in light of climate change and contemporary market complexity during the COVID-19 pandemic.
Muriithi and Matz (2015)	Panel household survey data from Kenya	Welfare effects of vegetable commercialization: evidence from smallholder producers in Kenya	More entree to inland, neighbor and global markets for vegetables could afford more income incentives (a positive connection between vegetable commercialization and household welfare enrichment)
BBS (2020)	Time series data (five year) on annual production covering all home-grown crop	Vegetables (summer and winter vegetables)	Nation's vegetable-oriented land rose by almost 29%, to nearly 1.25 million hectares in 2018-19 fiscal period from only 0.96 hectares in 2013-14. Additionally, its production around 26.7 million tons of vegetables had seen a significant rise of 37.63% in five years.

Mahmud *et al.*, (1994)	Four subprojects conducted by IFPRI, the Government of Bangladesh and USAID	Agricultural growth through crop diversification in Bangladesh	Under non-irrigated or semi-irrigated conditions, varietal agrarian practices in non- grain crops will be more lucrative and could lead to crop divergence as a fruitful aspect for nation agriculture.

Table B: Systematic review on physiography of Madhupur tract and vegetable cultivation pattern

Author (Year)	Context/Sample	Title	Findings
Begum *et al.* (2009)	114 alluvial samples from Sreepur and Kaliakair under Gazipur	Status of micronutrients in diverse soils of Gazipur district as related to soil properties and land type	The p^H was more acidic to temperately acidic entailed in red brownish soil mostly silty clay loam in nature.
Islam (2012)	30 agro-ecological regions in Bangladesh territory	Agro-Ecological Zones in Bangladesh (Madhupur Tract)	The northern climate of Madhupur tract is cooler than south in winter. Average temperatures varied from 10^o - 20^oC in winter and 28^oC to 32^oC in summer and precipitation ranged between 1,000 to 1,500 mm annually that are conducive to vegetable cultivation.
Lira *et al.* (2014)	Soil samples from 26 specific spots of six areas of Madhupur Tract	Quality assessment of Madhupur tract soil for agricultural activities	In Madhupur tract, mostly brownish acidic clay had been observed. High land soils were strongly acidic to slightly acidic in reaction.
Maynard *et al.* (2007)	Diversified vegetable grown at USA territory	Tolerance of vegetables to soil acidity	Green & colored vegetables raised pleasingly in acidic soil by keeping pH values 4.5 to 6.8.

Table C: Systematic review of comparative advantages in vegetable and grain crops cultivation

Author (Year)	Context/Sample	Title	Findings
Begum *et al.* (2011)	50 farmers for each crop in Lalmonirhat, Cumilla, Chattogram Jashore.	Profitability of some BARI released crop varieties in some locations of Bangladesh	The BCRs in respect to total costs were 1.61, 1.72, 3.55, 1.90, 2.17, 3.72, 1.94 and 2.64 for the production of maize, groundnut, mungbean, cabbage, cauliflower, tomato, cucumber and okra.
Bisbis *et al.* (2018)	Eurostat vegetable census in Western Europe terrain	Potential impact of climate change on vegetable production quality	Vegetables provide maximum output and more incentive per unit area of land to small-scale growers, particularly when compared to cereals under various weather impact.
BSS (2021)	Interview with Bidhu Bhusan (Add. Director, DAE, Rangpur region)	Vegetable farming becomes blessing for rural economy	Adopting newer cropping forms and know-hows entailed in an average yield rate of 16.4 tons vegetable per hectare of land in Rangpur region amid the Covid-19 pandemic
Chandra *et al.* (2020)	150 high value vegetable producers in five upazilas of Sirajgonj district	Problems, prospects, profitability analysis of high value vegetables cultivation in Sirajganj district	A splendid attainment in vegetable production including highest BCR (3.16) was from bottle gourd and the lowest BCR (2.08) in yard long bean on the basis of total cost calculation.
Chatterjee and Mukherjee (2019)	Year wise agricultural statistics conducted by Directorate of Economics and Statistics in India and Bangladesh Bureau of Statistics	Strategies for doubling farmers' income through horticulture	In India bordering to Bangladesh, the grain crops (oilseeds, pulses and cereal grains) occupied 77% of the gross cropped area but supported only 41% of total output of the crop sector. Meanwhile, almost equivalent output value was contributed by horticultural crops (fruits, flowers, spices and vegetables) which just occupying 19% of gross cropped area during 2013-14. With this assorted productivity, shifting

			one-hectare area from staple crops to high value crop has one lakh rupia more return.
Chowdhuri *et al.* (2014)	Three villages namely Brahmondi, Ghasirdia, Kharia under Shibpur, Narsingdi district	Profitability analysis of winter vegetables production in a selected area of Narsingdi district in Bangladesh	Per hectare net returns of cabbage, country bean, eggplant and were Tk. 289988, Tk. 184691, and Tk. 242223, respectively depicted vegetable cultivation is moderately money-making than alternative crops in Narsingdi.
Fatema (2006)	90 vegetable growers in Trishal upazila of Mymensingh district	Economics of some selected winter vegetables production in an area of Trishal upazila in Mymensingh district.	Vegetable crops are lucrative due to labor intensive cash harvests, relatively short production cycles and more profitable than staple crops and less risky as compared to mustard and pulse like field crops.
Hasan *et al*. (2020)	213 vegetable growers from Cumilla, Rajshahi & Mymensingh districts	Profitability and Technical Efficiency of Vegetable Production in Bangladesh	The BCR based on variable cost was 1.32 for bean, 1.33 for brinjal and 1.38 for tomato depicted that vegetables were gainful.
Parvin (2008)	120 farmers from Gaffargaon upazila in Mymensingh district under Madhupur tract	An economic study of rice and vegetables production in selected area of Mymensingh district	Boro rice, okra, cabbage and white gourd were main feature of fifty percent household and per hectare net returns of producing these crops were BDT 23581, 86898, 89640 and 99000 respectively.
Rasha *et al.* (2018)	60 sample farmers interview in Mymensingh district	Financial profitability and resource use efficiency of Boro rice production in Mymensingh	BCR of Boro rice seemed to be lucrative that enthused farmer to conduct for earning livelihood for the ensuing time. Human labor ship had positive influence on profit making.

Weinberger and Lumpkin (2005)	375 projects across the world by the UK's DFID scheming with global production and exports	Horticulture for Poverty Alleviation - the Unfunded Revolution	Farmers who are engaged in the production of vegetables often earn higher incomes than those engaged in the cereal crops alone.

Table D: Systematic review on earning source swapping from one to another

Author (Year)	Context/Sample	Title	Findings
El-Solh *et al.* (2009)	ICARDA operated projects on Arab peninsula states	Improving livelihoods of small farmers through the production of horticultural crops in protected agriculture in dry areas	Protection agriculture enabled farmers swap from conventional farming to a market-oriented production scheme, generating more earning sources for women-headed families. In Afghanistan annual income amplified to 138%, in Yemen 2-3 crops per year instead of single crop and in Pakistan scarce water was used efficiently.
Gurung *et al.* (2016)	400 sample households positioned across 10 villages in northern and southern Bangladesh	Transformation from rice farming to commercial aquaculture in Bangladesh: implications for gender, food security, and livelihood	Commercial aquaculture altered from rice production improved farm income and income inequality, brought in new sources of employment, changed gender roles and relations, altered women's access to and control of resources and increased market dependence for staple food.
Khandoker *et al.* (2014)	180 growers selected from Chapai Nawabganj Natore & Pabna districts	Impact of shifting of land from cereal crops to jujube cultivation in selected areas of Bangladesh	Area swapped in favor of fruits from cereal crop had been proposed as a viable option to stabilize and promote farm earning, enhance agricultural growth and employment chances.

Khandoker *et al.* (2017)	180 farmers from Chapai Nawabganj, Natore and Rajshahi districts	Comparative profitability analysis of shifting land from field crops to mango cultivation in selected areas of Bangladesh	Farmers were enthused by money-making compared to field crop and influenced by neighbor. Relative income, farm size and education turned out positively significant, while age was negative for swap from cereal to horticultural crop.

Table E: Systematic review of factors influencing farmers decision towards cultivation

Author (Date)	Context/Sample	Title	Findings
E.a. **Age distribution**			
Akter (2009)	90 farmers under Shibpur Upazila in Narsingdi district	An economic analysis of winter vegetables production in some selected areas of Narsingdi district	Active age cluster 25 to 48 years provided ample physical efforts in vegetable farming.
Ali *et al.* (2001)	1500 vegetable and non-veg farmers in Savar, Rangpur and Noakhali districts	Vegetables in Bangladesh: Economic and nutritional impact of new varieties and technologies	No significant differences across vegetable farm categories in age of the household head.
Battese and Coelli (1995)	Paddy farmers from several Indian villages having at least 10 years' experience	A model for technical inefficiency effects in a stochastic frontier production function for panel data	A young aged farmer can easily adopt new technology as s/he is more technically efficient than the older.
Farid *et al.* (2015)	Purposively selected 218 farmers in Dinajpur and Bagura district	Factors affecting adoption of improved farm practices by the farmers of Northern Bangladesh	No cabalistic relationship with age factor in deciding new improvise cultivation.

Kabir and Rainis (2015)	331 vegetable producers of Narsingdi district	Adoption and intensity of IPM vegetable farming in Bangladesh: an approach to sustainable agricultural development	Old aged growers with large families were less interested in adopting new variety technology.
E.b. **Arable Farm Size**			
Andrew and Anna (2005)	CIAT operating researches on 29 countries of sub-Saharan Africa	High value agricultural products for smallholder markets in sub-Saharan Africa: Trends, opportunities and research priorities	Small vegetable plots have privileged with respect to labor deployment, pests and disease management
Farid *et al.* (2015)	Purposively selected 218 farmers in Dinajpur and Bagura district	Factors affecting adoption of improved farm practices by the farmers of Northern Bangladesh	Adoption of vegetable farming practices is low among smallholders.
Joshi (2005)	Year wise agricultural statistics conducted by Directorate of Economics and Statistics on crop diversification in India	Crop diversification in India: Nature, Pattern and Drivers	Smallholders confronted a lack of assured markets and a lack of an efficient marketing system which led to havoc crop losses and farmers reluctant to produce farther.
E.c. **IPM Consciousness**			
Kabir and Rainis (2015)	331 vegetable producers of Narsingdi district	Adoption and intensity of integrated pest management (IPM) vegetable	Farmers who were more IPM cognized desired to cultivate vegetables in large locations under own

		farming in Bangladesh: an approach to sustainable agricultural development	household further.
E.d. **Women participation/assistance**			
Kabir and Sarker (2015)	70 rural women in Madhupur forest zones	Women's participation in agricultural activities at forest land areas of Bangladesh	Young and middle-aged women had a wide extent of involvement in agriculture.
Sobhan and Khondokar (2001)	Study on women participation in workplace undertaken by the Centre for Policy Dialogue in alliance with the UNRISD	Globalization and gender: Changing pattern of women employment in Bangladesh	Female individuals played dynamic role especially in homestead vegetable farming actions.
E.e. **Crop selling market**			
Muamba (2011)	World bank statistics on African LDC nations	Selling at the farmgate or traveling to the market: a conditional farm-level model	Greater market participation promoted the alteration of the farmers' economic status from subsistent or semi-subsistent to specialization where they cultivate crops for a comparative advantage.
Rabirou *et al.* (2009)	240 food farmers in the Oke-Ogun state, Nigeria	Arm location and determinants of agricultural productivity in the Oke-Ogun state, Nigeria	No negative impact of farm distance from market on food farmer's productivity.

Rahman (2020)	Survey on DAE certified farmers at Krishoker Bazar in Manik Mia Avenue, Dhaka.	Krishoker Bazar: Safe vegetable farmers team up to explore Dhaka market	Farmers receive immediate payment at harvest and can introduce with customer with their forthcoming production
E.f. **Grain crop independence at home**			
Khandoker *et al.* (2014)	180 farmers selected from Natore, Pabna and Chapai Nawabganj districts	Impact of shifting of land from cereal crops to jujube cultivation in selected areas of Bangladesh	Cereal food crop requirement had negative relation with the decision of substitution. It meant that additional cereal food requirements at household inhibited the extent of crop swap decision of the farmers.
Mahmud *et al.* (1994)	Four subprojects conducted by IFPRI, the Government of Bangladesh and USAID	Agricultural growth through crop diversification in Bangladesh	Due to irrigation in conveniences, a fierce competition for land between Boro season rice and non- grains.

Table F: Systematic review of vegetable cultivation and marketing perplexities

Author (Year)	Context/Sample	Title	Findings
Chandra *et al.* (2020)	150 high value vegetable producers in five upazilas of Sirajgonj district	Problems, prospects and profitability analysis of high value summer vegetables cultivation in Sirajganj district	Major difficulties were identified as low local market price, insect and disease infestation, lack of on modern technology facts, middle men outrage, environmental stress variety, lack of capital and labor crisis.

Hasan *et al.* (2020)	A field survey of 213 vegetable farmers under Mymensingh, Cumilla and Rajshahi districts	Profitability and Technical Efficiency of Vegetable Production in Bangladesh	Capital deficiency and storage inefficiency, insect and disease damages, price fluctuations of vegetables and lack of supervision were the foremost problems of farmers.
Missanga and Rubanza (2018)	A total 60 respondents in Dodoma and Manyara region of central and northern Tanzania	Management practices of insect-pests and diseases of common vegetable crop of selected districts of central and northern Tanzania	Quality seed deficiency, insect and disease, climate and environmental stress as well as along with not receiving agricultural extension service in-time made the major barriers in productivity of vegetables.

APPENDIX V

Noteworthy photographs of the researcher during data collection

APPENDIX VI

Cumulative Frequency Curve of socio-economic factors those had significant level impact

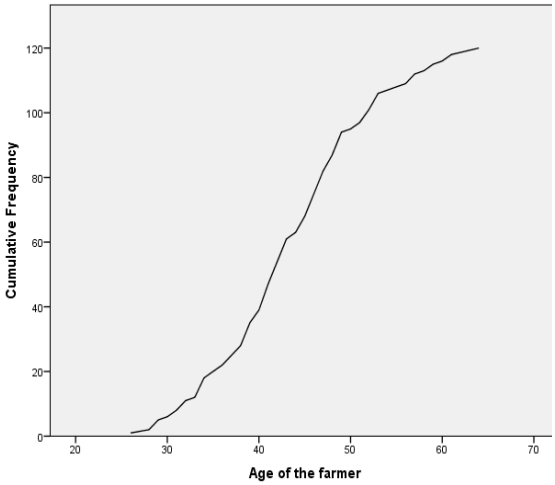

Figure A: Plot of observed cumulative frequency for age distribution

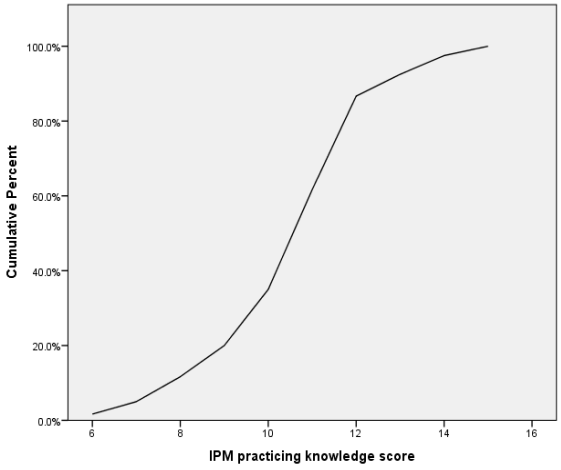

Figure B: Plot of observed cumulative frequency for IPM practicing consciousness

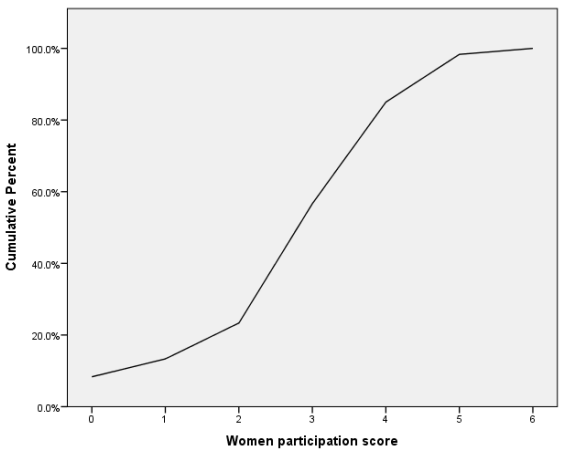

Figure C: Plot of observed cumulative frequency for women participation feasibility

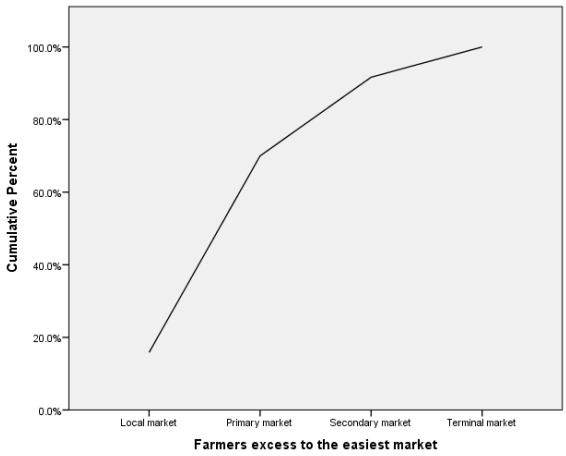

Figure D: Plot of observed cumulative frequency for crop selling market

APPENDIX VII

Summary output of logistic function analysis of factors that influenced farmer's willingness towards vegetable commercialization

Model Summery

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
66.658[a]	.374	.583

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001

Hosmer and Lemeshow Test

Chi-square	Df	Sig.
3.392	8	.863

Logistic Regression Test

Variables	Co-eff. Value	Std. Err.	P - value
Age_distr	- 0.07903	0.03943	0.045
Land_size	1.79036	1.38285	0.195
IPM_score	0.59909	0.20953	0.004
Women_score	0.70310	0.24943	0.005
Market_score_code			
Primary_market	1.56946	0.72890	0.031
Secondary_market	3.13543	1.16042	0.007
Grain_indpdn_code	1.29885	0.71454	0.069
_cons	- 7.69099	3.78353	0.042

Average Marginal Effect Co-efficient

Variables	dy/dx value	Std. Err.	P - value
Age_distr	-0.00692	0.00322	0.032
Land_size	0.156831	0.11891	0.187
IPM_score	0.05247	0.01598	0.001
Women_score	0.06159	0.01889	0.001
Market_score_code			
Primary_market	0.18078	0.08979	0.044
Secondary_market	0.28635	0.09261	0.002
Grain_indpdn_code	0.11378	0.05966	0.089

… … … Fi Amanillah … … …