Potentials of Farmer Interactive Action to Remedy Vegetable Marketing Problems: *Relevant to Selected Locations*

W.A.R. Wickramasinghe

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Hector Kobbekaduwa Agrarian Research and Training Institute
114, Wijerama Mawatha
Colombo 7
Sri Lanka

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FOREWORD

One of the most important sectors in the Sri Lankan agriculture is the vegetable sub-sector. Vegetables are grown in most of areas in Sri Lanka and annual production of vegetables is around 602,000 metric tons. Annual average export of vegetable is around 21,092 metric tons. Vegetable farming is a main source of income for vegetable farmer households. Marketable vegetable production is over 85 percent of the total production of all vegetables with an average of 91 percent of the total production.

A critical challenge with regard to vegetable sector is marketing. Problems related to marketing vegetables have affected vegetable production and efficiency of resources used for vegetable cultivation. Ultimately, vegetable marketing problems are connected with development issues of the country. Although there is an increasing trend of vegetable export and consequently increased demand for vegetables, vegetable marketing problems still persist. Further, contribution of supermarket to resolve vegetable marketing problems is not remarkable.

According to literature with regard to vegetable marketing, vegetable farmer has to be the price taker due to lack of bargaining power due to lack of market information, being in debt to the trader and being unorganized farmers. Thus, there is also a possibility for development in SMEs or farmer group association to reform existing marketing system to upgrade farm-gate income to producers. Further, previous studies have established that organizing small farmers into collective groups has been a strategy to reduce contract management cost and power imbalance. Therefore, this study is expected to provide information and suggestions to motivate farmer interactive action for finding solutions for vegetable marketing problems.

Keerthi B. Kotagama
Director

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Ranjith Wickramasinghe

EXECUTIVE SUMMARY

This study focuses on understanding strategies of vegetable farmers with regard to vegetable production and marketing, and problems related to these actions in order to identify potentials of farmer interactive actions to remedy vegetable marketing problems.

One specific objectives which are exploration of actions (strategies) implemented by vegetable farmers in vegetable production and marketing at present and benefits derived from these actions, identification determinants of choosing these actions implemented by vegetable farmers in vegetable production and marketing and exploring potentials of farmer interactive actions to remedy vegetable marketing problems.

Population of this study was reasonably selected vegetable farmers in Sri Lanka, mainly from upcountry and low-country. A sample of 233 vegetable farmers comprising 133 from Jaffna district and 100 from Nuwara Eliya district was selected. Data was collected from the selected sample using a structured questionnaire and focus group discussions.

Most of the farmers in Jaffna district grow both English and local vegetables such as beetroot, carrot, cabbage and long bean while those in the Nuwara Eliya district grow carrot, leeks, cabbage, beetroot, tomato and brinjal. Brinjal, bittergourd, long bean, okra, pumpkin, capsicum, snakegourd and cucumber are grown only in the Jaffna district.

The highest average cultivation extent of land is 0.4 ha of cucumber per farmer per year in the Jaffna district and 0.24 ha of tomato per farmer per year in the Nuwara Eliya district. Extent of land per farmer per year is higher in the Jaffna district than in the Nuwara Eliya district. The average extent of land under beetroot, snakegourd, cabbage, carrot, capsicum, brinjal and okra is below 0.4 ha farmer per year in Jaffna. In the case of Nuwara Eliya, the average extent of land under beetroot, carrot, cabbage, leeks and lettuce is below 0.12 ha per farmer per year.

Vegetable farmers in the Jaffna and Nuwara Eliya districts grow vegetables in lands belonging to different land tenure classes. The highest average extent of land reported by vegetable farmer in the Jaffna district was 0.82 ha, a rented land. The highest average extent of lands reported by vegetable farmer in the Nuwara Eliya district was 0.7 ha which is encroached. More than 60 percent of the interviewed farmers in the Jaffna district cultivate vegetables in transferred (44.36 %) and rented (27.82%) lands. Over three quarter of the interviewed farmers grow in transferred (46.94%) and LDO (31.63%) lands in the Nuwara Eliya district.

More than half (50%) of the interviewed vegetable farmers in the Jaffna district sell their vegetables at market and at farmgate whereas almost all the interviewed farmers in the Nuwara Eliya district sell their products only at farmgate. Of the interviewed farmers, fewer farmers in the Jaffna district and the Nuwara Eliya district sell vegetables by forward sales contracts. Compared to vegetable farmers from the Jaffna district, Nuwara Eliya farmers face difficulties in marketing their produce. However, vegetable farmers of both districts stated production excess as opposed to the demand as the main reason for receiving a deteriorated price. The vegetable farmers in the two districts are price takers and majority is faced with distorted market situations.

Vegetable farmers in Jaffna and Nuwara Eliya districts adopt varied strategies. Four strategies with regard to vegetable production are identified. With regard to the Jaffna district, average payoff corresponding to each strategy costs higher than that of Nuwara Eliya district farmers. Every respondent in Jaffna and Nuwara Eliya districts had employed a dominant strategy with regard to vegetable production. The strategies they adopt are at Nash equilibrium that explains every farmer adopts a strategy without considering strategy what other farmers adopt.

Seven determinants of strategies were identified. Profit corresponding to each strategy is the dependent variable which is significantly affected by cultivated extent of land, land tenure and credit availability.

According to the interviewed farmers, vegetable marketing and production problems can be resolved by forming a mechanism thereby enabling information sharing on vegetable production in adjoining areas in the country. There are potentials for organizing farmers to form such mechanism as barriers to form farmer organization being less.

For a finite game, vegetable farmers' interaction is at equilibrium in two districts and in an infinite game, equilibrium will change. Farmers' interactions can resolve issues related to vegetable production and marketing. There are potentials for forming such mechanisms enabling farmer interactions.

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CHAPTER ONE

Introduction

1. Introduction

Vegetable sub-sector is the most important sector in the Sri Lankan agriculture. Vegetables are grown all over the country and annual production of vegetables is around 602,000 metric tons (Department of Census and Statistics, 2012). Annual average export quantity of vegetables is around 21,092 metric tons (Department of Census and Statistics, 2012). Vegetable farming is a main income source of vegetable farmer households. Marketable vegetable production is over 85 percent of the total production with an average of 91 percent of the total production (Rupasena, 1999).

1.1 Vegetable Marketing Problem and Changes in Vegetable Supply Chain

Problems related to marketing vegetables affect vegetable farmer's household income as the price taken is less than the breakeven price. Five aspects of vegetable marketing problems have been identified by a study by Rupasena (1999): unreasonable price, poor road facilities, malpractice in selling, difficulties in selling and price fluctuation. All these problems affect the demand for vegetables and changes in vegetable market chain are expected to increase opportunities of having a better price to vegetable farmer through increased demand.

Despite the increased demand for vegetables due to exporting and upward export trend problems related to vegetable marketing still persist (Perera et Al., 2015). Another recent change witnessed in vegetable supply chain (vegetable market chain) is supermarkets entering into vegetable supply chain. Vegetable supply chain links the vegetable farmer and the consumer via different intermediate stakeholders. Vegetable supply chain changes on par with the changes occurring in intermediate stakeholders i.e. entering new intermediate stakeholders to the market chain and leaving existing intermediate stakeholders. Vegetable supply chain in Sri Lanka has changed over time with supermarkets entering the vegetable supply chain (Perera et al., 2004). No drastic change in income of vegetable farmers has been observed with supermarkets entering the vegetable supply chains except extensions of the vegetable market chains (Perera et al., 2004). Further, demand for vegetables by supermarkets is not sufficient to create a competition among vegetable buyers as supermarkets are not used by majority of the consumers to meet vegetable requirements i.e. consumers who procure vegetables from supermarket outlets are only about 33 percent of the consumers purchasing from supermarkets while others prefer to procure their vegetables from traditional retail outlets (e.g. at the '*Pola'*) (Wickramarachchi, 2004).

1.2 Vegetable Producer Price and Collective Action of Vegetable Farmers

Receiving an inadequate price for vegetable produce is a persistent problem with regard to vegetable marketing. Pricing vegetables at farmgate level has been solely dependent on the supply as the perishable nature of vegetable forces the farmers to sell their production at a price determined by the buyer (Rupasena, 1999). Although vegetable price competition is said to have been less during seasons in which supply is excess, oligopsony - that a few buyers determine market price, causes price determination and farmer becomes a price taker. Therefore, vegetable farmer has to be price taker due to lack of bargaining power resulted by information asymmetry, indebtedness to the trader and being unorganized (Rupasena, 1999).

Improvements or reforms in the marketing system could emerge from private enterprise, farmer group action or by the government (Gunawardena, 1981). There is also a possibility for development in SMEs or farmer group association to reform existing marketing system to upgrade farm-gate income of producers.

A study conducted by Chen *et al.,* (2005) has pointed out that individual small farmers are unable to compete with larger counterparts and they cannot supply vegetables to supermarkets without working as groups. Therefore, organizing small farmers into collective groups has been a strategy to reduce contract management cost and power imbalance (Little and Watts, 1994; Esham and Usami, 2005; Esham et al., 2006). In such situation, small vegetable farmers should be in need of new strategies to sustain and understanding of emerging issues is necessary to find new strategies. Shepherd (2006) has also pointed out that there is a need for government to recognize these trends, to identify ways to support farmers, and to assist existing marketing systems to compete with the supermarket sector.

1.3 Problem Statement

In the vegetable production sector of Sri Lanka, marketing vegetables has taken a key place as most of problems of vegetable value chain are centred on marketing. The prominent issue, highly discussed with regard to vegetable marketing most of the time is surplus production of vegetables resulting in a lower price to vegetable farmers. Although changes in vegetable supply chain in Sri Lanka have been made with the expectation of increasing market margin for stakeholders of the vegetable supply chain marketing problems are apparent yet.

Recent changes in vegetable supply chain are exporting vegetables, which is in an upward trend (Perera et al., 2015) and supermarkets entering the vegetable supply chain (Perera et al., 2004). Therefore, it seems that these changes of vegetable supply chain do not support vegetable market clearance. Further, in this scenario, emergence

of Oligopsony causes price determination and aggravates economic problems of vegetable farmer.

It seems that one solution for vegetable marketing problems is to maintain vegetable demand through controlling excessive production of one vegetable. Coordination among vegetable farmers is vital to get information on their cultivation variety to maintain the market share. To create a coordinated mechanism among farmers and organize their information on actions and strategies taken by farmers with regard to vegetable production plays a central role. Despite many studies (Esham and Usami, 2005; Esham et al., 2006; Rupasena, 1999; Wickramarachchi, 2004; Perera et al., 2004; Perera et. al., 2015) with regard to vegetable supply chain and marketing in Sri Lanka, no study has been conducted with regard to strategic behaviour of vegetable farmers in Sri Lanka. Therefore, this study is focused on investigating strategic actions of vegetable farmers, factors leading to these actions and potentials of transforming their actions into coordinating or cooperative actions.

1.4 Objectives

Main Objective

To understand existing actions (strategies) of vegetable farmers with regard to vegetable production and marketing, and problems with regard to these actions to increase potentials of farmer collective actions to remedy vegetable marketing problems.

Specific Objectives

1. To explore actions (strategies) implemented by vegetable farmers in vegetable production and marketing at present and benefits derived from these actions

2. To identify determinants of choosing these actions implemented by vegetable farmers in vegetable production and marketing

3. To find out potentials of farmer interactive actions to remedy vegetable marketing problems

CHAPTER TWO

Theoretical Framework

2. Theoretical Framework

Vegetable farmers in Sri Lanka also make decisions with regard to vegetable cultivation to maximize the utility derived from net income. Therefore, utility of a vegetable farmer derived from income from vegetable cultivation can be expressed in the following functional form:

$$U_v = f(I_v)$$

Where $U_v =$ utility from vegetable cultivation; $I_v =$ income from vegetable cultivation

Increase of utility or net income (outcome) from vegetable cultivation is the outcome of vegetable cultivation. Farmers individually make decisions to gain opportunities to maximize their net income. Net income from vegetables depends on quantity produced (Q), cost incurred in production (C) and price (P) at which production is sold. These three factors are determined separately by other factors. Quantity of a particular vegetable produced is determined by yield, extent of cultivation, quality of planting material and variety of the vegetable. Cost incurred includes cost of fertilizer, cost of pest control and cultural practices. Price at which a farmer sells his vegetables depends on market demand, available quantity at the market, prices of substitutes for this vegetable and the number of buyers at the market (competitiveness). In addition, some farmers make contracts (A^j) with buyers. Therefore, there are two strategies that make contracts (A^1) and do not make contracts (A^0).

Therefore, $A^j = \{A^1, A^0\}$, where j= {1, 0}.

According to these particulars, a farmer determines a strategy of cultivating vegetables. A strategy is description of a way of implementing an action (Kreps, 1989). A cultivating strategy depends on factors such as quantity of production, cost of production and the selling price. Therefore, there may be different cultivating strategies as per changes in these determinants.

$S_i = (S_i/Q_i, C_i, P_i)$

S_i is the i^{th} cultivating strategy based on the given quantity of production (Q), cost of production (C) and the selling price (P).

Therefore, different cultivating strategies can be indicated as $\overset{n}{\underset{i=1}{S_i}}$

Farmers select factors determining level of Q, C and P so that net income of vegetable cultivation is increased.

When a farmer cultivating strategy and contracting strategy are considered together, a farmers strategy profile can be written as $(\overset{n}{\underset{i=1}{S_i}}, A^1)$ and $(\overset{n}{\underset{i=1}{S_i}}, A^0)$

Vegetable farmers are assumed to be making strategic decisions in producing vegetables. Their strategic action can be presented as two-person game structure.

a). All vegetable farmers are considered as two imaginary entities: {1, 2}. These two entities are labeled as challenger *i* and contender *–I*, where the challenger is an average villager, which we consider in the analysis, while the contender represents an average of other farmers, which is evaluated in the mind of the challenger. More specifically, this study deals with *1* versus N-*1* game, where *N* is the number of vegetable farmers.

b). Player *i* chooses the strategies from two strategy profiles, $(\overset{n}{\underset{i=1}{S_i}}, A^1)$ or $(\overset{n}{\underset{i=1}{S_i}}, A^0)$

c). Payoff to the challenger *i* is represented by $\pi_i{}^j(\overset{n}{\underset{i=1}{S_i}}, A^j)$ corresponding to two strategy profiles, $(\overset{n}{\underset{i=1}{S_i}}, A^1)$ or $(\overset{n}{\underset{i=1}{S_i}}, A^0)$, $j = (1,0)$

d). Payoff matrix to two players is determined by the number of strategies implemented by the challenger and the contender.

Therefore, strategic profiles of a vegetable farmer can be assumed to be consisting of *2n* strategies as shown in the following table.

Table 2.1: Assumed Strategic Profile of a Vegetable Farmer

$\overset{n}{\underset{i=1}{S_i}}$	$A^j; j = (1,0)$	
	A^1	A^0
S_1	$S_1\ A^1$	$S_1\ A^0$
S_2	$S_2\ A^1$	$S_2\ A^0$
S_n	$S_n\ A^1$	$S_n\ A^0$

Table 2.2: Payoff Matrix of Vegetable Farmers for Assumed Pure Strategies

		Contender							
		$S_1\ A^1$	$S_2\ A^1$		$S_n\ A^1$	$S_1\ A^0$	$S_2\ A^0$		$S_n\ A^0$
Challenger	$S_1\ A^1$	π_1^1, π_1^1	π_1^1, π_2^1		π_1^1, π_n^1	π_1^1, π_1^0	π_1^1, π_2^0		π_1^1, π_n^0
	$S_2\ A^1$	π_2^1, π_1^1	π_2^1, π_2^1		π_2^1, π_n^1	π_2^1, π_1^0	π_2^1, π_2^0		π_2^1, π_n^0
	$S_n\ A^1$	π_n^1, π_1^1	π_n^1, π_2^1		π_n^1, π_n^1	π_n^1, π_1^0	π_n^1, π_2^0		π_n^1, π_n^0
	$S_1\ A^0$	π_1^0, π_1^1	π_1^0, π_2^1		π_1^0, π_n^1	π_1^0, π_1^0	π_1^0, π_2^0		π_1^0, π_n^0
	$S_2\ A^0$	π_2^0, π_1^1	π_2^0, π_2^1		π_2^0, π_n^1	π_2^0, π_1^0	π_2^0, π_2^0		π_2^0, π_n^0
	$S_n\ A^0$	π_n^0, π_1^1	π_n^0, π_2^1		π_n^0, π_n^1	π_n^0, π_1^0	π_n^0, π_2^0		π_n^0, π_n^0

Note: Pure strategy means that the move a player makes with a pure strategy in a game. Probability assigned to a pure strategy is 1.

Table 2.3: Payoff Matrix of Vegetable Farmers for Assumed Mixed Strategies

		Contender							
		$S_1\ A^1$	$S_2\ A^1$		$S_n\ A^1$	$S_1\ A^0$	$S_2\ A^0$		$S_n\ A^0$
Challenger	$S_1\ A^1$	$p_1^1\pi_1^1, q_1^1\pi_1^1$	$p_1^1\pi_1^1, q_2^1\pi_2^1$		$p_1^1\pi_1^1, q_n^1\pi_n^1$	$p_1^1\pi_1^1, q_1^0\pi_1^0$	$p_1^1\pi_1^1, q_2^0\pi_2^0$		$p_1^1\pi_1^1, q_n^0\pi_n^0$
	$S_2\ A^1$	$p_2^1\pi_2^1, q_1^1\pi_1^1$	$p_2^1\pi_2^1, q_2^1\pi_2^1$		$p_2^1\pi_2^1, q_n^1\pi_n^1$	$p_2^1\pi_2^1, q_1^0\pi_1^0$	$p_2^1\pi_2^1, q_2^0\pi_2^0$		$p_2^1\pi_2^1, q_n^0\pi_n^0$
	$S_n\ A^1$	$p_n^1\pi_n^1, q_1^1\pi_1^1$	$p_n^1\pi_n^1, q_2^1\pi_2^1$		$p_n^1\pi_n^1, q_n^1\pi_n^1$	$p_n^1\pi_n^1, q_1^0\pi_1^0$	$p_n^1\pi_n^1, q_2^0\pi_2^0$		$p_n^1\pi_n^1, q_n^0\pi_n^0$
	$S_1\ A^0$	$p_1^0\pi_1^0, q_1^1\pi_1^1$	$p_1^0\pi_1^0, q_2^1\pi_2^1$		$p_1^0\pi_1^0, q_n^1\pi_n^1$	$p_1^0\pi_1^0, q_1^0\pi_1^0$	$p_1^0\pi_1^0, q_2^0\pi_2^0$		$p_1^0\pi_1^0, q_n^0\pi_n^0$
	$S_2\ A^0$	$p_2^0\pi_2^0, q_1^1\pi_1^1$	$p_1^0\pi_1^0, q_2^1\pi_2^1$		$p_2^0\pi_2^0, q_n^1\pi_n^1$	$p_2^0\pi_2^0, q_1^0\pi_1^0$	$p_2^0\pi_2^0, q_2^0\pi_2^0$		$p_2^0\pi_2^0, q_n^0\pi_n^0$
	$S_n\ A^0$	$p_n^0\pi_n^0, q_1^1\pi_1^1$	$p_1^0\pi_1^0, q_2^1\pi_2^1$		$p_n^0\pi_n^0, q_n^1\pi_n^1$	$p_n^0\pi_n^0, q_1^0\pi_1^0$	$p_n^0\pi_n^0, q_2^0\pi_2^0$		$p_n^0\pi_n^0, q_n^0\pi_n^0$

Note: A **mixed strategy of *s* game** comprises two or more pure strategies. A probability is assigned to each pure strategy.

Challenger's probabilities of selecting pure strategies; $(p_1^1 + p_2^1 + ... + p_n^1) + (p_1^0 + p_2^0 + ... + p_n^0) = 1$

Contender's probabilities of selecting pure strategies; $(q_1^1 + q_2^1 + ... + q_n^1) + (q_1^0 + q_2^0 + ... + q_n^0) = 1$

Actions (strategies) taken by a vegetable farmer reflect their behaviours. According to order of payoffs each player obtains, different games can be identified. Games basically can be categorized into two as non-cooperative and cooperative based on the way of cooperating to attain higher benefits. With regard to non-cooperative games, it is assumed that the players cannot overtly cooperate to attain higher benefits. With regard to cooperative games, players adopt cooperative strategies i.e. players are allowed to make binding agreements. In non-cooperative games, equilibrium outcomes are self-enforcing and in cooperative games, outside mechanism can enforce binding agreements which can make players better off.

Decisions made by vegetable farmers in vegetable production have not been clearly identified and understood. However, in most of cases, the majority of farmers grow the same vegetable variety. It can be assumed that each farmer has followed what majority of farmers have done i.e. majority of farmers have adopted the same strategy. As per Runge (1981 & 1984), assurance game exists when one prefers to do what the other does, vegetable farmers' actions can be assumed as an assurance game. As different strategies which generate different payoffs result in different games; there may be different games with regard to vegetable farmers in study areas. Irrespective of the strategy selected by vegetable farmers, they expect to maximize net income or their utility. When vegetable farmers adhere to non-cooperative strategies they cannot reach to an equilibrium strategy. For instance, if all farmers resort to an assurance game that all farmers grow one type of vegetable, they cannot sell the produce at a higher price due to excess produce. Out of those farmers, contract farmers sometimes can sell their product at a higher price compared to others. Therefore, non-cooperative strategies do not result in Pareto optimal solution[1].

The logic of collective action describes the requirement of a mechanism or device that can produce coercion to make rational and self-interested individuals compelled to act in their common interest (Olson, 1971). Therefore, collective action is that all players act collectively with binding agreements and that result in coordinated action which can generate equilibrium outcomes. Coordinated actions can result in a coordination game (one of non-cooperative games) or a cooperative game. All players (vegetable farmers) can access to information of other farmers' actions relevant to vegetable production and market; they can select coordinated strategy or cooperative strategy with binding agreement with other farmers.

[1] **Pareto Optimal Solution** refers to a **solution**, around which there is no way of improving any objective without degrading at least one other objective (https://www.igi-global.com/dictionary/pareto-optimal-solution/21879)

CHAPTER THREE

Methodology

3. Methodology

This section has been described related to each objective.

3.1. Exploration of Actions (Strategies) Implemented by Vegetable Farmers in Vegetable Production and Marketing at Present and Benefits Derived from These Actions

3.1.1 Variables and Types of Data

Variables related to this objective are strategies adopted by vegetable farmers regarding vegetable production and marketing, and net benefits attributed to each strategy. As mentioned in the theory section, cultivating strategy varies corresponding to variation of the factors determining the level of quantity of production, cost of production and price at which farmers sell. Marketing strategy is described as contract farmers and not contract farmers. According to the theoretical section, payoffs of challenger and contender corresponding to each strategy are variables required for structuring the payoff matrix.

Net Benefit (pay off) Corresponding to Each Strategy

A pre-visit will be made to the selected areas where vegetables are grown, to identify different strategies adopted by farmers with regard to vegetable production and the number of farmers adopting each strategy. Data with regard to these strategies collected from a representative sample will be classified into each strategy and net benefit obtained by each farmer adopting each strategy will be calculated.

Benefit relevant to each strategy is a pay-off or net benefit (profit) from vegetable production corresponding to a particular strategy. Profit of vegetable production, π , is the difference between revenue from vegetable production and cost of vegetable production.

$$\pi_i = R_i - C_i$$

Where

π_i = Net benefit corresponding to i^{th} strategy

R_i = Revenue corresponding to i^{th} strategy

C_i = Cost corresponding to i^{th} strategy

Payoffs for Challenger and Contender

The challenger is an average vegetable farmer while the contender represents an average of other vegetable farmers. Payoff for a particular strategy of the challenger is net benefit corresponding to that strategy and is considered what farmer obtains. Payoff for the contender is an average of net benefits obtained by other farmers adopting a particular strategy.

π_i^{chl} = Net benefit corresponding to i^{th} strategy adopted by a challenger

π_i^{con} = Average net benefit corresponding to i^{th} strategy adopted by a contender

$$\pi_i^{con} = \sum_{j=1}^{(n_i-1)} \pi_{ij}^{con} \Big/ (n_i - 1)$$

Where

n_i = Number of farmers adopting i^{th} strategy

π_{ij}^{con} = Net benefit obtained by j^{th} contender adopting i^{th} strategy

Data

The above variables are calculated using the data given in the following table and the data are primary.

Table 3.1: Data Relevant to Each Vegetable Type

Data	Type of Vegetable Cultivated by a Farmer within a Year			
	Vegetable -1	**Vegetable -2**	**Vegetable -3**	**Vegetable -4**
No. of times cultivated a particular vegetable within a year.				
Extent cultivated by each vegetable				
Yield				
Price at which each crop sold by farmer				
Quality of planting material (success rate of plant growing)				
Variety of vegetable				
Cost of fertilizer				
Cost of pest control				
Cultural practices				
Cost incurred in cultural practices				
Cost of harvesting				
Quantity of crop losses				
Market demand				
Available quantity at the market				
Prices of substitute for a particular vegetable				
Number of buyers at the market				
Contract for marketing vegetables				

3.1.2 Analysis

Interactions of vegetable farmers in producing and marketing vegetables are analyzed based on game theory approach. Estimated payoffs relevant to each strategy are used to identify prevailing games.

3.2 Identification of Determinants of Choosing These Actions (Strategies) Implemented by Vegetable Farmers in Vegetable Production and Marketing

3.2.1 Hypotheses and Variables

The actions (or strategies) identified under the first objective are used for the second objective. Determinants for these actions are assumed to vary across the farmers. Actions or strategies implemented for producing vegetables determine the quantity of production and ultimately net benefit (profit) of vegetable cultivation. Therefore, factors determining production are also assumed to cause actions implemented for vegetable production.

Vegetable farmers choose strategies to maximize net benefits from vegetable cultivation. Therefore, each strategy results in a net benefit and a particular net benefit is attributed to a particular strategy. Net benefit relevant to each strategy is considered as the dependent variable.

Table 3.2: Variables and Related Hypotheses

Determinants of Choosing Actions in Vegetable Production and Marketing	Hypothesis	Variable
Type of vegetable	Vegetables with high value and demand increase net benefits	X_1
Number of vegetables per time	More types of vegetables per time increase net benefits	X_2
Extent of land used for cultivation	Larger the extent of land cultivated, higher the net benefits would be	X_3
Forward contract	Forward contract enables farmers to have a better price for their produce and therefore, increases net benefits	X_4
Land tenure	Owned land increases net benefits	X_5
Functioning extension services	Extension services increase net benefits	X_6
Policies and institutional factors	Functioning policies and institutional factors related to vegetable production and marketing are positive with net benefits	X_7
Collective action in production and marketing	Collective action of farmers are positively related with net benefits	X_8
Size of a farmer household	Number of household members is positively related with net benefit	X_9

Education level of vegetable farmer	Education of farmer is positively related with net benefit	X_{10}
Experience of vegetable farmer	Experience of farmer is positively related with net benefit	X_{11}
Availability of planting materials	Availability of planting materials (seeds) is positively related with net benefit	X_{12}
Availability of fertilizers and agrochemicals	Availability of fertilizers and agrochemicals is positively related with net benefit	X_{13}
Contribution of family labour	Contribution of family labour is positively related with net benefit	X_{14}
Contribution of hired labour	Contribution of hired labour is negatively related with net benefit	X_{15}
Accessibility to credit facilities	Accessibility to credit is positively related with net benefit	X_{16}

3.2.2 Measuring Variable

Some of variables relevant to the second objective have to be measured using data collected while others are directly collected from the vegetable farmers.

Land Tenure

Land tenure is a qualitative variable measured by assigning a weight arbitrarily. Weight is kept as per type of the land tenure. Type of land tenure is also a factor determining value of a particular land. Usually lands which have deeds are transferred lands and these lands have a higher market price than other types of lands. According to significance of land tenure to land value, weight is put assigned to type of land tenure as shown bellow.

Table 3.3: Types of Tenure and Given Weighted Values

Type of Tenure	Weight
Transferred land	4
LDO land	3
Rented in land	2
Encroached land	1

If a farmer has land with two types of tenure, total weight is calculated by adding the weight relevant to each type of tenure. Eg: A farmer has transferred land and LDO land, his weight is seven (7).

Collective Action

Collective action of vegetable farmers is a qualitative variable measured as a categorical data. Farmers act collectively are assigned 1 and those who do not act collectively are assigned 2.

Education Level of Vegetable Farmer

This variable is categorized into seven (7) groups ranked from one (1) to seven (7) as given in table 3.4.

Table 3.4: Education Level and Corresponding Given Rank

Education	Rank of Education
0-1	1
2-5	2
5-10	3
O/L	4
A/L	5
Diploma	6
Degree	7

3.2.3 Analysis

Variables relevant to the second objective are analyzed using an Ordinary Least Square Regression Model.

Ordinary Least Square Regression Model

Analysis with regard to this objective is done using the Ordinary Least Square regression model.

$$Y = \alpha + \sum_{i=1}^{16} \beta_i X_i + e$$

Where

Y = Dependent variable
X_i = i^{th} independent variable
α = Intercept of the equation
β_i = Coefficient of i^{th} independent variable
e = Error term

3.3 Finding out Potentials of Farmer Interactive Actions to Remedy Vegetable Marketing Problems

This objective is to explore ways and means required for motivating vegetable farmers to interact in coordinating or cooperatively. Identification of potentials depends on influences of reasons and factors on actions taken by vegetable farmers as identified under the second objective.

3.4 Population, Location, Sample and Data Collection

Population

Population of this study is vegetable farmers in Sri Lanka. Vegetable farmers are mainly low and upcountry vegetable farmers. These farmers may vary according to extent of available lands, types of vegetables frequently cultivated, geographical distribution, type of link with market (forward contract or non-contract farmers) and whether being part time or full time farmers.

Location

The study was conducted to conduct in two vegetable growing areas in upcountry (Nuwara Eliya) and low country dry zone (Jaffna).

Sample

The sample is selected randomly from the selected two districts and sample size is arbitrarily decided. Sample size is 233 vegetable farmers: 133 from Nuwara Eliya and 100 from Jaffna districts. Therefore, the sample will be a random sample.

Data collection

Data were collected through a sample survey using a structured questionnaire (Annex – 01) and focus group discussions conducted on the sample of the vegetable farmers selected from areas where vegetables are grown.

CHAPTER FOUR

An Overview of Vegetable Sector in Jaffna and Nuwara Eliya Districts

4.1 Vegetable Farmers and Their Education

Table 4.1 presents percentage of the interviewed vegetable farmers belonging to each education level. Majority of the interviewed farmers in two districts, Jaffna and Nuwara Eliya have studied up to O/L and they are 33.83 percent and 40.45 percent (36) respectively. Farmers having a degree are the lowest percentage of the interviewed vegetable farmers and they are 0.75 percent and 1.12 percent in Jaffna and Nuwara Eliya respectively.

Table 4.1: Percentage of the Interviewed Vegetable Farmers Belonging to Each Education Level

Education	Percentage of Farmers	
	Jaffna District	Nuwara Eliya
0-1	22.56% (30)	8.99% (8)
2-5	7.52% (10)	2.25% (2)
5-10	22.56% (30)	21.35% (19)
O/L	33.83% (45)	40.45% (36)
A/L	12.78% (17)	25.84% (23)
Diploma	0% (0)	0% (0)
Degree	0.75% (1)	1.12% (1)
	100% (133)	**100% (89)**

Source: Household Survey in 2016 Relevant to This Study

4.2 Types of Vegetables Cultivated and Extent of Lands in Jaffna and Nuwara Eliya Districts

As per table 4.2 which presents percentage of the interviewed farmers growing vegetables in each district and average extent of land per farmer per year under each vegetable in two districts, fifteen (15) types of vegetables were reported to have been cultivated in the Jaffna district and seven types of vegetables in the Nuwara Eliya district. The type of vegetable reported to have been grown by the highest percentage of farmers in the Jaffna district is beetroot and that in Nuwara Eliya district it is carrot. The percentage of farmers growing beet root is 65.41% (87) of the interviewed farmers in the Jaffna district and farmers growing carrot is 86.96% (80) of the interviewed farmers in the Nuwara Eliya district. Most of the farmers in the Jaffna district grow beetroot, carrot, cabbage and long bean while those in the Nuwara Eliya district grow carrot, leeks, cabbage, beetroot, tomato and brinjal. Compared to the Nuwara Eliya

district, farmers in the Jaffna district grow both English and local vegetables. As reported, the interviewed farmers in the Jaffna district grow brinjal, bitter gourd, long bean, okra, pumpkin, capsicum, snake gourd and cucumber and those in the Nuwara Eliya district do not grow these varieties.

As per table 4.2, average extent of land under each vegetable varies with type of vegetable. The highest average extent of land reported is for cucumber in the Jaffna district, which is 0.4 ha per farmer per year. In the Nuwara Eliaya district is considered, the highest average extent of land is under tomato cultivation, which is 0.24 ha per farmer per year. Extent of land per farmer per year is higher in the Jaffna district than in the Nuwara Eliya district. Average extent of land under beet root, snake gourd, cabbage, carrot, capsicum, brinjal and okra are 0.37 ha, 0.34 ha, 0.33 ha, 0.3 ha, 0.28 ha, 0.25 ha and 0.2 ha per farmer per year in Jaffna respectively. In the case of Nuwara Eliya, average extent of land under beetroot, carrot, cabbage, leeks and lettuce are 0.09 ha, 0.12 ha, 0.12 ha, 0.11 ha and 0.07 ha per farmer per year respectively. The reason for lower average extent of lands under vegetable cultivation in the Nuwara Eliya district relative to the Jaffna district is due to average extent of land owned by farmers in the Jaffna being larger (Table 4.3).

Table 4.2: Percentage of the Interviewed Farmers Growing Vegetables in Each District and Average Extent of Land per Farmer per Year under Each Vegetable in Two Districts

Type of Vegetable	% of Farmers Cultivating Vegetables in each District		Average Vegetable Grown Land Extent in each District (ha/farmer/year)	
	Jaffna	Nuwara eliya	Jaffna	Nuwara eliya
Beet root	65.41% (87)	16.30% (15)	0.37	0.09
Brinjal	15.04% (20)	0.00% (0)	0.25	0.00
Bitter gourd	9.77% (13)	0.00% (0)	0.22	0.00
Carrot	42.86% (57)	86.96% (80)	0.30	0.12
Cabbage	35.34% (47)	48.91% (45)	0.33	0.12
Leeks	3.01% (4)	69.57% (64)	0.13	0.11
Long (string)bean	25.56% (34)	0.00% (0)	0.14	0.00
Okra	10.53% (14)	0.00% (0)	0.20	0.00
Tomato	19.55% (26)	2.17% (2)	0.19	0.24
Radish	0.75% (1)	3.26% (3)	0.10	0.10
Pumpkin	1.50% (2)	0.00% (0)	0.15	0.00
Snake gourd	4.51% (6)	0.00% (0)	0.34	0.00
Capsicum	13.53% (18)	0.00% (0)	0.28	0.00
Lettuce	0.75% (1)	3.26% (3)	0.10	0.07
Cucumber	1.50% (2)	0.00% (0)	0.40	0.00

Source: Household Survey in 2016 Relevant to This Study

4.3 Land Tenure of Vegetable Farmers in the Jaffna and the Nuwara Eliya Districts

According to Table 4.3 that presents extents of low and high lands under different land tenures and the number of the interviewed farmers using these lands in the Jaffna and the Nuwara Eliya districts, farmers in the Jaffna and the Nuwara Eliya districts grow vegetables in lands belonging to different land tenure classes. These land tenure classes are transferred lands, LDO lands, rented lands and encroached lands. Farmers in Nuwara Eliya district grow vegetables in all those land tenure classes while those in the Jaffna district do not use encroached lands for cultivation. The highest average extent of land reported from the Jaffna district is 0.82 ha per farmer, which is a rented land. In the case of Nuwara Eliya district, the highest average extent of lands reported is 0.7 ha per farmer, which is an encroached land. However, generally, of the two districts, average extent of land used for vegetable cultivation in the Jaffna district is higher.

As shown in Table 4.4 that presents percentage of farmers growing vegetables in different types and tenure of lands, 44.36 percent (59) of the interviewed farmers in the Jaffna district cultivate vegetables in transferred and rented lands. The number of farmers growing vegetables only in rented lands is 27.82 percent (37) of the interviewed in Jaffna district and that growing vegetables only in transferred lands is 21.05 percent. It seems that more than 60 percent of the interviewed farmers in the Jaffna district cultivate vegetables in transferred and rented lands. In the case of Nuwara Eliya district, 46.94 percent (46) of the interviewed farmers grow vegetables in transferred lands and 31.63 percent (31) of the interviewed farmers grow vegetables in LDO lands. Therefore, more than 75 percent of the interviewed farmers grow in transferred and LDO lands in the Nuwara Eliya district.

Table 4.3: Extents of Low and High Lands under Different Land Tenures and the Number of the Interviewed Farmers Using These Lands in Jaffna and Nuwara Eliya Districts

		Transferred		LDO		Rented		Encroached	
		Low Land	High Land	Low Land	High Land	Low Land	High Land	Low Land	High Land
Jaffna district	Number of farmers	4	90	0	2	3	99	0	0
	Total extent (ha)	3.20	58.06	0	0.55	1.60	81.05	0	0
	Average extent (ha)	0.80	0.65	0	0.28	0.53	0.82	0	0
Nuwara Eliya district	Number of farmers	2	53	2	31	1	15	0	1
	Total extent (ha)	1	9.05	0.10	6.28	0.05	5.50	0	0.70
	Average extent (ha)	0.50	0.17	0.05	0.20	0.05	0.37	0	0.70

Source: Household Survey in 2016 Relevant to This Study

Table 4.4: Percentage of Farmers Growing Vegetables in Different Types and Tenure of Lands

	Transferred Land		LDO Land		Rented Land		Encroached Land		Percentage of Farmers
	Low	High	Low	High	Low	High	Low	High	
Jaffna district	x				x				1.50% (2)
	x					x			0.75% (1)
	x								0.75% (1)
		x			x				0.75% (1)
		x							0.75% (1)
		x				x			44.36% (59)
		x							21.05% (28)
		x				x			0.75% (1)
		x		x					0.75% (1)
				x					0.75% (1)
						x			27.82% (37)
									100% (133)
Nuwara Eliya district	x								2.04% (2)
		x				X			6.12% (6)
		x						X	1.02% (1)
		x							46.94% (46)
			x						2.04% (2)
				x					31.63% (31)
					X				1.02% (1)
						X			9.18% (9)
									100% (98)

Source: Household Survey in 2016 Relevant to This Study

4.4 Markets for Vegetable Produced in the Jaffna and the Nuwara Eliya Districts

Farmers sell their production at farm gate, at market places, in both ways and under forward contract. Table 4.5 presents the places where the interviewed farmers sell their produce. As Table 4.5 shows, more than half of the interviewed vegetable farmers in the Jaffna district sell their vegetables at market and at farm gate. With regard to the Nuwara Eliya district, 99 percent of the interviewed farmers sell their product only at farm gate. The percentage of the interviewed farmers who sell their vegetables through

forward sales contracts is 2.3 percent in the Jaffna district and one percent (1%) in the Nuwara Eliya district.

Table 4.5: Ways by which Vegetables are Sold and Percentage of the Interviewed Vegetable Farmers

Way of selling vegetables	Percentage	
	Jaffna	N'Eliya
Vegetables are sold only to buyers arriving at the farm gate	24.8% (33)	99% (99)
Vegetables are carried only to the market where buyers come	39.1% (52)	0
Vegetables are sold to buyers at farm gate and buyers at market places	33.8% (45)	0
Vegetables are sold to a particular buyer with whom the farmer has made a forward contract	2.3% (3)	1% (1)

Source: Household Survey in 2016 Relevant to This Study

According to Table 4.6 which shows percentage of the interviewed farmers responding to vegetable marketing, 63 percent (84) and 15 percent (15) of the interviewed farmers from the Jaffna and the Nuwara Eliya districts respectively can sell their produce as they wish. Out of the interviewed farmers from the Nuwara Eliya district, 81 percent (81) stated that they cannot sell their vegetable production as they wish and the percentage in the Jaffna district is 34 percent (45). As per Table 4.5, majority of the farmers from Jaffna sell their vegetable at markets with higher buyer population while majority of farmers from Nuwara Eliya sell their products to the buyers who visit the farm. Then, it was revealed that farmers from Jaffna can sell their produce at a competitive price compared to those in Nuwara Eliya the reason which leads to Jaffna farmers having a relatively higher price for their produce.

Table 4.6: Percentage of the Interviewed Farmers Responding to Vegetable Marketing

Response on vegetable marketing	Percentage of Farmers	
	Jaffna	N'Eliya
Those can sell vegetable as wish	63% (84)	15% (15)
Those cannot sell vegetable as wish	34% (45)	81% (81)
Not responded	3% (4)	4% (4)

Source: Household Survey in 2016 Relevant to This Study

Although some of the interviewed farmers in the two districts reported that they can sell their produce at a preferred price, most of farmers have reported to be facing marketing issues every season. Table 4.7 presents reasons reported by vegetable farmers for not receiving an expected price. As per the statistics the major reason rated

by the majority respondents in the two districts is production being higher than the demand. This description is futile us it can be clearly seen from the Table 4.7.

Table 4.7: Issues Reported by Vegetable Farmers for Receiving Below par Price

Reason	Percentage	
	Jaffna	N'Eliya
Excess production that exceeds demand	94% (125)	61% (61)
Lack of buyers that is not sufficient to create a competitive market situation	13% (17)	18% (18)
All buyers have themselves decided a price at which they should buy	12% (9)	39% (39)
Quality of vegetable is not sufficient to have a better price	8% (11)	3% (3)
Vegetables from other areas reaching their market	14% (18)	0%

Source: Household Survey in 2016 Relevant to This Study

Price at which transaction between vegetable buyers and vegetable farmers take place discovered by two parties. Price discovery depends on factors such as market structure (number, size, location, and competitiveness of buyers and sellers); market behavior (buyer procurement and pricing methods); market information and price reporting (amount, timeliness, and reliability of information); and future markets and risk management alternatives. Table 4.8 that presents ways of discovering prices of vegetables reported by the responded farmers indicates that majority of the interviewed farmers from the two districts sell their vegetables at prices set by the buyers. Therefore, most of the vegetable farmers in the two districts are price takers. As per Table 4.8, less than 10 percent of the interviewed farmers in each division are price makers. In theory of market economy, if buyer sets the price, buyer has the power. With regard to majority cases, buyers control market and no competitiveness among buyers can be observed, which means a competitive market situation does not prevail with regard to vegetable marketing at grower level. Therefore, this reflects prevalence of vegetable marketing problems.

Table 4.8: Ways of Determining Prices of Vegetables Reported by the Respondents

Way of Determining Price	Percentage	
	Jaffna	N'Eliya
Growers fix the price	9% (12)	1% (1)
Buyers determine price	42% (56)	95% (95)
Buyers and growers consider prices of vegetables in other areas	12% (16)	4% (4)
As per market situation	37% (49)	0

Source: Household Survey in 2016 Relevant to This Study

CHAPTER FIVE

Existing Actions (Strategies) Related to Vegetable Production and Marketing and Benefits Derived from these Actions

5.1 Strategies of Vegetable Farmers

Strategy has been defined based on the number of vegetables grown within a year. According to the number of vegetables grown by farmers per year, four strategies have been identified in two districts as strategy 1, 2, 3 and 4 (see Annex 2 and Annex 3 which present details of each strategy implemented by the interviewed vegetable farmers). Strategy 1 included farmers growing one vegetable per year. Similarly, strategy 2, 3 and 4 include farmers growing two, three and four vegetables per year respectively. All interviewed players in two districts have been represented by two players – row player and column player. Payoff is annual average net profit corresponding to each strategy.

5.2 Payoff Matrix of Vegetable Farmers from Jaffna District

Table 5.1 (payoff matrix for vegetable farmers in Jaffna district) is concerned with payoffs corresponding to four strategies implemented by the interviewed vegetable farmers in Jaffna district. These farmers are categorized into four groups as per four strategies. Strategy 1, 2, 3 and 4 include 16.67 percent, 39.47 percent, 26.32 percent and 17.54 percent of the interviewed farmers respectively (see annex 2). These farmer groups are supposed to have been in a vegetable growing game and vegetable farmers in each group interact with farmers of another group. Therefore, interaction between two farmer groups based on strategies can be presented in a two player game matrix. If four farmer groups of four strategies are considered, payoffs corresponding to these four strategies can be arrayed into six two player game matrices (see Appendix 4).

With regard to the Jaffna district, average payoff corresponding to each strategy is Rs. 456,913/= for first strategy, Rs. 364,740/= for the second strategy, Rs. 419,150/= for third strategy and Rs. 564,230/= for fourth strategy. Therefore, players belonging to a particular strategy interact with players implementing other strategies. This vegetable production game is a finite game and as per Table 4.8, average payoff corresponding to each strategy does not change irrespective of the strategy implemented by other vegetable farmers. Therefore, each (player) of the interviewed farmers in the Jaffna district is engaged in dominant strategy with regard to vegetable production. Then, vegetable farmers interact in a finite game of vegetable production and the strategies they adopt are at Nash equilibrium. A strategy becomes Nash equilibrium when a particular strategy of a game is optimal to each player while other players stick to their strategies, (Kreps, 1989). Vegetable farmers adopt these strategies without any external enforcement and implementation of these strategies by these farmers is self-enforcing. Self-enforcing is necessary for Nash equilibrium (Kreps, 1989) and selection of these strategies for implementation has been implicitly agreed by these farmers.

Table 5.1: Two Player Payoff (Rs.) Matrix of the Interviewed Vegetable Farmers in Jaffna District

		Strategies of Column Player							
		1		2		3		4	
Strategies of row player	1	456913	456913	456913	364740	456913	419150	456913	564230
	2	364740	456913	364740	364740	364740	419150	364740	564230
	3	419150	456913	419150	364740	419150	419150	419150	564230
	4	564230	456913	564230	364740	564230	419150	564230	564230

Source: Household Survey in 2016 Relevant to This Study

5.3 Payoff Matrix of Vegetable Farmers from Nuwara Eliya District

Table 5.2 (payoff matrix for vegetable farmers in Nuwara Eliya district) is concerned with payoffs corresponding to four strategies implemented by the interviewed vegetable farmers in the Nuwara Eliya district. These farmers are categorized into four groups as per four strategies. Strategy 1, 2, 3 and 4 includes 17.58 percent, 39.56 percent, 41.76 percent and 1.10 percent of the interviewed farmers respectively (see Annex 3). These farmer groups are supposed to have been in a vegetable growing game and vegetable farmers in each group interact with farmers of another group. Therefore, interaction between two farmer groups based on strategies can be presented in a two player game matrix. If four farmer groups of four strategies are considered, payoffs corresponding to these four strategies can be arrayed into six two player game matrices (see Appendix 4).

In Nuwara Eliya district, average payoff corresponding to each strategy is Rs. 131,319/= for first strategy, Rs. 146,478/= for the second strategy, Rs. 255,820/= for third strategy and Rs. 15,100/= for fourth strategy. Therefore, players belonging to a particular strategy interact with players implementing other strategies. This vegetable production game is a finite game and as per Table 5.2, average payoff corresponding to each strategy does not change regardless of strategy implemented by other vegetable farmers. Therefore, each (player) of the interviewed farmers in the Nuwara Eliya district is also engaged in dominant strategy with regard to vegetable production. Then, vegetable farmers interact in a finite game of vegetable production and the strategies they adopt are at Nash equilibrium. Similar to the interviewed farmers in Jaffna district, the interviewed farmers in Nuwara Eliya district are in equilibrium with regard to vegetable production.

Table 5.2: Two Player Payoff (Rs.) Matrix of the Interviewed Vegetable Farmers in Nuwara Eliya District

		Strategies of Column Player							
		1		2		3		4	
Strategies of row player	1	131319	131319	131319	146478	131319	255820	131319	15100
	2	146478	131319	146478	146478	146478	255820	146478	15100
	3	255820	131319	255820	146478	255820	255820	255820	15100
	4	15100	131319	15100	146478	15100	255820	15100	15100

Source: Household Survey in 2016 Relevant to This Study

CHAPTER SIX

Determinants of Choosing Strategies by Farmers in Vegetable Production and Marketing

6.1 Factors Determining the Strategies Related to Vegetable Production

Thirteen determinants that impact the choice of vegetable production strategies were identified. However, six determinants were left off when estimating the final model considering correlation of the independent variables and their significance. As per the correlation matrix of independent variables of the initial model, significant correlations exist among variable x1 (total land extent) and x2 (cultivating extent per year), and x10 (availability of planting materials), x11 (availability of fertilizer) and x12 (availability of pesticides). Correlations among these variables are more than half. Therefore, variables - total land extent and availability of planting materials, availability of fertilizer and availability of pesticides were removed from the model. In addition, variables - existence of forward sales contracts and family size were removed as the reported number of farmers engaged in forward sale contracts being very few and family size showing the highest insignificance.

Table 6.1 shows descriptive statistics variables of the selected model. Dependent variable is profit and mean profit is Rs. 321,080/= per year. The reported value of the profit from vegetable cultivation of the interviewed farmers in two districts varied from Rs. -348,000/= (loss) to Rs. 3,129,920/= per year. Average profit of a vegetable farmer per month is Rs. 26,756/=

Extent of land where vegetables are cultivated within a year varies from 0.03 ha to 2.75 ha. Average extent of land used for cultivating vegetables is 0.5131 ha. Cropping intensity of a land area is meant as ratio of total land area covered by vegetables within a year to actual total land area i.e. cultivating area is measured relative to actual land area. Cropping intensity of lands used for vegetable cultivation varies from 0.03 (3%) to 9.17 (917%) and average cropping intensity is 1.2 (120%) that is one hectare is cultivated more than one time. With regard to lands used for vegetable cultivation in these two districts, cropping intensity is higher than 100 percent. Land tenure variable which has been measured as a weight varies from two to six. Average value of this variable is four (mode of the land tenure weight is also four) and that reflects transferred lands. Collective action of vegetable farmers is categorical data and majority of farmers do not act collectively as average value is 1.5. Value denoting involvement in collective action is one (1) and value denoting no involvement in collective action is two (2). Average value becoming two (2) means that more observations are having value two (2) that reflects that most of farmers are not engaging in collective action. Education level has been ranked from one (1) to seven (7) considering the level to which the interviewed farmer

has studied. Mean value of education level is 3.5 means that most of farmers have not studied till degree level. Majority of farmers have studied up to grade 10 and GCE (O/L) for which values of rank given to them are three (3) and four (4) respectively. Experience of vegetable cultivation varies from one (1) to fifty (50) years. Mean value of experience is 21.6 years and that means most of the interviewed farmers have been cultivating vegetables for 20 to 25 years. Credit availability is a qualitative variable and it varies from zero (0) to one (1). Mean value is 0.6 that means that credit is available for about 60 percent of the interviewed farmers.

Table 6.1: Descriptive Statistics of Variables of the Selected Model

Variable	Mean	Maximum	Minimum
Profit (Rs./year)	321,080	3,129,920	-348,000
Cultivated extent (ha/year)	0.5131	2.75	0.03
Cropping intensity (ratio)	1.1956	9.17	0.03
Land tenure weight	4.0778	6	2
Collective action	1.5000	2	1
Education level	3.5056	7	1
Experience	21.5917	50	1
Credit availability	0.5889	1	0

Source: Household Survey in 2016 Relevant to This Study

6.2 Influence of Factors on Profit of Vegetable Farmer

Initially 13 independent variables were considered in the regression analysis. However, as per the correlation matrix, some variables had correlations (Annex 5: Correlation matrix of determinants leading to choose vegetable production strategies). Therefore, these variables were left out and the final model includes seven independent variables. R-squared of the model is 33.59% (Adjusted R-squared of the model is 30.89 percent which indicates that 33.59 percent of the dependent variable of the model is explained by the independent variables. The calculated F value, 12.43 for the model exceeds the critical value, 2.009 at 0.05 probability level for given degree of freedoms, F(7, 172). Therefore, the null hypothesis that explanatory variables simultaneously influence variation of dependent variable of the model is zero is rejected and the estimated regression model is significant.

Table 6.2 presents determinants of choosing strategies by vegetable farmers. Profit corresponding to each strategy adopted by each farmer is the dependent variable. Cultivated extent positively related with the profit and the relation is significant at 0.05 probability level. Land tenure shows negative relation with profit although it is significant at 0.05 probability level. Value of land tenure is indicated as a weight and magnitude of the weight depends on tenure type. According to data, transferable land

tenure shows low profit compared to lands with lower weights such as rented-in-land and encroached-lands. Farmers interested in growing vegetables have the propensity to grow vegetables by renting in lands. These farmers work hard to get higher profit. Credit availability is positively related with profit and this relation is significant at 0.05 probability level.

Table 6.2: Determinants of Choice Strategies by Vegetable Farmers

Variable	Coefficient	Std. Error	t-value	P-value
Cultivated extent (ha)	374788	56125.52	6.68	0.000*
Cropping intensity (ratio)	39103.73	29042.09	1.35	0.180
Land tenure weight	-48122.26	20813.81	-2.31	0.022*
Collective action	20838.57	48621.65	0.43	0.669
Education level	-25130.82	21776.44	-1.15	0.250
Experience	177.63	2218.74	0.08	0.936
Credit availability	197611.50	60356.35	3.27	0.001*
Constant	214884.1	153095	1.40	0.162

*significant at 0.05 probability level

Source: Household Survey in 2016 Relevant to This Study

CHAPTER SEVEN

Potentials of Farmer Interactive Actions to Remedy Vegetable Marketing Problems

7.1 Factors Considered by Farmers in Making Decisions on Vegetable Growing

Potential of farmers to interact in achieving their interest is propelled by farmers' understanding or perception on the importance of interaction to achieve their interest. Interaction among the interviewed farmers is prevalent and is evidenced by information presented in Table 7.1 which presents factors considered by farmers in making decisions on vegetable growing. Majority of the interviewed farmers in both districts have considered climatic condition in growing vegetables and they are 51.88 percent in the Jaffna district and 82 percent in the Nuwara Eliya district. Out of the interviewed farmers, 33.83 percent in the Jaffna district and one fourth in the Nuwera Eliya district consider type of vegetables grown in adjoining lands when making decision on vegetable cultivation. Vegetable farmers interviewed in the Jaffna and Nuwera Eliya districts revealed that the type of vegetable grown in adjoining villages is imperative and the percentage of farmers that considered it was 33.83 percent and 25 percent respectively. Of the interviewed farmers, 48.87 percent in the Jaffna district and eight percent (8%) in the Nuwara Eliya district considered the type of vegetable grown in other districts when determining the type of vegetables to grow. Therefore, farmers cultivating decisions have an impact on the cultivating decisions on the surrounding farmers.

Table 7.1: Factors Considered by Farmers in Making Decisions on Vegetable Growing

Factor	Percentage of the farmers interviewed	
	Jaffna District	Nuwara Eliya District
Type of vegetable grown in adjoining lands	33.83%	25%
Type of vegetable grown in adjoining villages	25.56%	8%
Type of vegetable grown in other districts	48.87%	8%
Vegetablesthat fetched price gave a highest profit in the previous season	48.87%	40%
Climate condition of a particular area	51.88%	82%
Possible pest and disease problems	12.78%	52%

Source: Household Survey in 2016 Relevant to This Study

7.2 Farmers' Confidence on their Capacity to Resolve Problems of Vegetable Production

Table 7.2 indicating the percentage of farmers who admitted both vegetable production and marketing related problems can be resolved by sharing information on vegetable production and making collective decision. Majority of the interviewed farmers in the Jaffna district believe that they can resolve vegetable production and marketing problems themselves whereas majority of Nuwara Eliya farmers believed in negative. However, majority of the interviewed farmers in the both districts, admit that information sharing is a plausible way of addressing marketing and production related issues.

Table 7.2: Farmers' Ability to Resolve Production and Marketing Issues on Their Own by Information Sharing and through Collective Decision

District	% of Farmers Responded		% of Farmers not Responded	Subtotal
	Yes	No		
Jaffna	86.47% (115)	9.77% (13)	3.76% (5)	100% (133)
Nuwara Eliya	33% (33)	60% (60)	7% (7)	100% (100)
Total	63.52% (148)	30.9% (73)	5.15% (12)	100% (233)

Source: Household Survey in 2016 Relevant to This Study

Of the interviewed farmers, 90.23 percent (120) from the Jaffna district and 29 percent (29) from the Nuwara Eliya district admit that if information on vegetable production of other areas is available, they can adjust their vegetable production aiming at a higher price. Table 7.3 indicates possible adjustments that farmers can make to resolve market and production problems when information on production is available. Of the interviewed vegetable farmers, 62.41 percent in the Jaffna district and 10 percent in the Nuwara Eliya district think that they can grow vegetables not grown by the other farmers to have a better price. Of the interviewed, 52.63 percent in the Jaffna district and 11 percent in the Nuwara Eliya district believe they can grow vegetables to harvest during the lean supply season. Certain farmers in the two districts believe that growing more than one type of vegetable at a time can reduce loss of profit.

Table 7.3: Possible Adjustments of Farmers when Information on Production is Available

Adjustment Proposed Farmers Revealed	Jaffna District	Nuwara Eliya District
Growing vegetables that most of people are not growing	62.41% (83)	10% (10)
Growing vegetables to harvest when a short supply is available at the market	52.63% (70)	11% (11)
Crop diversification so as to cover lost from one vegetable from others	45.11% (60)	10% (10)

Source: Household Survey in 2016 Relevant to This Study

7.3 Importance of Information on Extent and Time of Cultivation

According to Table 7.4 indicating importance of information on extent and time of vegetable cultivation, the number of vegetable farmers from the Jaffna district who believe in that fact is higher than that from the Nuwara Eliya district. These farmers believe that such information is vital to make important decisions related to vegetable cultivation. Of the interviewed farmers, 87.22 percent (116) from the Jaffna district and 46 percent (46) from the Nuwara Eliya district said they can increase profit by avoiding excess quantities of the same vegetable while 54.14 percent (72) from the Jaffna district and 17 percent (17) from the Nuwara Eliya district said that growing vegetables that are not commonly growing by others also helped increase profit. Further, farmers can make decisions on the types of vegetables, time of cultivation and, extent of cultivation collectively. Therefore, acting collectively in vegetable production is hailed.

Table 7.4: Importance of Information on Extent and Time of Vegetable Cultivation

Importance of Information	% of Agreed Farmers	
	Jaffna	Nuwara Eliya
If information on number of farmers growing a vegetable and extent of cultivation is available, types of vegetables to be grown can be selected in this season	61.65% (82)	24% (24)
If information on time of cultivation, farmers can adjust their cultivation time to prevent flood of vegetables coming to the market at the same time	42.86% (57)	18% (18)
Farmers can decide together extent of cultivation for each vegetable	47.37% (63)	6% (6)

Source: Household Survey in 2016 Relevant to This Study

7.4 Possibilities of Organizing Farmers

Interactive action requires organizing of farmers. More than half (50%) of the farmers interviewed believe that farmers can develop a mechanism through Farmer Organizations (FO) to share information on vegetable cultivation and marketing. Of the interviewed farmers, 93.23 percent (124) from the Jaffna district and 33 percent (33) from the Nuwara Eliya district are members of the vegetable farmers' organization. According to Table 7.5 which indicates barriers in organizing farmers to share information, less than 50 percent admitted that there is a barrier. However, a higher percentage of farmers from the Jaffna district agreed that the barrier is farmers' lack of interest to organize. Therefore, collective action of farmers can be a plausible solution.

Table 7.5: Barriers in Organizing Farmers to Share Information

Barrier	% of Admitted	
	Jaffna	Nuwara Eliya
Farmers are not aware of organizing	28.57% (38)	28% (28)
Farmers do not like and are not interested	54.14% (72)	41% (41)
No private or public sector entity to provide farmers directions necessary for organizing	22.56% (30)	31% (31)

Source: Household Survey in 2016 Relevant to This Study

CHAPTER EIGHT

Conclusion

According to the interviewed, the types of vegetables grown in the Jaffna district are higher than that of Nuwara Eliya. Fifteen types of vegetables are grown in the Jaffna district and seven types are grown in the Nuwara Eliya district. Most of farmers in the Jaffna district grow both English vegetables such as beetroot, carrot, cabbage and local vegetables such as long bean, brinjal, bitter gourd, okra, pumpkin, snake gourd and cucumber. Most of the farmers from the Nuwara Eliya district grow carrot, leeks, cabbage, beetroot, tomato and brinjal. Average extent of land allocated for each crop per farmer is larger in the Jaffna district compared to the Nuwara Eliya district as farmers in Jaffna own transferable lands which are higher in extent compared to the farmers in the Nuwara Eliya district.

Most of the farmers in the Jaffna district sell their vegetables at market place and therefore, these farmers have opportunities to sell their vegetables at a competitive price compared to the farmers in the Nuwara Eliya district where most of the farmers sell their vegetables at the farm. However, majority of farmers from these two districts say that they sell their vegetables at a price set by buyers making the majority of farmers price takers. Presence of price takers indicates absence of competitiveness. Therefore, vegetable markets in these two districts are monopsonomic or oligopsonic.

Vegetable farmers from the two districts tend to grow one or more vegetables within a year. The number of vegetables grown per year is supposed to be determining strategy of a vegetable farmer. Therefore, the interviewed farmers have four strategies as strategy 1, 2, 3 and 4. In the Jaffna district, majority of the interviewed farmers, (39.47%) implement strategy 2 that denotes growing two types of vegetables per year. Average payoff for the strategy 2 is Rs. 364,740/=. Average payoffs of the strategy 1, strategy 3 and strategy 4 are Rs. 456,913/=, Rs. 419,150/= and Rs. 564,230/= per year respectively. It was observed that higher the diversity of vegetables higher the profit a farmer received. Each of the interviewed farmers in the Jaffna district is engaged in a dominant strategy as no farmer tends to change the strategy of vegetable production being practiced regard less of the strategy implemented by the other farmer. Therefore, strategies they adopt are at Nash equilibrium.

In the Nuwara Eliya district, almost an equal number of the interviewed farmers are engaged in strategy 2 and strategy 3 separately. Percentage of the interviewed farmers engaged in strategy 2 is nearly 40 percent and strategy 3 is around 42 percent. Average payoffs are Rs. 131,319/= for first strategy, Rs. 146,478/= for the second strategy, Rs. 255,820/= for third strategy and Rs. 15,100/= for fourth strategy. Each of the interviewed farmers in the Nuwara Eliya district is also engaged in a dominant strategy

as no farmer tends to change the existing strategy of vegetable production corresponding to strategies implemented by other farmers. Therefore, strategies they adopt are at Nash equilibrium.

Equilibrium of vegetable production game of two districts is a finite game considering a year. If the game is constructed over a period of years, equilibrium will be changed. Therefore, a study for generating an infinite game analysis should be made.

As per the study, average profit of a vegetable farmer is about Rs. 26,756/= per month. Average extent of vegetable growing land is about 0.51 hectares. Cropping intensity which reflects the number of times vegetables are grown in the same land varies from 3 percent to 917 percent. Average cropping intensity is 120 percent. Cropping intensity of vegetable farmers in the two districts is higher than 100 percent. Average value of land tenure weight is four (4) that the majority of the interviewed vegetable farmers have transferable lands. Majority of the interviewed farmers do not act collectively with regard to vegetable production and marketing. Majority of the interviewed farmers have studied up to grade 10 or GCE (O/L). Most of the interviewed vegetable farmers have been growing vegetables for 20 – 25 years. Credit is available for about 60 percent of the respondents.

Of the interviewed farmers, those who wish to increase profit from vegetable need to increase the extent of vegetable cultivation. As land is a main factor of production, increase of the extent under vegetable cultivation leads to increased scale of production thereby increasing profit. Thus, farmers who want to expand their vegetable cultivation rent in lands and cultivate vegetables. These farmers have increased their profit. Therefore, higher profits have been drawn by farmers who have cultivated higher extent of lands which have been rented in. When farmers grow vegetables in larger extent of lands, farmers tend to invest more capital. Therefore, with availability of credit facilities, farmers tend to cultivate vegetables in larger extent of land and derive more profits.

A few interviewed farmers stated that they consider other farmers' vegetable cultivations when they make decisions related to growing vegetables. Vegetable production is a game among vegetable farmers. Therefore, vegetable farmers can resolve problems related to vegetable cultivation and marketing through sharing information. Interactive (collective) action of farmers enables farmers to decide the type of vegetable, time of cultivation and extent of cultivation to resolve such issue. Barriers for organizing farmers inhibit this and farmers' collective action is possible to reach a consensus.

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Annexes

Annex 1:

Questionnaire for the Household Survey of the Research - Potentials of Farmer Interactive Action to Remedy Vegetable Marketing Problems in Sri Lanka - October to December, 2016

(A). Information of farmer family, land tenure, and land use

1. Information on Family Members, Age, Education and Employment

Family member	Age (years)	Education	Employment
Farmer			
Wife			
Son			
Daughter			

2. Information on Land Tenure and Land Use

Type of land tenure		Extent of land (ha)	Land use pattern (code-a)
Transferred land	Low land		
	High land		
LDO land	Low land		
	High land		
Rented in land	Low land		
	High land		
Encroached land	Low land		
	High land		

Code-a: (1). Homestead; (2). Paddy in Maha season and vegetable in Yala season; (3). Vegetables in both Maha and Yala seasons; (4). Vegetables and yams in Maha and Yala seasons

B) Information on vegetable cultivation

1. Crop usually cultivated, cultivating time period, extent of land under each crop, land tenure and cost for land

Crop (vegetable)	Month	Extent of land (hectare)	low land/high land	Tenure	Cost for land

2. Cost of cultivation of each vegetable per year

Cost item	Unit	Unit cost	Cost for each vegetable cultivated within an year							
			1.		2.		3.		4.	
			No. of units	Cost	No. of units	Cost	No. of units	Cost	No. of units	Cost
Land extent	ha									
1. Land preparation										
Land clearing	md									
Ploughing	md									
Bed preparation	md									
2. Fertilizer										
Material cost	kg									
Application	md									
3. Pest control										
Material cost										
Application	machine									
Labour	md									
4. Disease control										
Material cost										
Application	machine									

Labour	md									
5. Watering										
Fuel cost	liter									
Application	machine									
Labour	md									
6. Cultural practices/ weeding										
Labour	md									
Application cost										
7. Harvesting										
Labour	md									
Application cost										
8. Transporting										

Note: md – man days

3. Yield and harvest

Vegetable	**Extent (ha/year)**	**Yield (kg/ha)**	**Harvest (kg)**	

4. How long have you been engaging in vegetable cultivation? .....

5. How do you fulfill cost of vegetable cultivation?

Saved money	
Taking credits from banks	
Borrowing money from private money lender	
Borrowing money from friends	

6. Are credits (loans) available sufficiently for vegetable farming? Yes/ No

7. If yes, what are the sources?

Public banks	
Private banks	
Sanasa bank	
Rural development bank	

8. Availability of inputs of vegetable production

Input	**Level of availability**		
	Without any delay		
Fertilizer			
Pesticide			
Planting material			

C). Marketing vegetable

1. How do you sell your vegetable production?

- Vegetables are sold to buyers coming to the farm gate
- Vegetables are carried to the market where buyers come
- Vegetables are sold to a particular buyer with whom the farmer has made a forward contract
- Specify any other way

2. Can you sell your vegetable production as you wish? Yes/ No

2.1. If yes, can you sell whatever vegetable you grow at a price you wish in every season of a year?

Yes/ No

If yes, what are the vegetables you grow and prices at which each vegetable is sold?

Vegetable	Price you wish	Season

If no, Can you sell vegetables as you wish at least in some season? (What are those vegetables and in which season?)

Vegetable	Price you wish	Season

2.2. If you cannot sell vegetables you produce at a price you wish, what can be the reason/s?

Excess production that exceeds demand	
Lack of buyer that is not sufficient to create a competitive market situation	
All buyers have themselves decided a price at which they should buy	
Quality of vegetable is not sufficient to have a better price	
Other specify	

2.3. What is the cost that you would bear when marketing vegetables?

Type of marketing cost	Average cost per year (Rs.)
Toll or fee for the market place	
Discount paid for the buyer (eg: 10 kg : 1 kg in Jaffna)	
Damage cost	
Any other cost specify	

2.4. How does the price determination process occur when you sell your vegetables?

- Buyers buy vegetables at a price growers make
- Growers sell vegetables at a price the buyers make

- Buyers and growers consider prices of vegetables in other areas
- Other

2.5. What are the factors causing price determination of vegetables?

- Price of previous season/year of a particular vegetable
- Price of vegetable markets of other areas in the country
- Changes in climate conditions causing damages to vegetables
- Pest damages to vegetables
- Other reasons specify

D). Interactions among vegetable farmers

1. Do you think that decisions you take with regard to vegetable production such as cultivating area for each vegetable and type of vegetable grown etc are caused by decisions taken by other vegetable farmers with regard to vegetable cultivation? Yes/ No

2. Do you consider following factors when taking decisions with regard to vegetable growing?

Type of vegetable that is grown by other farmers in adjoining lands	
Type of vegetable that is grown by other farmers in adjoining villages	
Type of vegetable that is grown by other farmers in areas	
Vegetable that gave a highest profit in the previous season	
Climate condition of a particular area	
Possible pest and disease problems	

3. Types of vegetable you have grown in this season and the last season, extent of land under each vegetable and reasons for selecting these vegetables in these seasons

This season		
Vegetable	**Extent (ha)**	**Reasons to select**
The last season		
Vegetable	**Extent (ha)**	**Reasons to select**

4. What are the areas (regions or villages) of which vegetable productions affect prices of your vegetables production?

5. Do you think that if information on vegetable production of other areas is available before you start the cultivation you can adjust your vegetable production to take a higher price? Yes/ No

6. If yes, how does that can happen?

Growing vegetables that most of people are not growing	
Growing a particular vegetable at the time before or after other farmers grow to harvest when a least production of the vegetable is available at the market	
Growing more than one vegetable at a time (crop diversification) so as to cover lost from one vegetable from others	

E). Collective action / coordination among vegetable farmers

1. Do you think that if farmers in a particular area (or region) of the country share information on vegetable production and make decision on vegetable production together, farmers can resolve production and marketing problems on vegetable cultivation? Yes/ No

2. If yes, how can you resolve?

If we know number of farmers growing a particular vegetable and extent of cultivation, we can decide the types of vegetables to grow in this season	
If we know the time of cultivation, we can adjust our cultivation time so that whole production of vegetables going to the market at the same time is prevented	
Farmers can decide together extent of cultivation for each vegetable	

3. Can you have information on vegetable cultivation of farmers in your area and other areas at present? Yes / No

4. If no, what are the reasons for not having this information?

There is no mechanism like extension services or other public sector or private sector involvement	
No relation or mechanism among farmers for sharing information on vegetable cultivation even happening implicitly	
No vegetable farmer organization intervenes in transferring this information	
There is no mechanism linking all vegetable farmers in an area or a region	
Other	

5. Do you think that Farmers can develop a mechanism through Farmer Organization (FO) to share information on vegetable cultivation and marketing? Yes / No

6. What are the barriers for organizing farmers to share this information?

Farmers are not aware of that	
Farmers do not like and are not interest	
No person or public sector entity to provide farmers directions necessary for that	

7. Are you a member of a farmer organization? Yes/ No

8. If yes, is that farmer organization with regard to vegetable farming? Yes/ No

9. If no, what are its roles?

10. Do you think that if you had a collective mechanism of farmers to share information on vegetable production and marketing, you would be able to increase your profit of vegetable cultivation? Yes/ No

11. If yes, how would the profit increase?

Preventing production of excess quantities of same vegetable	
Growing a vegetable that most of farmers do not grow	

12. What would be the expected changes in profits you can have related to ways in question (11) by following a collective mechanism?

Ways of increasing profit with collective action	Percentage change in profit with the collective action relative to present situation
Preventing production of excess quantities of same vegetable	
Growing a vegetable that most of farmers do not grow	

F). Expected utility of vegetable farmers

1. Type of vegetable, extent grown each vegetable, harvest and price at which you sold vegetable and price you expected for the last five seasons

Last five seasons	Type of vegetable	Extent grown (ha)	Quantity harvested (kg)	Price you sold (Rs.)	Price you expected (Rs.)
1					
2					
3					
4					
5					

2. Have you experienced any damage to vegetable you cultivated in last five seasons? Yes / No

Last five seasons	Type of vegetable	Type of damage/loss	Quantity lost (kg)	Cost of the damage (Rs.)
1				
2				
3				
4				
5				

Comments :-

Annex 2: Details of strategies implemented by the interviewed vegetable farmers in growing vegetables in Jaffna district

Strategy (vegetable type and number of cultivation per year)				Average net benefit/year (Rs.)	Percentage of vegetable growers
Cultivation-1	Cultivation-2	Cultivation-3	Cultivation-4		
Beet root				922976.7	5.3% (6)
Brinjal				414800	3.5% (4)
Cabbage				367233.3	2.6% (3)
Curry chilly				87720	4.4% (5)
Pumpkin				-56000	0.9% (1)
Beet root	Beet Root			390000	0.9% (1)
Beetroot	Cabbage			602466	4.4% (5)
Beet root	Carrot			393336.9	14.0%(16)
Beet Root	Curry chilly			615930	1.8%(2)
Beet root	String been			109980	1.8%(2)
Beet root	Tomato			553175	3.5%(4)
Bitter gourd	Snake gourd			73900	0.9%(1)
Beet Root	Leeks			348600	0.9%(1)
Brinjal	Carrot			-67400	0.9%(1)
Brinjal	String bean			95850	0.9%(1)
Brinjal	Tomato			652400	1.8%(2)
Cabbage	Carrot			185975	1.8%(2)
Cabbage	Tomato			704575	1.8%(2)
Cabbage	Brinjal			206800	0.9%(1)
Carrot	String been			-36580	0.9%(1)
Curry chillie	Cabbage			52800	0.9%(1)
Curry chilly	Tomato			98350	0.9%(1)
Okra	String bean			29450	0.9%(1)
Beet root	Cabbage	Tomato		775935	3.5%(4)
Beet root	Cabbage	Carrot		570116.4	9.6%(11)
Beet Root	Carrot	Tomato		307960	0.9%(1)
Beet Root	Curry chilly	String bean		116880	0.9%(1)
bitter gourd	Sank gourd	Tomato		-8850	0.9%(1)
Bitter gourd	Brinjal	String bean		185280	0.9%(1)
Beet root	Carrot	Leeks		447250	0.9%(1)
Bitter gourd	String bean	Tomato		94345	0.9%(1)
Brinjal	Okra	String bean		707750	0.9%(1)

Cabbage	Carrot	Leeks		1067640	0.9%(1)
Cabbage	Carrot	Sting been		22680	0.9%(1)
Cabbage	Curry chillie	Tomato		58597	2.6%(3)
Curry chillie	String bean	Tomato		785800	0.9%(1)
Curry chillie	Pumpkin	Tomato		152660	0.9%(1)
Cabbage	Snake gourd	String been		-3400	0.9%(1)
Beet root	bitter gourd	Carrot	Tomato	402400	0.9%(1)
Beet root	Bitter gourd	Brinjal	Snake gourd	2980	0.9%(1)
Beet root	Bitter gourd	Brinjal	string bean	473040	0.9%(1)
Beet root	Bitter gourd	cucumber	snake gourd	226100	0.9%(1)
Beet root	Bitter gourd	Okra	string bean	1536480	0.9%(1)
Beet root	Brinjal	Carrot	Okra	245780	0.9%(1)
Beet root	Brinjal	Carrot	String Been	331970	1.8%(2)
Beet root	Cabbage	Carrot	Okra	639250	1.8%(2)
Beet root	Cabbage	Carrot	String bean	343000	0.9%(1)
Beet root	Cabbage	Carrot	Tomato	889100	0.9%(1)
Beet root	Cabbage	Cucumber	String bean	569040	0.9%(1)
Beet root	Carrot	Okra	Lettuce	982560	0.9%(1)
Beet root	Carrot	Okra	string bean	913025	1.8%(2)
Beet root	Carrot	String bean	Tomato	276683	0.9%(1)
Beet root	Curry chilly	String bean	Tomato	26450	0.9%(1)
Bitter gourd	Carrot	Curry chilly	Green bean	1612080	0.9%(1)
Cabbage	Carrot	Curry chilly	Tomato	47400	0.9%(1)
Total					**100% (114)**

Annex 3: Details of strategies implemented by the interviewed vegetable farmers in growing vegetables in Nuwara Eliya district

Strategy (vegetable type and number of cultivation per year)				Average net benefit/year (Rs.)	Percentage of vegetable growers
Cultivation-1	Cultivation-2	Cultivation-3	Cultivation-4		
Carrot				209111	9.9% (9)
Cabbage				3325	4.4% (4)
Leeks				68600	3.3% (3)
cabbage	Carrot			221630	14.3% (13)
Carrot	Leeks			104191	19.8% (18)
Cabbage	Leeks			5547	3.3% (3)
Carrot	Radish			430100	1.1% (1)
Leaks	Radish			69800	1.1% (1)
Carrot	Beet root	Leeks		180187	13.2% (12)
Cabbage	Carrot	Leeks		306256	25.3% (23)
Carrot	Cabbage	Radish		50560	1.1% (1)
Carrot	Cabbage	Tomato		208640	1.1% (1)
Leeks	beet root	Tomato		118400	1.1% (1)
Leeks	Carrot	Beet root	Radish	15100	1.1% (1)
Total					**100% (91)**

Annex 4: Payoff matrices of two players game structures of vegetable farmers in Jaffna district

Table A4.1: Two player payoff matrix corresponding to strategy 1 and 2

		Strategies of column player			
		1		2	
Strategies of row player	1	456913	456913	456913	364740
	2	364740	456913	364740	364740

Table A4.2: Two player payoff matrix corresponding to strategy 1 and 3

		Strategies of column player			
		1		3	
Strategies of row player	1	456913	456913	456913	419150
	3	419150	456913	419150	419150

Table A4.3: Two player payoff matrix corresponding to strategy 1 and 4

		Strategies of column player			
		1		4	
Strategies of row player	1	456913	456913	456913	564230
	4	564230	456913	564230	564230

Table A4.4: Two player payoff matrix corresponding to strategy 2 and 3

		Strategies of column player			
		2		3	
Strategies of row player	2	364740	364740	364740	419150
	3	419150	364740	419150	419150

Table A4.5: Two player payoff matrix corresponding to strategy 2 and 4

		Strategies of column player			
		2		4	
Strategies of row player	2	364740	364740	364740	564230
	4	564230	364740	564230	564230

Table A4.6: Two player payoff matrix corresponding to strategy 3 and 4

		Strategies of column player			
		3		4	
Strategies of row player	3	419150	419150	419150	564230
	4	564230	419150	564230	564230

Annex 5: Correlation matrix of determinants causing to choose vegetable production strategies

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13
x1	1.0000												
x2	0.7001	1.0000											
x3	-0.3566	-0.0158	1.0000										
x4	-0.0692	-0.0789	-0.0444	1.0000									
x5	0.4833	0.1515	-0.2887	-0.0703	1.0000								
x6	-0.0917	0.1126	0.1605	-0.0356	-0.1585	1.0000							
x7	-0.0293	0.0250	0.0082	0.0240	-0.0116	0.1178	1.0000						
x8	-0.1041	-0.0685	0.1006	-0.1540	0.0365	-0.1791	0.1085	1.0000					
x9	0.1983	0.1782	0.0040	0.0182	0.1135	0.2156	0.1086	-0.0300	1.0000				
x10	0.2430	0.2079	-0.0020	-0.3130	0.1444	-0.0384	0.0324	0.1074	0.0740	1.0000			
x11	0.2352	0.2181	-0.0154	-0.4317	0.1055	-0.0517	0.0475	0.0897	0.1047	0.8057	1.0000		
x12	0.2316	0.1887	-0.0127	-0.2988	0.0945	-0.0908	0.0272	0.1289	0.0831	0.7857	0.8476	1.0000	
x13	0.3466	0.3324	-0.2256	0.1096	0.1586	0.0338	0.0447	-0.0616	0.1164	0.0471	0.0737	0.0274	1.0000

CHAPTER ONE

Introduction

1. Introduction

Vegetable sub-sector is the most important sector in the Sri Lankan agriculture. Vegetables are grown all over the country and annual production of vegetables is around 602,000 metric tons (Department of Census and Statistics, 2012). Annual average export quantity of vegetables is around 21,092 metric tons (Department of Census and Statistics, 2012). Vegetable farming is a main income source of vegetable farmer households. Marketable vegetable production is over 85 percent of the total production with an average of 91 percent of the total production (Rupasena, 1999).

1.2 Vegetable Marketing Problem and Changes in Vegetable Supply Chain

Problems related to marketing vegetables affect vegetable farmer's household income as the price taken is less than the breakeven price. Five aspects of vegetable marketing problems have been identified by a study by Rupasena (1999): unreasonable price, poor road facilities, malpractice in selling, difficulties in selling and price fluctuation. All these problems affect the demand for vegetables and changes in vegetable market chain are expected to increase opportunities of having a better price to vegetable farmer through increased demand.

Despite the increased demand for vegetables due to exporting and upward export trend problems related to vegetable marketing still persist (Perera et Al., 2015). Another recent change witnessed in vegetable supply chain (vegetable market chain) is supermarkets entering into vegetable supply chain. Vegetable supply chain links the vegetable farmer and the consumer via different intermediate stakeholders. Vegetable supply chain changes on par with the changes occurring in intermediate stakeholders i.e. entering new intermediate stakeholders to the market chain and leaving existing intermediate stakeholders. Vegetable supply chain in Sri Lanka has changed over time with supermarkets entering the vegetable supply chain (Perera et al., 2004). No drastic change in income of vegetable farmers has been observed with supermarkets entering the vegetable supply chains except extensions of the vegetable market chains (Perera et al., 2004). Further, demand for vegetables by supermarkets is not sufficient to create a competition among vegetable buyers as supermarkets are not used by majority of the consumers to meet vegetable requirements i.e. consumers who procure vegetables from supermarket outlets are only about 33 percent of the consumers purchasing from supermarkets while others prefer to procure their vegetables from traditional retail outlets (e.g. at the '*Pola*') (Wickramarachchi, 2004).

1.2 Vegetable Producer Price and Collective Action of Vegetable Farmers

Receiving an inadequate price for vegetable produce is a persistent problem with regard to vegetable marketing. Pricing vegetables at farmgate level has been solely dependent on the supply as the perishable nature of vegetable forces the farmers to sell their production at a price determined by the buyer (Rupasena, 1999). Although vegetable price competition is said to have been less during seasons in which supply is excess, oligopsony - that a few buyers determine market price, causes price determination and farmer becomes a price taker. Therefore, vegetable farmer has to be price taker due to lack of bargaining power resulted by information asymmetry, indebtedness to the trader and being unorganized (Rupasena, 1999).

Improvements or reforms in the marketing system could emerge from private enterprise, farmer group action or by the government (Gunawardena, 1981). There is also a possibility for development in SMEs or farmer group association to reform existing marketing system to upgrade farm-gate income of producers.

A study conducted by Chen *et al.,* (2005) has pointed out that individual small farmers are unable to compete with larger counterparts and they cannot supply vegetables to supermarkets without working as groups. Therefore, organizing small farmers into collective groups has been a strategy to reduce contract management cost and power imbalance (Little and Watts, 1994; Esham and Usami, 2005; Esham et al., 2006). In such situation, small vegetable farmers should be in need of new strategies to sustain and understanding of emerging issues is necessary to find new strategies. Shepherd (2006) has also pointed out that there is a need for government to recognize these trends, to identify ways to support farmers, and to assist existing marketing systems to compete with the supermarket sector.

1.3 Problem Statement

In the vegetable production sector of Sri Lanka, marketing vegetables has taken a key place as most of problems of vegetable value chain are centred on marketing. The prominent issue, highly discussed with regard to vegetable marketing most of the time is surplus production of vegetables resulting in a lower price to vegetable farmers. Although changes in vegetable supply chain in Sri Lanka have been made with the expectation of increasing market margin for stakeholders of the vegetable supply chain marketing problems are apparent yet.

Recent changes in vegetable supply chain are exporting vegetables, which is in an upward trend (Perera et al., 2015) and supermarkets entering the vegetable supply chain (Perera et al., 2004). Therefore, it seems that these changes of vegetable supply chain do not support vegetable market clearance. Further, in this scenario, emergence

of Oligopsony causes price determination and aggravates economic problems of vegetable farmer.

It seems that one solution for vegetable marketing problems is to maintain vegetable demand through controlling excessive production of one vegetable. Coordination among vegetable farmers is vital to get information on their cultivation variety to maintain the market share. To create a coordinated mechanism among farmers and organize their information on actions and strategies taken by farmers with regard to vegetable production plays a central role. Despite many studies (Esham and Usami, 2005; Esham et al., 2006; Rupasena, 1999; Wickramarachchi, 2004; Perera et al., 2004; Perera et. al., 2015) with regard to vegetable supply chain and marketing in Sri Lanka, no study has been conducted with regard to strategic behaviour of vegetable farmers in Sri Lanka. Therefore, this study is focused on investigating strategic actions of vegetable farmers, factors leading to these actions and potentials of transforming their actions into coordinating or cooperative actions.

1.5 Objectives

Main Objective

To understand existing actions (strategies) of vegetable farmers with regard to vegetable production and marketing, and problems with regard to these actions to increase potentials of farmer collective actions to remedy vegetable marketing problems.

Specific Objectives

1. To explore actions (strategies) implemented by vegetable farmers in vegetable production and marketing at present and benefits derived from these actions

2. To identify determinants of choosing these actions implemented by vegetable farmers in vegetable production and marketing

3. To find out potentials of farmer interactive actions to remedy vegetable marketing problems

CHAPTER TWO

Theoretical Framework

2. Theoretical Framework

Vegetable farmers in Sri Lanka also make decisions with regard to vegetable cultivation to maximize the utility derived from net income. Therefore, utility of a vegetable farmer derived from income from vegetable cultivation can be expressed in the following functional form:

$$U_v = f(I_v)$$

Where $U_v =$ utility from vegetable cultivation; $I_v =$ income from vegetable cultivation

Increase of utility or net income (outcome) from vegetable cultivation is the outcome of vegetable cultivation. Farmers individually make decisions to gain opportunities to maximize their net income. Net income from vegetables depends on quantity produced (Q), cost incurred in production (C) and price (P) at which production is sold. These three factors are determined separately by other factors. Quantity of a particular vegetable produced is determined by yield, extent of cultivation, quality of planting material and variety of the vegetable. Cost incurred includes cost of fertilizer, cost of pest control and cultural practices. Price at which a farmer sells his vegetables depends on market demand, available quantity at the market, prices of substitutes for this vegetable and the number of buyers at the market (competitiveness). In addition, some farmers make contracts (A^j) with buyers. Therefore, there are two strategies that make contracts (A^1) and do not make contracts (A^0).

Therefore, $A^j = \{A^1, A^0\}$, where j= {1, 0}.

According to these particulars, a farmer determines a strategy of cultivating vegetables. A strategy is description of a way of implementing an action (Kreps, 1989). A cultivating strategy depends on factors such as quantity of production, cost of production and the selling price. Therefore, there may be different cultivating strategies as per changes in these determinants.

$S_i = (S_i/Q_i, C_i, P_i)$

S_i is the i^{th} cultivating strategy based on the given quantity of production (Q), cost of production (C) and the selling price (P).

Therefore, different cultivating strategies can be indicated as $\overset{n}{\underset{i=1}{S_i}}$

Farmers select factors determining level of Q, C and P so that net income of vegetable cultivation is increased.

When a farmer cultivating strategy and contracting strategy are considered together, a farmers strategy profile can be written as $(\overset{n}{\underset{i=1}{S_i}}, A^1)$ and $(\overset{n}{\underset{i=1}{S_i}}, A^0)$

Vegetable farmers are assumed to be making strategic decisions in producing vegetables. Their strategic action can be presented as two-person game structure.

a). All vegetable farmers are considered as two imaginary entities: {1, 2}. These two entities are labeled as challenger *i* and contender *–I*, where the challenger is an average villager, which we consider in the analysis, while the contender represents an average of other farmers, which is evaluated in the mind of the challenger. More specifically, this study deals with *1* versus N-*1* game, where *N* is the number of vegetable farmers.

b). Player *i* chooses the strategies from two strategy profiles, $(\overset{n}{\underset{i=1}{S_i}}, A^1)$ or $(\overset{n}{\underset{i=1}{S_i}}, A^0)$

c). Payoff to the challenger *i* is represented by $\pi_i{}^j(\overset{n}{\underset{i=1}{S_i}}, A^j)$ corresponding to two strategy profiles, $(\overset{n}{\underset{i=1}{S_i}}, A^1)$ or $(\overset{n}{\underset{i=1}{S_i}}, A^0)$, $j = (1,0)$

d). Payoff matrix to two players is determined by the number of strategies implemented by the challenger and the contender.

Therefore, strategic profiles of a vegetable farmer can be assumed to be consisting of *2n* strategies as shown in the following table.

Table 2.1: Assumed Strategic Profile of a Vegetable Farmer

$\overset{n}{\underset{i=1}{S_i}}$	$A^j; j = (1,0)$	
	A^1	A^0
S_1	$S_1\ A^1$	$S_1\ A^0$
S_2	$S_2\ A^1$	$S_2\ A^0$
S_n	$S_n\ A^1$	$S_n\ A^0$

Table 2.2: Payoff Matrix of Vegetable Farmers for Assumed Pure Strategies

		Contender							
		$S_1\ A^1$	$S_2\ A^1$		$S_n\ A^1$	$S_1\ A^0$	$S_2\ A^0$		$S_n\ A^0$
Challenger	$S_1\ A^1$	π_1^1, π_1^1	π_1^1, π_2^1		π_1^1, π_n^1	π_1^1, π_1^0	π_1^1, π_2^0		π_1^1, π_n^0
	$S_2\ A^1$	π_2^1, π_1^1	π_2^1, π_2^1		π_2^1, π_n^1	π_2^1, π_1^0	π_2^1, π_2^0		π_2^1, π_n^0
	$S_n\ A^1$	π_n^1, π_1^1	π_n^1, π_2^1		π_n^1, π_n^1	π_n^1, π_1^0	π_n^1, π_2^0		π_n^1, π_n^0
	$S_1\ A^0$	π_1^0, π_1^1	π_1^0, π_2^1		π_1^0, π_n^1	π_1^0, π_1^0	π_1^0, π_2^0		π_1^0, π_n^0
	$S_2\ A^0$	π_2^0, π_1^1	π_2^0, π_2^1		π_2^0, π_n^1	π_2^0, π_1^0	π_2^0, π_2^0		π_2^0, π_n^0
	$S_n\ A^0$	π_n^0, π_1^1	π_n^0, π_2^1		π_n^0, π_n^1	π_n^0, π_1^0	π_n^0, π_2^0		π_n^0, π_n^0

Note: Pure strategy means that the move a player makes with a pure strategy in a game. Probability assigned to a pure strategy is 1.

Table 2.3: Payoff Matrix of Vegetable Farmers for Assumed Mixed Strategies

		Contender							
		$S_1\ A^1$	$S_2\ A^1$		$S_n\ A^1$	$S_1\ A^0$	$S_2\ A^0$		$S_n\ A^0$
Challenger	$S_1\ A^1$	$p_1^1\pi_1^1, q_1^1\pi_1^1$	$p_1^1\pi_1^1, q_2^1\pi_2^1$		$p_1^1\pi_1^1, q_n^1\pi_n^1$	$p_1^1\pi_1^1, q_1^0\pi_1^0$	$p_1^1\pi_1^1, q_2^0\pi_2^0$		$p_1^1\pi_1^1, q_n^0\pi_n^0$
	$S_2\ A^1$	$p_2^1\pi_2^1, q_1^1\pi_1^1$	$p_2^1\pi_2^1, q_2^1\pi_2^1$		$p_2^1\pi_2^1, q_n^1\pi_n^1$	$p_2^1\pi_2^1, q_1^0\pi_1^0$	$p_2^1\pi_2^1, q_2^0\pi_2^0$		$p_2^1\pi_2^1, q_n^0\pi_n^0$
	$S_n\ A^1$	$p_n^1\pi_n^1, q_1^1\pi_1^1$	$p_n^1\pi_n^1, q_2^1\pi_2^1$		$p_n^1\pi_n^1, q_n^1\pi_n^1$	$p_n^1\pi_n^1, q_1^0\pi_1^0$	$p_n^1\pi_n^1, q_2^0\pi_2^0$		$p_n^1\pi_n^1, q_n^0\pi_n^0$
	$S_1\ A^0$	$p_1^0\pi_1^0, q_1^1\pi_1^1$	$p_1^0\pi_1^0, q_2^1\pi_2^1$		$p_1^0\pi_1^0, q_n^1\pi_n^1$	$p_1^0\pi_1^0, q_1^0\pi_1^0$	$p_1^0\pi_1^0, q_2^0\pi_2^0$		$p_1^0\pi_1^0, q_n^0\pi_n^0$
	$S_2\ A^0$	$p_2^0\pi_2^0, q_1^1\pi_1^1$	$p_1^0\pi_1^0, q_2^1\pi_2^1$		$p_2^0\pi_2^0, q_n^1\pi_n^1$	$p_2^0\pi_2^0, q_1^0\pi_1^0$	$p_2^0\pi_2^0, q_2^0\pi_2^0$		$p_2^0\pi_2^0, q_n^0\pi_n^0$
	$S_n\ A^0$	$p_n^0\pi_n^0, q_1^1\pi_1^1$	$p_1^0\pi_1^0, q_2^1\pi_2^1$		$p_n^0\pi_n^0, q_n^1\pi_n^1$	$p_n^0\pi_n^0, q_1^0\pi_1^0$	$p_n^0\pi_n^0, q_2^0\pi_2^0$		$p_n^0\pi_n^0, q_n^0\pi_n^0$

Note: A **mixed strategy of *s* game** comprises two or more pure strategies. A probability is assigned to each pure strategy.

Challenger's probabilities of selecting pure strategies; $(p_1^1 + p_2^1 + ... + p_n^1) + (p_1^0 + p_2^0 + ... + p_n^0) = 1$

Contender's probabilities of selecting pure strategies; $(q_1^1 + q_2^1 + ... + q_n^1) + (q_1^0 + q_2^0 + ... + q_n^0) = 1$

Actions (strategies) taken by a vegetable farmer reflect their behaviours. According to order of payoffs each player obtains, different games can be identified. Games basically can be categorized into two as non-cooperative and cooperative based on the way of cooperating to attain higher benefits. With regard to non-cooperative games, it is assumed that the players cannot overtly cooperate to attain higher benefits. With regard to cooperative games, players adopt cooperative strategies i.e. players are allowed to make binding agreements. In non-cooperative games, equilibrium outcomes are self-enforcing and in cooperative games, outside mechanism can enforce binding agreements which can make players better off.

Decisions made by vegetable farmers in vegetable production have not been clearly identified and understood. However, in most of cases, the majority of farmers grow the same vegetable variety. It can be assumed that each farmer has followed what majority of farmers have done i.e. majority of farmers have adopted the same strategy. As per Runge (1981 & 1984), assurance game exists when one prefers to do what the other does, vegetable farmers' actions can be assumed as an assurance game. As different strategies which generate different payoffs result in different games; there may be different games with regard to vegetable farmers in study areas. Irrespective of the strategy selected by vegetable farmers, they expect to maximize net income or their utility. When vegetable farmers adhere to non-cooperative strategies they cannot reach to an equilibrium strategy. For instance, if all farmers resort to an assurance game that all farmers grow one type of vegetable, they cannot sell the produce at a higher price due to excess produce. Out of those farmers, contract farmers sometimes can sell their product at a higher price compared to others. Therefore, non-cooperative strategies do not result in Pareto optimal solution[2].

The logic of collective action describes the requirement of a mechanism or device that can produce coercion to make rational and self-interested individuals compelled to act in their common interest (Olson, 1971). Therefore, collective action is that all players act collectively with binding agreements and that result in coordinated action which can generate equilibrium outcomes. Coordinated actions can result in a coordination game (one of non-cooperative games) or a cooperative game. All players (vegetable farmers) can access to information of other farmers' actions relevant to vegetable production and market; they can select coordinated strategy or cooperative strategy with binding agreement with other farmers.

[2] **Pareto Optimal Solution** refers to a **solution**, around which there is no way of improving any objective without degrading at least one other objective (https://www.igi-global.com/dictionary/pareto-optimal-solution/21879)

CHAPTER THREE

Methodology

3. Methodology

This section has been described related to each objective.

3.1. Exploration of Actions (Strategies) Implemented by Vegetable Farmers in Vegetable Production and Marketing at Present and Benefits Derived from These Actions

3.1.1 Variables and Types of Data

Variables related to this objective are strategies adopted by vegetable farmers regarding vegetable production and marketing, and net benefits attributed to each strategy. As mentioned in the theory section, cultivating strategy varies corresponding to variation of the factors determining the level of quantity of production, cost of production and price at which farmers sell. Marketing strategy is described as contract farmers and not contract farmers. According to the theoretical section, payoffs of challenger and contender corresponding to each strategy are variables required for structuring the payoff matrix.

Net Benefit (pay off) Corresponding to Each Strategy

A pre-visit will be made to the selected areas where vegetables are grown, to identify different strategies adopted by farmers with regard to vegetable production and the number of farmers adopting each strategy. Data with regard to these strategies collected from a representative sample will be classified into each strategy and net benefit obtained by each farmer adopting each strategy will be calculated.

Benefit relevant to each strategy is a pay-off or net benefit (profit) from vegetable production corresponding to a particular strategy. Profit of vegetable production, π , is the difference between revenue from vegetable production and cost of vegetable production.

$$\pi_i = R_i - C_i$$

Where

π_i = Net benefit corresponding to i^{th} strategy

R_i = Revenue corresponding to i^{th} strategy

C_i = Cost corresponding to i^{th} strategy

Payoffs for Challenger and Contender

The challenger is an average vegetable farmer while the contender represents an average of other vegetable farmers. Payoff for a particular strategy of the challenger is net benefit corresponding to that strategy and is considered what farmer obtains. Payoff for the contender is an average of net benefits obtained by other farmers adopting a particular strategy.

π_i^{chl} = Net benefit corresponding to i^{th} strategy adopted by a challenger

π_i^{con} = Average net benefit corresponding to i^{th} strategy adopted by a contender

$$\pi_i^{con} = \sum_{j=1}^{(n_i-1)} \pi_{ij}^{con} \Big/ (n_i - 1)$$

Where

n_i = Number of farmers adopting i^{th} strategy

π_{ij}^{con} = Net benefit obtained by j^{th} contender adopting i^{th} strategy

Data

The above variables are calculated using the data given in the following table and the data are primary.

Table 3.1: Data Relevant to Each Vegetable Type

Data	Type of Vegetable Cultivated by a Farmer within a Year			
	Vegetable -1	**Vegetable -2**	**Vegetable -3**	**Vegetable -4**
No. of times cultivated a particular vegetable within a year.				
Extent cultivated by each vegetable				
Yield				
Price at which each crop sold by farmer				
Quality of planting material (success rate of plant growing)				
Variety of vegetable				
Cost of fertilizer				
Cost of pest control				
Cultural practices				
Cost incurred in cultural practices				
Cost of harvesting				
Quantity of crop losses				
Market demand				
Available quantity at the market				
Prices of substitute for a particular vegetable				
Number of buyers at the market				
Contract for marketing vegetables				

3.1.2 Analysis

Interactions of vegetable farmers in producing and marketing vegetables are analyzed based on game theory approach. Estimated payoffs relevant to each strategy are used to identify prevailing games.

3.2 Identification of Determinants of Choosing These Actions (Strategies) Implemented by Vegetable Farmers in Vegetable Production and Marketing

3.2.1 Hypotheses and Variables

The actions (or strategies) identified under the first objective are used for the second objective. Determinants for these actions are assumed to vary across the farmers. Actions or strategies implemented for producing vegetables determine the quantity of production and ultimately net benefit (profit) of vegetable cultivation. Therefore, factors determining production are also assumed to cause actions implemented for vegetable production.

Vegetable farmers choose strategies to maximize net benefits from vegetable cultivation. Therefore, each strategy results in a net benefit and a particular net benefit is attributed to a particular strategy. Net benefit relevant to each strategy is considered as the dependent variable.

Table 3.2: Variables and Related Hypotheses

Determinants of Choosing Actions in Vegetable Production and Marketing	Hypothesis	Variable
Type of vegetable	Vegetables with high value and demand increase net benefits	X_1
Number of vegetables per time	More types of vegetables per time increase net benefits	X_2
Extent of land used for cultivation	Larger the extent of land cultivated, higher the net benefits would be	X_3
Forward contract	Forward contract enables farmers to have a better price for their produce and therefore, increases net benefits	X_4
Land tenure	Owned land increases net benefits	X_5
Functioning extension services	Extension services increase net benefits	X_6
Policies and institutional factors	Functioning policies and institutional factors related to vegetable production and marketing are positive with net benefits	X_7
Collective action in production and marketing	Collective action of farmers are positively related with net benefits	X_8
Size of a farmer household	Number of household members is positively related with net benefit	X_9

Education level of vegetable farmer	Education of farmer is positively related with net benefit	X_{10}
Experience of vegetable farmer	Experience of farmer is positively related with net benefit	X_{11}
Availability of planting materials	Availability of planting materials (seeds) is positively related with net benefit	X_{12}
Availability of fertilizers and agrochemicals	Availability of fertilizers and agrochemicals is positively related with net benefit	X_{13}
Contribution of family labour	Contribution of family labour is positively related with net benefit	X_{14}
Contribution of hired labour	Contribution of hired labour is negatively related with net benefit	X_{15}
Accessibility to credit facilities	Accessibility to credit is positively related with net benefit	X_{16}

3.2.2 Measuring Variable

Some of variables relevant to the second objective have to be measured using data collected while others are directly collected from the vegetable farmers.

Land Tenure

Land tenure is a qualitative variable measured by assigning a weight arbitrarily. Weight is kept as per type of the land tenure. Type of land tenure is also a factor determining value of a particular land. Usually lands which have deeds are transferred lands and these lands have a higher market price than other types of lands. According to significance of land tenure to land value, weight is put assigned to type of land tenure as shown bellow.

Table 3.3: Types of Tenure and Given Weighted Values

Type of Tenure	Weight
Transferred land	4
LDO land	3
Rented in land	2
Encroached land	1

If a farmer has land with two types of tenure, total weight is calculated by adding the weight relevant to each type of tenure. Eg: A farmer has transferred land and LDO land, his weight is seven (7).

Collective Action

Collective action of vegetable farmers is a qualitative variable measured as a categorical data. Farmers act collectively are assigned 1 and those who do not act collectively are assigned 2.

Education Level of Vegetable Farmer

This variable is categorized into seven (7) groups ranked from one (1) to seven (7) as given in table 3.4.

Table 3.4: Education Level and Corresponding Given Rank

Education	Rank of Education
0-1	1
2-5	2
5-10	3
O/L	4
A/L	5
Diploma	6
Degree	7

3.2.3 Analysis

Variables relevant to the second objective are analyzed using an Ordinary Least Square Regression Model.

Ordinary Least Square Regression Model

Analysis with regard to this objective is done using the Ordinary Least Square regression model.

$$Y = \alpha + \sum_{i=1}^{16} \beta_i X_i + e$$

Where

Y = Dependent variable
X_i = i^{th} independent variable
α = Intercept of the equation
β_i = Coefficient of i^{th} independent variable
e = Error term

3.3 Finding out Potentials of Farmer Interactive Actions to Remedy Vegetable Marketing Problems

This objective is to explore ways and means required for motivating vegetable farmers to interact in coordinating or cooperatively. Identification of potentials depends on influences of reasons and factors on actions taken by vegetable farmers as identified under the second objective.

3.4 Population, Location, Sample and Data Collection

Population

Population of this study is vegetable farmers in Sri Lanka. Vegetable farmers are mainly low and upcountry vegetable farmers. These farmers may vary according to extent of available lands, types of vegetables frequently cultivated, geographical distribution, type of link with market (forward contract or non-contract farmers) and whether being part time or full time farmers.

Location

The study was conducted to conduct in two vegetable growing areas in upcountry (Nuwara Eliya) and low country dry zone (Jaffna).

Sample

The sample is selected randomly from the selected two districts and sample size is arbitrarily decided. Sample size is 233 vegetable farmers: 133 from Nuwara Eliya and 100 from Jaffna districts. Therefore, the sample will be a random sample.

Data collection

Data were collected through a sample survey using a structured questionnaire (Annex – 01) and focus group discussions conducted on the sample of the vegetable farmers selected from areas where vegetables are grown.

CHAPTER FOUR

An Overview of Vegetable Sector in Jaffna and Nuwara Eliya Districts

4.1 Vegetable Farmers and Their Education

Table 4.1 presents percentage of the interviewed vegetable farmers belonging to each education level. Majority of the interviewed farmers in two districts, Jaffna and Nuwara Eliya have studied up to O/L and they are 33.83 percent and 40.45 percent (36) respectively. Farmers having a degree are the lowest percentage of the interviewed vegetable farmers and they are 0.75 percent and 1.12 percent in Jaffna and Nuwara Eliya respectively.

Table 4.1: Percentage of the Interviewed Vegetable Farmers Belonging to Each Education Level

Education	Percentage of Farmers	
	Jaffna District	Nuwara Eliya
0-1	22.56% (30)	8.99% (8)
2-5	7.52% (10)	2.25% (2)
5-10	22.56% (30)	21.35% (19)
O/L	33.83% (45)	40.45% (36)
A/L	12.78% (17)	25.84% (23)
Diploma	0% (0)	0% (0)
Degree	0.75% (1)	1.12% (1)
	100% (133)	**100% (89)**

Source: Household Survey in 2016 Relevant to This Study

4.2 Types of Vegetables Cultivated and Extent of Lands in Jaffna and Nuwara Eliya Districts

As per table 4.2 which presents percentage of the interviewed farmers growing vegetables in each district and average extent of land per farmer per year under each vegetable in two districts, fifteen (15) types of vegetables were reported to have been cultivated in the Jaffna district and seven types of vegetables in the Nuwara Eliya district. The type of vegetable reported to have been grown by the highest percentage of farmers in the Jaffna district is beetroot and that in Nuwara Eliya district it is carrot. The percentage of farmers growing beet root is 65.41% (87) of the interviewed farmers in the Jaffna district and farmers growing carrot is 86.96% (80) of the interviewed farmers in the Nuwara Eliya district. Most of the farmers in the Jaffna district grow beetroot, carrot, cabbage and long bean while those in the Nuwara Eliya district grow carrot, leeks, cabbage, beetroot, tomato and brinjal. Compared to the Nuwara Eliya

district, farmers in the Jaffna district grow both English and local vegetables. As reported, the interviewed farmers in the Jaffna district grow brinjal, bitter gourd, long bean, okra, pumpkin, capsicum, snake gourd and cucumber and those in the Nuwara Eliya district do not grow these varieties.

As per table 4.2, average extent of land under each vegetable varies with type of vegetable. The highest average extent of land reported is for cucumber in the Jaffna district, which is 0.4 ha per farmer per year. In the Nuwara Eliaya district is considered, the highest average extent of land is under tomato cultivation, which is 0.24 ha per farmer per year. Extent of land per farmer per year is higher in the Jaffna district than in the Nuwara Eliya district. Average extent of land under beet root, snake gourd, cabbage, carrot, capsicum, brinjal and okra are 0.37 ha, 0.34 ha, 0.33 ha, 0.3 ha, 0.28 ha, 0.25 ha and 0.2 ha per farmer per year in Jaffna respectively. In the case of Nuwara Eliya, average extent of land under beetroot, carrot, cabbage, leeks and lettuce are 0.09 ha, 0.12 ha, 0.12 ha, 0.11 ha and 0.07 ha per farmer per year respectively. The reason for lower average extent of lands under vegetable cultivation in the Nuwara Eliya district relative to the Jaffna district is due to average extent of land owned by farmers in the Jaffna being larger (Table 4.3).

Table 4.2: Percentage of the Interviewed Farmers Growing Vegetables in Each District and Average Extent of Land per Farmer per Year under Each Vegetable in Two Districts

Type of Vegetable	% of Farmers Cultivating Vegetables in each District		Average Vegetable Grown Land Extent in each District (ha/farmer/year)	
	Jaffna	Nuwara eliya	Jaffna	Nuwara eliya
Beet root	65.41% (87)	16.30% (15)	0.37	0.09
Brinjal	15.04% (20)	0.00% (0)	0.25	0.00
Bitter gourd	9.77% (13)	0.00% (0)	0.22	0.00
Carrot	42.86% (57)	86.96% (80)	0.30	0.12
Cabbage	35.34% (47)	48.91% (45)	0.33	0.12
Leeks	3.01% (4)	69.57% (64)	0.13	0.11
Long (string)bean	25.56% (34)	0.00% (0)	0.14	0.00
Okra	10.53% (14)	0.00% (0)	0.20	0.00
Tomato	19.55% (26)	2.17% (2)	0.19	0.24
Radish	0.75% (1)	3.26% (3)	0.10	0.10
Pumpkin	1.50% (2)	0.00% (0)	0.15	0.00
Snake gourd	4.51% (6)	0.00% (0)	0.34	0.00
Capsicum	13.53% (18)	0.00% (0)	0.28	0.00
Lettuce	0.75% (1)	3.26% (3)	0.10	0.07
Cucumber	1.50% (2)	0.00% (0)	0.40	0.00

Source: Household Survey in 2016 Relevant to This Study

4.3 Land Tenure of Vegetable Farmers in the Jaffna and the Nuwara Eliya Districts

According to Table 4.3 that presents extents of low and high lands under different land tenures and the number of the interviewed farmers using these lands in the Jaffna and the Nuwara Eliya districts, farmers in the Jaffna and the Nuwara Eliya districts grow vegetables in lands belonging to different land tenure classes. These land tenure classes are transferred lands, LDO lands, rented lands and encroached lands. Farmers in Nuwara Eliya district grow vegetables in all those land tenure classes while those in the Jaffna district do not use encroached lands for cultivation. The highest average extent of land reported from the Jaffna district is 0.82 ha per farmer, which is a rented land. In the case of Nuwara Eliya district, the highest average extent of lands reported is 0.7 ha per farmer, which is an encroached land. However, generally, of the two districts, average extent of land used for vegetable cultivation in the Jaffna district is higher.

As shown in Table 4.4 that presents percentage of farmers growing vegetables in different types and tenure of lands, 44.36 percent (59) of the interviewed farmers in the Jaffna district cultivate vegetables in transferred and rented lands. The number of farmers growing vegetables only in rented lands is 27.82 percent (37) of the interviewed in Jaffna district and that growing vegetables only in transferred lands is 21.05 percent. It seems that more than 60 percent of the interviewed farmers in the Jaffna district cultivate vegetables in transferred and rented lands. In the case of Nuwara Eliya district, 46.94 percent (46) of the interviewed farmers grow vegetables in transferred lands and 31.63 percent (31) of the interviewed farmers grow vegetables in LDO lands. Therefore, more than 75 percent of the interviewed farmers grow in transferred and LDO lands in the Nuwara Eliya district.

Table 4.3: Extents of Low and High Lands under Different Land Tenures and the Number of the Interviewed Farmers Using These Lands in Jaffna and Nuwara Eliya Districts

		Transferred		LDO		Rented		Encroached	
		Low Land	High Land	Low Land	High Land	Low Land	High Land	Low Land	High Land
Jaffna district	Number of farmers	4	90	0	2	3	99	0	0
	Total extent (ha)	3.20	58.06	0	0.55	1.60	81.05	0	0
	Average extent (ha)	0.80	0.65	0	0.28	0.53	0.82	0	0
Nuwara Eliya district	Number of farmers	2	53	2	31	1	15	0	1
	Total extent (ha)	1	9.05	0.10	6.28	0.05	5.50	0	0.70
	Average extent (ha)	0.50	0.17	0.05	0.20	0.05	0.37	0	0.70

Source: Household Survey in 2016 Relevant to This Study

Table 4.4: Percentage of Farmers Growing Vegetables in Different Types and Tenure of Lands

	Transferred Land		LDO Land		Rented Land		Encroached Land		Percentage of Farmers
	Low	High	Low	High	Low	High	Low	High	
Jaffna district	x				x				1.50% (2)
	x					x			0.75% (1)
	x								0.75% (1)
		x			x				0.75% (1)
		x							0.75% (1)
		x				x			44.36% (59)
		x							21.05% (28)
		x				x			0.75% (1)
		x		x					0.75% (1)
				x					0.75% (1)
						x			27.82% (37)
									100% (133)
Nuwara Eliya district	x								2.04% (2)
		x				X			6.12% (6)
		x						X	1.02% (1)
		x							46.94% (46)
			x						2.04% (2)
				x					31.63% (31)
					X				1.02% (1)
						X			9.18% (9)
									100% (98)

Source: Household Survey in 2016 Relevant to This Study

4.4 Markets for Vegetable Produced in the Jaffna and the Nuwara Eliya Districts

Farmers sell their production at farm gate, at market places, in both ways and under forward contract. Table 4.5 presents the places where the interviewed farmers sell their produce. As Table 4.5 shows, more than half of the interviewed vegetable farmers in the Jaffna district sell their vegetables at market and at farm gate. With regard to the Nuwara Eliya district, 99 percent of the interviewed farmers sell their product only at farm gate. The percentage of the interviewed farmers who sell their vegetables through

forward sales contracts is 2.3 percent in the Jaffna district and one percent (1%) in the Nuwara Eliya district.

Table 4.5: Ways by which Vegetables are Sold and Percentage of the Interviewed Vegetable Farmers

Way of selling vegetables	Percentage	
	Jaffna	N'Eliya
Vegetables are sold only to buyers arriving at the farm gate	24.8% (33)	99% (99)
Vegetables are carried only to the market where buyers come	39.1% (52)	0
Vegetables are sold to buyers at farm gate and buyers at market places	33.8% (45)	0
Vegetables are sold to a particular buyer with whom the farmer has made a forward contract	2.3% (3)	1% (1)

Source: Household Survey in 2016 Relevant to This Study

According to Table 4.6 which shows percentage of the interviewed farmers responding to vegetable marketing, 63 percent (84) and 15 percent (15) of the interviewed farmers from the Jaffna and the Nuwara Eliya districts respectively can sell their produce as they wish. Out of the interviewed farmers from the Nuwara Eliya district, 81 percent (81) stated that they cannot sell their vegetable production as they wish and the percentage in the Jaffna district is 34 percent (45). As per Table 4.5, majority of the farmers from Jaffna sell their vegetable at markets with higher buyer population while majority of farmers from Nuwara Eliya sell their products to the buyers who visit the farm. Then, it was revealed that farmers from Jaffna can sell their produce at a competitive price compared to those in Nuwara Eliya the reason which leads to Jaffna farmers having a relatively higher price for their produce.

Table 4.6: Percentage of the Interviewed Farmers Responding to Vegetable Marketing

Response on vegetable marketing	Percentage of Farmers	
	Jaffna	N'Eliya
Those can sell vegetable as wish	63% (84)	15% (15)
Those cannot sell vegetable as wish	34% (45)	81% (81)
Not responded	3% (4)	4% (4)

Source: Household Survey in 2016 Relevant to This Study

Although some of the interviewed farmers in the two districts reported that they can sell their produce at a preferred price, most of farmers have reported to be facing marketing issues every season. Table 4.7 presents reasons reported by vegetable farmers for not receiving an expected price. As per the statistics the major reason rated

by the majority respondents in the two districts is production being higher than the demand. This description is futile us it can be clearly seen from the Table 4.7.

Table 4.7: Issues Reported by Vegetable Farmers for Receiving Below par Price

Reason	Percentage	
	Jaffna	N'Eliya
Excess production that exceeds demand	94% (125)	61% (61)
Lack of buyers that is not sufficient to create a competitive market situation	13% (17)	18% (18)
All buyers have themselves decided a price at which they should buy	12% (9)	39% (39)
Quality of vegetable is not sufficient to have a better price	8% (11)	3% (3)
Vegetables from other areas reaching their market	14% (18)	0%

Source: Household Survey in 2016 Relevant to This Study

Price at which transaction between vegetable buyers and vegetable farmers take place discovered by two parties. Price discovery depends on factors such as market structure (number, size, location, and competitiveness of buyers and sellers); market behavior (buyer procurement and pricing methods); market information and price reporting (amount, timeliness, and reliability of information); and future markets and risk management alternatives. Table 4.8 that presents ways of discovering prices of vegetables reported by the responded farmers indicates that majority of the interviewed farmers from the two districts sell their vegetables at prices set by the buyers. Therefore, most of the vegetable farmers in the two districts are price takers. As per Table 4.8, less than 10 percent of the interviewed farmers in each division are price makers. In theory of market economy, if buyer sets the price, buyer has the power. With regard to majority cases, buyers control market and no competitiveness among buyers can be observed, which means a competitive market situation does not prevail with regard to vegetable marketing at grower level. Therefore, this reflects prevalence of vegetable marketing problems.

Table 4.8: Ways of Determining Prices of Vegetables Reported by the Respondents

Way of Determining Price	Percentage	
	Jaffna	N'Eliya
Growers fix the price	9% (12)	1% (1)
Buyers determine price	42% (56)	95% (95)
Buyers and growers consider prices of vegetables in other areas	12% (16)	4% (4)
As per market situation	37% (49)	0

Source: Household Survey in 2016 Relevant to This Study

CHAPTER FIVE

Existing Actions (Strategies) Related to Vegetable Production and Marketing and Benefits Derived from these Actions

5.1 Strategies of Vegetable Farmers

Strategy has been defined based on the number of vegetables grown within a year. According to the number of vegetables grown by farmers per year, four strategies have been identified in two districts as strategy 1, 2, 3 and 4 (see Annex 2 and Annex 3 which present details of each strategy implemented by the interviewed vegetable farmers). Strategy 1 included farmers growing one vegetable per year. Similarly, strategy 2, 3 and 4 include farmers growing two, three and four vegetables per year respectively. All interviewed players in two districts have been represented by two players – row player and column player. Payoff is annual average net profit corresponding to each strategy.

5.2 Payoff Matrix of Vegetable Farmers from Jaffna District

Table 5.1 (payoff matrix for vegetable farmers in Jaffna district) is concerned with payoffs corresponding to four strategies implemented by the interviewed vegetable farmers in Jaffna district. These farmers are categorized into four groups as per four strategies. Strategy 1, 2, 3 and 4 include 16.67 percent, 39.47 percent, 26.32 percent and 17.54 percent of the interviewed farmers respectively (see annex 2). These farmer groups are supposed to have been in a vegetable growing game and vegetable farmers in each group interact with farmers of another group. Therefore, interaction between two farmer groups based on strategies can be presented in a two player game matrix. If four farmer groups of four strategies are considered, payoffs corresponding to these four strategies can be arrayed into six two player game matrices (see Appendix 4).

With regard to the Jaffna district, average payoff corresponding to each strategy is Rs. 456,913/= for first strategy, Rs. 364,740/= for the second strategy, Rs. 419,150/= for third strategy and Rs. 564,230/= for fourth strategy. Therefore, players belonging to a particular strategy interact with players implementing other strategies. This vegetable production game is a finite game and as per Table 4.8, average payoff corresponding to each strategy does not change irrespective of the strategy implemented by other vegetable farmers. Therefore, each (player) of the interviewed farmers in the Jaffna district is engaged in dominant strategy with regard to vegetable production. Then, vegetable farmers interact in a finite game of vegetable production and the strategies they adopt are at Nash equilibrium. A strategy becomes Nash equilibrium when a particular strategy of a game is optimal to each player while other players stick to their strategies, (Kreps, 1989). Vegetable farmers adopt these strategies without any external enforcement and implementation of these strategies by these farmers is self-enforcing. Self-enforcing is necessary for Nash equilibrium (Kreps, 1989) and selection of these strategies for implementation has been implicitly agreed by these farmers.

Table 5.1: Two Player Payoff (Rs.) Matrix of the Interviewed Vegetable Farmers in Jaffna District

		Strategies of Column Player							
		1		2		3		4	
Strategies of row player	1	456913	456913	456913	364740	456913	419150	456913	564230
	2	364740	456913	364740	364740	364740	419150	364740	564230
	3	419150	456913	419150	364740	419150	419150	419150	564230
	4	564230	456913	564230	364740	564230	419150	564230	564230

Source: Household Survey in 2016 Relevant to This Study

5.3 Payoff Matrix of Vegetable Farmers from Nuwara Eliya District

Table 5.2 (payoff matrix for vegetable farmers in Nuwara Eliya district) is concerned with payoffs corresponding to four strategies implemented by the interviewed vegetable farmers in the Nuwara Eliya district. These farmers are categorized into four groups as per four strategies. Strategy 1, 2, 3 and 4 includes 17.58 percent, 39.56 percent, 41.76 percent and 1.10 percent of the interviewed farmers respectively (see Annex 3). These farmer groups are supposed to have been in a vegetable growing game and vegetable farmers in each group interact with farmers of another group. Therefore, interaction between two farmer groups based on strategies can be presented in a two player game matrix. If four farmer groups of four strategies are considered, payoffs corresponding to these four strategies can be arrayed into six two player game matrices (see Appendix 4).

In Nuwara Eliya district, average payoff corresponding to each strategy is Rs. 131,319/= for first strategy, Rs. 146,478/= for the second strategy, Rs. 255,820/= for third strategy and Rs. 15,100/= for fourth strategy. Therefore, players belonging to a particular strategy interact with players implementing other strategies. This vegetable production game is a finite game and as per Table 5.2, average payoff corresponding to each strategy does not change regardless of strategy implemented by other vegetable farmers. Therefore, each (player) of the interviewed farmers in the Nuwara Eliya district is also engaged in dominant strategy with regard to vegetable production. Then, vegetable farmers interact in a finite game of vegetable production and the strategies they adopt are at Nash equilibrium. Similar to the interviewed farmers in Jaffna district, the interviewed farmers in Nuwara Eliya district are in equilibrium with regard to vegetable production.

Table 5.2: Two Player Payoff (Rs.) Matrix of the Interviewed Vegetable Farmers in Nuwara Eliya District

		Strategies of Column Player							
		1		2		3		4	
Strategies of row player	1	131319	131319	131319	146478	131319	255820	131319	15100
	2	146478	131319	146478	146478	146478	255820	146478	15100
	3	255820	131319	255820	146478	255820	255820	255820	15100
	4	15100	131319	15100	146478	15100	255820	15100	15100

Source: Household Survey in 2016 Relevant to This Study

CHAPTER SIX

Determinants of Choosing Strategies by Farmers in Vegetable Production and Marketing

6.1 Factors Determining the Strategies Related to Vegetable Production

Thirteen determinants that impact the choice of vegetable production strategies were identified. However, six determinants were left off when estimating the final model considering correlation of the independent variables and their significance. As per the correlation matrix of independent variables of the initial model, significant correlations exist among variable x1 (total land extent) and x2 (cultivating extent per year), and x10 (availability of planting materials), x11 (availability of fertilizer) and x12 (availability of pesticides). Correlations among these variables are more than half. Therefore, variables - total land extent and availability of planting materials, availability of fertilizer and availability of pesticides were removed from the model. In addition, variables - existence of forward sales contracts and family size were removed as the reported number of farmers engaged in forward sale contracts being very few and family size showing the highest insignificance.

Table 6.1 shows descriptive statistics variables of the selected model. Dependent variable is profit and mean profit is Rs. 321,080/= per year. The reported value of the profit from vegetable cultivation of the interviewed farmers in two districts varied from Rs. -348,000/= (loss) to Rs. 3,129,920/= per year. Average profit of a vegetable farmer per month is Rs. 26,756/=

Extent of land where vegetables are cultivated within a year varies from 0.03 ha to 2.75 ha. Average extent of land used for cultivating vegetables is 0.5131 ha. Cropping intensity of a land area is meant as ratio of total land area covered by vegetables within a year to actual total land area i.e. cultivating area is measured relative to actual land area. Cropping intensity of lands used for vegetable cultivation varies from 0.03 (3%) to 9.17 (917%) and average cropping intensity is 1.2 (120%) that is one hectare is cultivated more than one time. With regard to lands used for vegetable cultivation in these two districts, cropping intensity is higher than 100 percent. Land tenure variable which has been measured as a weight varies from two to six. Average value of this variable is four (mode of the land tenure weight is also four) and that reflects transferred lands. Collective action of vegetable farmers is categorical data and majority of farmers do not act collectively as average value is 1.5. Value denoting involvement in collective action is one (1) and value denoting no involvement in collective action is two (2). Average value becoming two (2) means that more observations are having value two (2) that reflects that most of farmers are not engaging in collective action. Education level has been ranked from one (1) to seven (7) considering the level to which the interviewed farmer

has studied. Mean value of education level is 3.5 means that most of farmers have not studied till degree level. Majority of farmers have studied up to grade 10 and GCE (O/L) for which values of rank given to them are three (3) and four (4) respectively. Experience of vegetable cultivation varies from one (1) to fifty (50) years. Mean value of experience is 21.6 years and that means most of the interviewed farmers have been cultivating vegetables for 20 to 25 years. Credit availability is a qualitative variable and it varies from zero (0) to one (1). Mean value is 0.6 that means that credit is available for about 60 percent of the interviewed farmers.

Table 6.1: Descriptive Statistics of Variables of the Selected Model

Variable	Mean	Maximum	Minimum
Profit (Rs./year)	321,080	3,129,920	-348,000
Cultivated extent (ha/year)	0.5131	2.75	0.03
Cropping intensity (ratio)	1.1956	9.17	0.03
Land tenure weight	4.0778	6	2
Collective action	1.5000	2	1
Education level	3.5056	7	1
Experience	21.5917	50	1
Credit availability	0.5889	1	0

Source: Household Survey in 2016 Relevant to This Study

6.2 Influence of Factors on Profit of Vegetable Farmer

Initially 13 independent variables were considered in the regression analysis. However, as per the correlation matrix, some variables had correlations (Annex 5: Correlation matrix of determinants leading to choose vegetable production strategies). Therefore, these variables were left out and the final model includes seven independent variables. R-squared of the model is 33.59% (Adjusted R-squared of the model is 30.89 percent which indicates that 33.59 percent of the dependent variable of the model is explained by the independent variables. The calculated F value, 12.43 for the model exceeds the critical value, 2.009 at 0.05 probability level for given degree of freedoms, F(7, 172). Therefore, the null hypothesis that explanatory variables simultaneously influence variation of dependent variable of the model is zero is rejected and the estimated regression model is significant.

Table 6.2 presents determinants of choosing strategies by vegetable farmers. Profit corresponding to each strategy adopted by each farmer is the dependent variable. Cultivated extent positively related with the profit and the relation is significant at 0.05 probability level. Land tenure shows negative relation with profit although it is significant at 0.05 probability level. Value of land tenure is indicated as a weight and magnitude of the weight depends on tenure type. According to data, transferable land

tenure shows low profit compared to lands with lower weights such as rented-in-land and encroached-lands. Farmers interested in growing vegetables have the propensity to grow vegetables by renting in lands. These farmers work hard to get higher profit. Credit availability is positively related with profit and this relation is significant at 0.05 probability level.

Table 6.2: Determinants of Choice Strategies by Vegetable Farmers

Variable	Coefficient	Std. Error	t-value	P-value
Cultivated extent (ha)	374788	56125.52	6.68	0.000*
Cropping intensity (ratio)	39103.73	29042.09	1.35	0.180
Land tenure weight	-48122.26	20813.81	-2.31	0.022*
Collective action	20838.57	48621.65	0.43	0.669
Education level	-25130.82	21776.44	-1.15	0.250
Experience	177.63	2218.74	0.08	0.936
Credit availability	197611.50	60356.35	3.27	0.001*
Constant	214884.1	153095	1.40	0.162

*significant at 0.05 probability level

Source: Household Survey in 2016 Relevant to This Study

CHAPTER SEVEN

Potentials of Farmer Interactive Actions to Remedy Vegetable Marketing Problems

7.1 Factors Considered by Farmers in Making Decisions on Vegetable Growing

Potential of farmers to interact in achieving their interest is propelled by farmers' understanding or perception on the importance of interaction to achieve their interest. Interaction among the interviewed farmers is prevalent and is evidenced by information presented in Table 7.1 which presents factors considered by farmers in making decisions on vegetable growing. Majority of the interviewed farmers in both districts have considered climatic condition in growing vegetables and they are 51.88 percent in the Jaffna district and 82 percent in the Nuwara Eliya district. Out of the interviewed farmers, 33.83 percent in the Jaffna district and one fourth in the Nuwera Eliya district consider type of vegetables grown in adjoining lands when making decision on vegetable cultivation. Vegetable farmers interviewed in the Jaffna and Nuwera Eliya districts revealed that the type of vegetable grown in adjoining villages is imperative and the percentage of farmers that considered it was 33.83 percent and 25 percent respectively. Of the interviewed farmers, 48.87 percent in the Jaffna district and eight percent (8%) in the Nuwara Eliya district considered the type of vegetable grown in other districts when determining the type of vegetables to grow. Therefore, farmers cultivating decisions have an impact on the cultivating decisions on the surrounding farmers.

Table 7.1: Factors Considered by Farmers in Making Decisions on Vegetable Growing

Factor	Percentage of the farmers interviewed	
	Jaffna District	Nuwara Eliya District
Type of vegetable grown in adjoining lands	33.83%	25%
Type of vegetable grown in adjoining villages	25.56%	8%
Type of vegetable grown in other districts	48.87%	8%
Vegetablesthat fetched price gave a highest profit in the previous season	48.87%	40%
Climate condition of a particular area	51.88%	82%
Possible pest and disease problems	12.78%	52%

Source: Household Survey in 2016 Relevant to This Study

7.2 Farmers' Confidence on their Capacity to Resolve Problems of Vegetable Production

Table 7.2 indicating the percentage of farmers who admitted both vegetable production and marketing related problems can be resolved by sharing information on vegetable production and making collective decision. Majority of the interviewed farmers in the Jaffna district believe that they can resolve vegetable production and marketing problems themselves whereas majority of Nuwara Eliya farmers believed in negative. However, majority of the interviewed farmers in the both districts, admit that information sharing is a plausible way of addressing marketing and production related issues.

Table 7.2: Farmers' Ability to Resolve Production and Marketing Issues on Their Own by Information Sharing and through Collective Decision

District	% of Farmers Responded		% of Farmers not Responded	Subtotal
	Yes	No		
Jaffna	86.47% (115)	9.77% (13)	3.76% (5)	100% (133)
Nuwara Eliya	33% (33)	60% (60)	7% (7)	100% (100)
Total	63.52% (148)	30.9% (73)	5.15% (12)	100% (233)

Source: Household Survey in 2016 Relevant to This Study

Of the interviewed farmers, 90.23 percent (120) from the Jaffna district and 29 percent (29) from the Nuwara Eliya district admit that if information on vegetable production of other areas is available, they can adjust their vegetable production aiming at a higher price. Table 7.3 indicates possible adjustments that farmers can make to resolve market and production problems when information on production is available. Of the interviewed vegetable farmers, 62.41 percent in the Jaffna district and 10 percent in the Nuwara Eliya district think that they can grow vegetables not grown by the other farmers to have a better price. Of the interviewed, 52.63 percent in the Jaffna district and 11 percent in the Nuwara Eliya district believe they can grow vegetables to harvest during the lean supply season. Certain farmers in the two districts believe that growing more than one type of vegetable at a time can reduce loss of profit.

Table 7.3: Possible Adjustments of Farmers when Information on Production is Available

Adjustment Proposed Farmers Revealed	Jaffna District	Nuwara Eliya District
Growing vegetables that most of people are not growing	62.41% (83)	10% (10)
Growing vegetables to harvest when a short supply is available at the market	52.63% (70)	11% (11)
Crop diversification so as to cover lost from one vegetable from others	45.11% (60)	10% (10)

Source: Household Survey in 2016 Relevant to This Study

7.3 Importance of Information on Extent and Time of Cultivation

According to Table 7.4 indicating importance of information on extent and time of vegetable cultivation, the number of vegetable farmers from the Jaffna district who believe in that fact is higher than that from the Nuwara Eliya district. These farmers believe that such information is vital to make important decisions related to vegetable cultivation. Of the interviewed farmers, 87.22 percent (116) from the Jaffna district and 46 percent (46) from the Nuwara Eliya district said they can increase profit by avoiding excess quantities of the same vegetable while 54.14 percent (72) from the Jaffna district and 17 percent (17) from the Nuwara Eliya district said that growing vegetables that are not commonly growing by others also helped increase profit. Further, farmers can make decisions on the types of vegetables, time of cultivation and, extent of cultivation collectively. Therefore, acting collectively in vegetable production is hailed.

Table 7.4: Importance of Information on Extent and Time of Vegetable Cultivation

Importance of Information	% of Agreed Farmers	
	Jaffna	Nuwara Eliya
If information on number of farmers growing a vegetable and extent of cultivation is available, types of vegetables to be grown can be selected in this season	61.65% (82)	24% (24)
If information on time of cultivation, farmers can adjust their cultivation time to prevent flood of vegetables coming to the market at the same time	42.86% (57)	18% (18)
Farmers can decide together extent of cultivation for each vegetable	47.37% (63)	6% (6)

Source: Household Survey in 2016 Relevant to This Study

7.4 Possibilities of Organizing Farmers

Interactive action requires organizing of farmers. More than half (50%) of the farmers interviewed believe that farmers can develop a mechanism through Farmer Organizations (FO) to share information on vegetable cultivation and marketing. Of the interviewed farmers, 93.23 percent (124) from the Jaffna district and 33 percent (33) from the Nuwara Eliya district are members of the vegetable farmers' organization. According to Table 7.5 which indicates barriers in organizing farmers to share information, less than 50 percent admitted that there is a barrier. However, a higher percentage of farmers from the Jaffna district agreed that the barrier is farmers' lack of interest to organize. Therefore, collective action of farmers can be a plausible solution.

Table 7.5: Barriers in Organizing Farmers to Share Information

Barrier	% of Admitted	
	Jaffna	Nuwara Eliya
Farmers are not aware of organizing	28.57% (38)	28% (28)
Farmers do not like and are not interested	54.14% (72)	41% (41)
No private or public sector entity to provide farmers directions necessary for organizing	22.56% (30)	31% (31)

Source: Household Survey in 2016 Relevant to This Study

CHAPTER EIGHT

Conclusion

According to the interviewed, the types of vegetables grown in the Jaffna district are higher than that of Nuwara Eliya. Fifteen types of vegetables are grown in the Jaffna district and seven types are grown in the Nuwara Eliya district. Most of farmers in the Jaffna district grow both English vegetables such as beetroot, carrot, cabbage and local vegetables such as long bean, brinjal, bitter gourd, okra, pumpkin, snake gourd and cucumber. Most of the farmers from the Nuwara Eliya district grow carrot, leeks, cabbage, beetroot, tomato and brinjal. Average extent of land allocated for each crop per farmer is larger in the Jaffna district compared to the Nuwara Eliya district as farmers in Jaffna own transferable lands which are higher in extent compared to the farmers in the Nuwara Eliya district.

Most of the farmers in the Jaffna district sell their vegetables at market place and therefore, these farmers have opportunities to sell their vegetables at a competitive price compared to the farmers in the Nuwara Eliya district where most of the farmers sell their vegetables at the farm. However, majority of farmers from these two districts say that they sell their vegetables at a price set by buyers making the majority of farmers price takers. Presence of price takers indicates absence of competitiveness. Therefore, vegetable markets in these two districts are monopsonomic or oligopsonic.

Vegetable farmers from the two districts tend to grow one or more vegetables within a year. The number of vegetables grown per year is supposed to be determining strategy of a vegetable farmer. Therefore, the interviewed farmers have four strategies as strategy 1, 2, 3 and 4. In the Jaffna district, majority of the interviewed farmers, (39.47%) implement strategy 2 that denotes growing two types of vegetables per year. Average payoff for the strategy 2 is Rs. 364,740/=. Average payoffs of the strategy 1, strategy 3 and strategy 4 are Rs. 456,913/=, Rs. 419,150/= and Rs. 564,230/= per year respectively. It was observed that higher the diversity of vegetables higher the profit a farmer received. Each of the interviewed farmers in the Jaffna district is engaged in a dominant strategy as no farmer tends to change the strategy of vegetable production being practiced regard less of the strategy implemented by the other farmer. Therefore, strategies they adopt are at Nash equilibrium.

In the Nuwara Eliya district, almost an equal number of the interviewed farmers are engaged in strategy 2 and strategy 3 separately. Percentage of the interviewed farmers engaged in strategy 2 is nearly 40 percent and strategy 3 is around 42 percent. Average payoffs are Rs. 131,319/= for first strategy, Rs. 146,478/= for the second strategy, Rs. 255,820/= for third strategy and Rs. 15,100/= for fourth strategy. Each of the interviewed farmers in the Nuwara Eliya district is also engaged in a dominant strategy

as no farmer tends to change the existing strategy of vegetable production corresponding to strategies implemented by other farmers. Therefore, strategies they adopt are at Nash equilibrium.

Equilibrium of vegetable production game of two districts is a finite game considering a year. If the game is constructed over a period of years, equilibrium will be changed. Therefore, a study for generating an infinite game analysis should be made.

As per the study, average profit of a vegetable farmer is about Rs. 26,756/= per month. Average extent of vegetable growing land is about 0.51 hectares. Cropping intensity which reflects the number of times vegetables are grown in the same land varies from 3 percent to 917 percent. Average cropping intensity is 120 percent. Cropping intensity of vegetable farmers in the two districts is higher than 100 percent. Average value of land tenure weight is four (4) that the majority of the interviewed vegetable farmers have transferable lands. Majority of the interviewed farmers do not act collectively with regard to vegetable production and marketing. Majority of the interviewed farmers have studied up to grade 10 or GCE (O/L). Most of the interviewed vegetable farmers have been growing vegetables for 20 – 25 years. Credit is available for about 60 percent of the respondents.

Of the interviewed farmers, those who wish to increase profit from vegetable need to increase the extent of vegetable cultivation. As land is a main factor of production, increase of the extent under vegetable cultivation leads to increased scale of production thereby increasing profit. Thus, farmers who want to expand their vegetable cultivation rent in lands and cultivate vegetables. These farmers have increased their profit. Therefore, higher profits have been drawn by farmers who have cultivated higher extent of lands which have been rented in. When farmers grow vegetables in larger extent of lands, farmers tend to invest more capital. Therefore, with availability of credit facilities, farmers tend to cultivate vegetables in larger extent of land and derive more profits.

A few interviewed farmers stated that they consider other farmers' vegetable cultivations when they make decisions related to growing vegetables. Vegetable production is a game among vegetable farmers. Therefore, vegetable farmers can resolve problems related to vegetable cultivation and marketing through sharing information. Interactive (collective) action of farmers enables farmers to decide the type of vegetable, time of cultivation and extent of cultivation to resolve such issue. Barriers for organizing farmers inhibit this and farmers' collective action is possible to reach a consensus.

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Annexes

Annex 1:

Questionnaire for the Household Survey of the Research - Potentials of Farmer Interactive Action to Remedy Vegetable Marketing Problems in Sri Lanka - October to December, 2016

(A). Information of farmer family, land tenure, and land use

1. Information on Family Members, Age, Education and Employment

Family member	Age (years)	Education	Employment
Farmer			
Wife			
Son			
Daughter			

2. Information on Land Tenure and Land Use

Type of land tenure		Extent of land (ha)	Land use pattern (code-a)
Transferred land	Low land		
	High land		
LDO land	Low land		
	High land		
Rented in land	Low land		
	High land		
Encroached land	Low land		
	High land		

Code-a: (1). Homestead; (2). Paddy in Maha season and vegetable in Yala season; (3). Vegetables in both Maha and Yala seasons; (4). Vegetables and yams in Maha and Yala seasons

B) Information on vegetable cultivation

1. Crop usually cultivated, cultivating time period, extent of land under each crop, land tenure and cost for land

Crop (vegetable)	Month	Extent of land (hectare)	low land/high land	Tenure	Cost for land

2. Cost of cultivation of each vegetable per year

Cost item	Unit	Unit cost	Cost for each vegetable cultivated within an year							
			1.		2.		3.		4.	
			No. of units	Cost	No. of units	Cost	No. of units	Cost	No. of units	Cost
Land extent	ha									
1. Land preparation										
Land clearing	md									
Ploughing	md									
Bed preparation	md									
2. Fertilizer										
Material cost	kg									
Application	md									
3. Pest control										
Material cost										
Application	machine									
Labour	md									
4. Disease control										
Material cost										
Application	machine									

Labour	md									
5. Watering										
Fuel cost	liter									
Application	machine									
Labour	md									
6. Cultural practices/ weeding										
Labour	md									
Application cost										
7. Harvesting										
Labour	md									
Application cost										
8. Transporting										

Note: md – man days

3. Yield and harvest

Vegetable	Extent (ha/year)	Yield (kg/ha)	Harvest (kg)	

4. How long have you been engaging in vegetable cultivation? .....

5. How do you fulfill cost of vegetable cultivation?

Saved money	
Taking credits from banks	
Borrowing money from private money lender	
Borrowing money from friends	

6. Are credits (loans) available sufficiently for vegetable farming? Yes/ No

7. If yes, what are the sources?

Public banks	
Private banks	
Sanasa bank	
Rural development bank	

8. Availability of inputs of vegetable production

Input	**Level of availability**		
	Without any delay		
Fertilizer			
Pesticide			
Planting material			

C). Marketing vegetable

1. How do you sell your vegetable production?

- Vegetables are sold to buyers coming to the farm gate
- Vegetables are carried to the market where buyers come
- Vegetables are sold to a particular buyer with whom the farmer has made a forward contract
- Specify any other way

2. Can you sell your vegetable production as you wish? Yes/ No

2.1. If yes, can you sell whatever vegetable you grow at a price you wish in every season of a year?

Yes/ No

If yes, what are the vegetables you grow and prices at which each vegetable is sold?

Vegetable	Price you wish	Season

If no, Can you sell vegetables as you wish at least in some season? (What are those vegetables and in which season?)

Vegetable	Price you wish	Season

2.2. If you cannot sell vegetables you produce at a price you wish, what can be the reason/s?

Excess production that exceeds demand	
Lack of buyer that is not sufficient to create a competitive market situation	
All buyers have themselves decided a price at which they should buy	
Quality of vegetable is not sufficient to have a better price	
Other specify	

2.3. What is the cost that you would bear when marketing vegetables?

Type of marketing cost	Average cost per year (Rs.)
Toll or fee for the market place	
Discount paid for the buyer (eg: 10 kg : 1 kg in Jaffna)	
Damage cost	
Any other cost specify	

2.4. How does the price determination process occur when you sell your vegetables?

- Buyers buy vegetables at a price growers make
- Growers sell vegetables at a price the buyers make

- Buyers and growers consider prices of vegetables in other areas
- Other

2.5. What are the factors causing price determination of vegetables?

- Price of previous season/year of a particular vegetable
- Price of vegetable markets of other areas in the country
- Changes in climate conditions causing damages to vegetables
- Pest damages to vegetables
- Other reasons specify

D). Interactions among vegetable farmers

1. Do you think that decisions you take with regard to vegetable production such as cultivating area for each vegetable and type of vegetable grown etc are caused by decisions taken by other vegetable farmers with regard to vegetable cultivation? Yes/ No

2. Do you consider following factors when taking decisions with regard to vegetable growing?

Type of vegetable that is grown by other farmers in adjoining lands	
Type of vegetable that is grown by other farmers in adjoining villages	
Type of vegetable that is grown by other farmers in areas	
Vegetable that gave a highest profit in the previous season	
Climate condition of a particular area	
Possible pest and disease problems	

3. Types of vegetable you have grown in this season and the last season, extent of land under each vegetable and reasons for selecting these vegetables in these seasons

This season		
Vegetable	**Extent (ha)**	**Reasons to select**
The last season		
Vegetable	**Extent (ha)**	**Reasons to select**

4. What are the areas (regions or villages) of which vegetable productions affect prices of your vegetables production?

5. Do you think that if information on vegetable production of other areas is available before you start the cultivation you can adjust your vegetable production to take a higher price? Yes/ No

6. If yes, how does that can happen?

Growing vegetables that most of people are not growing	
Growing a particular vegetable at the time before or after other farmers grow to harvest when a least production of the vegetable is available at the market	
Growing more than one vegetable at a time (crop diversification) so as to cover lost from one vegetable from others	

E). Collective action / coordination among vegetable farmers

1. Do you think that if farmers in a particular area (or region) of the country share information on vegetable production and make decision on vegetable production together, farmers can resolve production and marketing problems on vegetable cultivation? Yes/ No

2. If yes, how can you resolve?

If we know number of farmers growing a particular vegetable and extent of cultivation, we can decide the types of vegetables to grow in this season	
If we know the time of cultivation, we can adjust our cultivation time so that whole production of vegetables going to the market at the same time is prevented	
Farmers can decide together extent of cultivation for each vegetable	

3. Can you have information on vegetable cultivation of farmers in your area and other areas at present? Yes / No

4. If no, what are the reasons for not having this information?

There is no mechanism like extension services or other public sector or private sector involvement	
No relation or mechanism among farmers for sharing information on vegetable cultivation even happening implicitly	
No vegetable farmer organization intervenes in transferring this information	
There is no mechanism linking all vegetable farmers in an area or a region	
Other	

5. Do you think that Farmers can develop a mechanism through Farmer Organization (FO) to share information on vegetable cultivation and marketing? Yes / No

6. What are the barriers for organizing farmers to share this information?

Farmers are not aware of that	
Farmers do not like and are not interest	
No person or public sector entity to provide farmers directions necessary for that	

7. Are you a member of a farmer organization? Yes/ No

8. If yes, is that farmer organization with regard to vegetable farming? Yes/ No

9. If no, what are its roles?

10. Do you think that if you had a collective mechanism of farmers to share information on vegetable production and marketing, you would be able to increase your profit of vegetable cultivation? Yes/ No

11. If yes, how would the profit increase?

Preventing production of excess quantities of same vegetable	
Growing a vegetable that most of farmers do not grow	

12. What would be the expected changes in profits you can have related to ways in question (11) by following a collective mechanism?

Ways of increasing profit with collective action	Percentage change in profit with the collective action relative to present situation
Preventing production of excess quantities of same vegetable	
Growing a vegetable that most of farmers do not grow	

F). Expected utility of vegetable farmers

1. Type of vegetable, extent grown each vegetable, harvest and price at which you sold vegetable and price you expected for the last five seasons

Last five seasons	Type of vegetable	Extent grown (ha)	Quantity harvested (kg)	Price you sold (Rs.)	Price you expected (Rs.)
1					
2					
3					
4					
5					

2. Have you experienced any damage to vegetable you cultivated in last five seasons? Yes / No

Last five seasons	Type of vegetable	Type of damage/loss	Quantity lost (kg)	Cost of the damage (Rs.)
1				
2				
3				
4				
5				

Comments :-

Annex 2: Details of strategies implemented by the interviewed vegetable farmers in growing vegetables in Jaffna district

Strategy (vegetable type and number of cultivation per year)				Average net benefit/year (Rs.)	Percentage of vegetable growers
Cultivation-1	Cultivation-2	Cultivation-3	Cultivation-4		
Beet root				922976.7	5.3% (6)
Brinjal				414800	3.5% (4)
Cabbage				367233.3	2.6% (3)
Curry chilly				87720	4.4% (5)
Pumpkin				-56000	0.9% (1)
Beet root	Beet Root			390000	0.9% (1)
Beetroot	Cabbage			602466	4.4% (5)
Beet root	Carrot			393336.9	14.0%(16)
Beet Root	Curry chilly			615930	1.8%(2)
Beet root	String been			109980	1.8%(2)
Beet root	Tomato			553175	3.5%(4)
Bitter gourd	Snake gourd			73900	0.9%(1)
Beet Root	Leeks			348600	0.9%(1)
Brinjal	Carrot			-67400	0.9%(1)
Brinjal	String bean			95850	0.9%(1)
Brinjal	Tomato			652400	1.8%(2)
Cabbage	Carrot			185975	1.8%(2)
Cabbage	Tomato			704575	1.8%(2)
Cabbage	Brinjal			206800	0.9%(1)
Carrot	String been			-36580	0.9%(1)
Curry chillie	Cabbage			52800	0.9%(1)
Curry chilly	Tomato			98350	0.9%(1)
Okra	String bean			29450	0.9%(1)
Beet root	Cabbage	Tomato		775935	3.5%(4)
Beet root	Cabbage	Carrot		570116.4	9.6%(11)
Beet Root	Carrot	Tomato		307960	0.9%(1)
Beet Root	Curry chilly	String bean		116880	0.9%(1)
bitter gourd	Sank gourd	Tomato		-8850	0.9%(1)
Bitter gourd	Brinjal	String bean		185280	0.9%(1)
Beet root	Carrot	Leeks		447250	0.9%(1)
Bitter gourd	String bean	Tomato		94345	0.9%(1)
Brinjal	Okra	String bean		707750	0.9%(1)

Cabbage	Carrot	Leeks		1067640	0.9%(1)
Cabbage	Carrot	Sting been		22680	0.9%(1)
Cabbage	Curry chillie	Tomato		58597	2.6%(3)
Curry chillie	String bean	Tomato		785800	0.9%(1)
Curry chillie	Pumpkin	Tomato		152660	0.9%(1)
Cabbage	Snake gourd	String been		-3400	0.9%(1)
Beet root	bitter gourd	Carrot	Tomato	402400	0.9%(1)
Beet root	Bitter gourd	Brinjal	Snake gourd	2980	0.9%(1)
Beet root	Bitter gourd	Brinjal	string bean	473040	0.9%(1)
Beet root	Bitter gourd	cucumber	snake gourd	226100	0.9%(1)
Beet root	Bitter gourd	Okra	string bean	1536480	0.9%(1)
Beet root	Brinjal	Carrot	Okra	245780	0.9%(1)
Beet root	Brinjal	Carrot	String Been	331970	1.8%(2)
Beet root	Cabbage	Carrot	Okra	639250	1.8%(2)
Beet root	Cabbage	Carrot	String bean	343000	0.9%(1)
Beet root	Cabbage	Carrot	Tomato	889100	0.9%(1)
Beet root	Cabbage	Cucumber	String bean	569040	0.9%(1)
Beet root	Carrot	Okra	Lettuce	982560	0.9%(1)
Beet root	Carrot	Okra	string bean	913025	1.8%(2)
Beet root	Carrot	String bean	Tomato	276683	0.9%(1)
Beet root	Curry chilly	String bean	Tomato	26450	0.9%(1)
Bitter gourd	Carrot	Curry chilly	Green bean	1612080	0.9%(1)
Cabbage	Carrot	Curry chilly	Tomato	47400	0.9%(1)
Total					**100% (114)**

Annex 3: Details of strategies implemented by the interviewed vegetable farmers in growing vegetables in Nuwara Eliya district

Strategy (vegetable type and number of cultivation per year)				Average net benefit/year (Rs.)	Percentage of vegetable growers
Cultivation-1	Cultivation-2	Cultivation-3	Cultivation-4		
Carrot				209111	9.9% (9)
Cabbage				3325	4.4% (4)
Leeks				68600	3.3% (3)
cabbage	Carrot			221630	14.3% (13)
Carrot	Leeks			104191	19.8% (18)
Cabbage	Leeks			5547	3.3% (3)
Carrot	Radish			430100	1.1% (1)
Leaks	Radish			69800	1.1% (1)
Carrot	Beet root	Leeks		180187	13.2% (12)
Cabbage	Carrot	Leeks		306256	25.3% (23)
Carrot	Cabbage	Radish		50560	1.1% (1)
Carrot	Cabbage	Tomato		208640	1.1% (1)
Leeks	beet root	Tomato		118400	1.1% (1)
Leeks	Carrot	Beet root	Radish	15100	1.1% (1)
Total					**100% (91)**

Annex 4: Payoff matrices of two players game structures of vegetable farmers in Jaffna district

Table A4.1: Two player payoff matrix corresponding to strategy 1 and 2

		Strategies of column player			
		1		2	
Strategies of row player	1	456913	456913	456913	364740
	2	364740	456913	364740	364740

Table A4.2: Two player payoff matrix corresponding to strategy 1 and 3

		Strategies of column player			
		1		3	
Strategies of row player	1	456913	456913	456913	419150
	3	419150	456913	419150	419150

Table A4.3: Two player payoff matrix corresponding to strategy 1 and 4

		Strategies of column player			
		1		4	
Strategies of row player	1	456913	456913	456913	564230
	4	564230	456913	564230	564230

Table A4.4: Two player payoff matrix corresponding to strategy 2 and 3

		Strategies of column player			
		2		3	
Strategies of row player	2	364740	364740	364740	419150
	3	419150	364740	419150	419150

Table A4.5: Two player payoff matrix corresponding to strategy 2 and 4

		Strategies of column player			
		2		4	
Strategies of row player	2	364740	364740	364740	564230
	4	564230	364740	564230	564230

Table A4.6: Two player payoff matrix corresponding to strategy 3 and 4

		Strategies of column player			
		3		4	
Strategies of row player	3	419150	419150	419150	564230
	4	564230	419150	564230	564230

Annex 5: Correlation matrix of determinants causing to choose vegetable production strategies

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13
x1	1.0000												
x2	0.7001	1.0000											
x3	-0.3566	-0.0158	1.0000										
x4	-0.0692	-0.0789	-0.0444	1.0000									
x5	0.4833	0.1515	-0.2887	-0.0703	1.0000								
x6	-0.0917	0.1126	0.1605	-0.0356	-0.1585	1.0000							
x7	-0.0293	0.0250	0.0082	0.0240	-0.0116	0.1178	1.0000						
x8	-0.1041	-0.0685	0.1006	-0.1540	0.0365	-0.1791	0.1085	1.0000					
x9	0.1983	0.1782	0.0040	0.0182	0.1135	0.2156	0.1086	-0.0300	1.0000				
x10	0.2430	0.2079	-0.0020	-0.3130	0.1444	-0.0384	0.0324	0.1074	0.0740	1.0000			
x11	0.2352	0.2181	-0.0154	-0.4317	0.1055	-0.0517	0.0475	0.0897	0.1047	0.8057	1.0000		
x12	0.2316	0.1887	-0.0127	-0.2988	0.0945	-0.0908	0.0272	0.1289	0.0831	0.7857	0.8476	1.0000	
x13	0.3466	0.3324	-0.2256	0.1096	0.1586	0.0338	0.0447	-0.0616	0.1164	0.0471	0.0737	0.0274	1.0000