An Analysis of Farmer Decision Making and Its Effects on Price Volatility in Mid Country Vegetable Sector in Sri Lanka

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FOREWORD

Sri Lanka's varied agro-climatic regions have enabled cultivation of a wide variety of vegetables through the country.

Vegetables grown in Sri Lanka are broadly divided into two groups: up-country types and low-country types, based on the agro-ecological adaptability. Beans, carrot, Leek, beetroot radish, knolkhol and tomato were more adapted to upcountry wet zone, up-country intermediate zone, mid-country wet and intermediate zones while the other group comprised the low-country types which are preferably grown in agro- ecological zones such as low-country wet, intermediate and dry zones, and mid-country dry and intermediate zones include capsicum, ladies fingers, brinjal, pumpkin, cucumber, bitter gourd, snake gourd, drumsticks, luffa, long beans, winged beans and ash plantain. Though vegetable is considered one of the cash crops in Sri Lanka, farmers engaging in the business are frequently affected by high price fluctuation. Therefore, the study attempts to analyze the endogenous factors that affect the production variation and to suggest possible solutions. Next, the study aimed at identifying time series fluctuation features including trends and seasonality of each vegetable item and to select a forecasting method to predict future prices.

The results revealed that price expectation based on previous seasons' price signals was the main factor considered by farmers in selecting the type of vegetable/s to grow in the upcoming season. Among up-country vegetables, the highest price volatility index was observed for tomato followed by cabbage while the lowest price volatility index was reported for beans. The calculated annualized volatility indices for the selected vegetables in Sri Lanka were considerably higher than the reported price volatility of tropical food items such as coffee and banana in the international market. As managing the excess supply is difficult, it seemed that preventing excess production is an effective way of managing the price fluctuation. Therefore, planning the production based on market, finding an effective ways and means of influencing the farmer decisions, making the farmers aware of the nature of price fluctuation in the vegetable sector and assisting them to select alternative crops have been suggested by this study.

Haputhanthri Dharmasena
Director

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P.A. Jayamini Champika

ABSTRACT

The vegetable sub-sector contribution to the national GDP has been stagnant over the recent five years, despite of its increased extent and productivity. The sector has been experiencing high price instability over the last decade, a key feature of most of the agricultural commodities in developing countries.

Severe price fluctuation experienced in agriculture sector is recognized as price volatality, often defined as excessive season to season changes that are not explained by seasonality or normal trend. The causes for these price fluctuations can be divided into two categories as endogenous (changes in supply and demand within the sector) and exogenous (changes take place outside the economic environment) causes. One of the main reasons behind the endogenous price fluctuation in agriculture sector is supply variability. Among the wide range of decisions that farmers have to make, deciding which crop to grow in the next season is the most important one. This decision greatly impacts the variation in the supply in the next season, which finally gives rise to excessive price fluctuations. Therefore, one has to study the farmer decision making criteria to gain a sound understanding about the reasons behind the price fluctuations in the vegetable sub-sector of Sri Lanka. Therefore, this research attempts to find the effects of one of the endogenous causes of price volatility; identified as erroneous expectations of future prices. Through principal component analysis (PCA), it revealed the latent variables which caused the obvious variation in the data set while finding out their different dimensions. Further, the study compared the performance of various smoothing techniques in explaining the wholesale price behaviour of vegetables grown in Sri Lanka, incorporating the trend and movement of direction of the prices.

A sample survey was conducted to collect primary data. The survey was carried out in Matale, Badulla and Kandy districts by administrating a pre-tested semi structured questionnaire to the farmers who had cultivated at least one type of mid-country vegetable for the commercial purpose, either in 2012/13 *Maha* season or 2013 *Yala* season. As the first step, three divisional secretariat divisions (DSDs) were selected from both Matale and Badulla districts and two DSDs were selected from Kandy district purposively, based on the prevalence of vegetable cultivation (extent). Next, farmers' lists were obtained from the respective Agrarian Services Divisional Offices and 40 respondents from each selected DSD were chosen randomly for the questionnaire survey. The interview was conducted either by the head of the household or with a decision maker who has made the decision in crop selection in the current season. For the analysis of farmer decision making process, 15variables were developed and the farmers were asked to choose one from each answer constructed as a five point Likert scale. After checking the questionnaires for the completion, 271 questionnaires were selected for the principal component analysis.

The results of the PCA indicated that price expectation based on previous seasons' price signals was the main factor considered by farmers in selecting the type of vegetable/s to grow in the following season. The other main factors considered by the farmers were individual preference, availability of alternative water sources, potential harvesting frequency and influence of the external parties.

Among upcountry vegetables, the highest price volatility index was observed for tomato followed by cabbage while the lowest price volatility index was reported for beans. Next, time series analysis techniques were applied to select the best fitted method to predict the wholesale prices of selected vegetables. The results revealed that monthly wholesale prices of tomato, cabbage and beans have shown an upward trend during the period of 2002-2012.The smoothing techniques suggested that double exponential smoothing as the best fitted technique in describing the wholesale prices of tomato whilst single exponential smoothing was more appropriate in describing the wholesale prices of cabbage and beans.

The calculated annualized volatility indices for the selected vegetables in Sri Lanka were considerably higher than the reported price volatility of tropical food items such as coffee and banana in the international market. As revealed by the pattern of the extent vs. production relationship, productivity has increased over time and the rate of increase seemed to have accelerated to a higher phase after 2004. Price fluctuations also followed the same pattern, reporting highest intra - year variation either in 2011 or 2012 in most of the vegetables. Therefore, it was evident that price fluctuations have intensified with the productivity increases over time. At the same time, exotic hybrid varieties became popular in Sri Lanka due to their favorable agronomical characteristics. Considering all these factors, increased price fluctuation in the vegetable sector was regarded as an indirect effect of popularization of exotic hybrid varieties.

It revealed that managing excess supply is difficult. Therefore, planning the production based on market seemed to be the most suitable measure of preventing excess production. In order to manage the excess supply, study suggest to develop an effective price forecasting model based on weather forecasts and price behavior of the previous seasons and to take necessary steps to made available the results to the farming community before commencing the cultivation season. Further, making the farmers aware of the nature of price fluctuation in vegetable sector may be an effective measure in reducing the price fluctuation. They should be made aware of the effect of each and every individual decision on creating excessive price fluctuations. Next, relevant officers of the Department of Agriculture can assist farmers in selecting alternative crops to grow during the season.

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ABBRIVIATIONS

ARPAs	Agriculture Research and Development Assistants
CFM	Common Factor Model
COC	Cost of Cultivation
DECs	Dedicated Economic Centre's
DOA	Department of Agriculture
DOs	Divisional Officers
DSDs	Divisional Secretariat Division
ECLAC	Economic Commission for Latin America and the Caribbean
FAO	Food and Agriculture Organization
GARCH	Generalized Auto Regressive Conditional Heteroscedasticity
GDP	Gross Domestic Products
HARTI	Hector Kobbekaduwa Agrarian Research and Training Institute
IICA	Inter-American Institute for Cooperation on Agriculture
KMO	Kaiser-Meyer-Olkin test
MAD	Mean Absolute Deviation
MAPE	Mean Absolute Percentage Error
MSD	Mean Squared Deviation
PCA	Principal Component Analysis
USDA	U.S. Department of Agriculture
WFP	United Nations World Food Programme
WHO	World Health Organization

CHAPTER ONE

Introduction

1.1 Background of the Study - Vegetable Sub Sector in Sri Lanka

The vegetable (sub-sector) (Table1.1) is a key segment of the other food sector, which makes a significant contribution to the country's economy in terms of saving and earning foreign exchange and providing employment for the rural poor. Total area under vegetable cultivation in 2013 was 113,259 ha and the total production was approximately 1 million metric tons (Data and Information unit of the Presidential Secretariat, 2014). The government policy is to expand the cultivation of vegetables up to 1.2 million ha in 2015. Uncultivated lands in Monaragala, Hambantota, Matale, Puttlam and released land in Eastern and Northern provinces are to be utilized for vegetable cultivation (Ministry of Finance and Planning, 2010).

Table 1.1: Share of Vegetable Sector to the National GDP

Share of GDP %					
	2008	**2009**	**2010**	**2011 (a)**	**2012 (b)**
Other Food Crops	3.8	3.9	3.8	3.6	3.7
Highland Crops	1.2	1.3	1.3	1.2	1.2
Vegetables	2.5	2.5	2.5	2.3	2.4
Fruits	0.1	0.1	0.1	0.1	0.1

Source: Department of census and statistics, 2008-2012(a) Revised (b) Provisional

1.2 Importance of Vegetables in Daily Diet

As the World Health Organization (WHO) indicated, low intake of fruits and vegetables is one of the top risk factors of death caused by non-communicable diseases (NCD) and micronutrient deficiencies. According to the USDA dietary guideline report 2010, the recommended vegetable intake per person per day should be at least two times of 0.5 cups (200ml) per day (200g of fresh weight equivalent)(U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2010). Further, if it is consume draw it would be more desirable for the human health. As the WHO reports and USDA dietary guidelines further emphasize, global populations are consistently deficient in key nutrients such as foliate, potassium, fiber, vitamin A, C, K and magnesium found in fruits and vegetables. The insufficient intake of fruits and vegetables was estimated to have caused 14% of stomach cancer deaths, 11% of deaths caused by ischemic heart disease and about 9% of stroke deaths worldwide. However, the intake of vegetables (leafy vegetables + other types of vegetables) in Sri Lanka is around 111.6/g per day, at present (Ministry of Agriculture, 2012).

1.3 Vegetable Farming in Sri Lanka

Vegetables grown in Sri Lanka are broadly divided into two groups, such as upcountry types and lowcountry types, based on the agro-ecological adaptability. The upcountry types (the vegetables, which are preferably grown in agro - ecological zones[1] such as upcountry wet zone, upcountry intermediate zone, midcountry wet and intermediate zones), constitute vegetables such as beans (*Phaseolus vulgaris)*, carrot (*Daucus carota*), leek (*Allium ampeloprasum var.porrum*), cabbage*(Brassica oleracea)*, beetroot (*Beta vulgaris*), raddish (*Raphanus sativusvar. longipinnatus*), knolkhol (*Brassica caulorapa*) and tomato (*Lycopersicon esculentum)*.

The other group comprises the lowcountry types which are preferably grown in agro-ecological zones such as lowcountry wet, intermediate and dry zones, and midcounty dry and intermediate zones), which include capsicum(*Capsicum annum)*, ladies fingers (*Hibiscus esculentus)*, brinjal (*Solanum melongina)*, pumpkin (*Cucurbita maxima)*, cucumber (*Cucumis sativus)*, bittergourd (*Mormodica charantia)*, snakegourd (*Trichosanthes cucumerina)*, drumsticks (*Moringa oleifera*), luffa (*Luffa acutangula)*, long beans (*Vignaun guiculatassp. sesquipedalis*), winged beans (*Psophocarpus tetragonolobus)* and ash plantain (*Musa paradisiaca)*. Growing of lowcountry vegetables mostly depends upon the availability of rainwater, due to the water scarcity in dry and intermediate zones. Whilst in the central highlands, upcountry vegetables are grown with high cropping intensity all year-round, as upcountry wet and intermediate zones receive ample amount of rainfall from both North eastern and South western monsoons (Department of Agriculture, 2013).

Even though upcountry varieties are more popular in midcountry areas, a considerable amount of lowcountry varieties are also grown in these areas inter - changeably. As it is described in Table 1.2, considering the most recent seasons, Nuwara Eliya, Badulla, Kandy and Matale districts accounted for 70.3% of the *Maha*[2] seasons' upcountry vegetable cultivation and 74.1% *Yala*[3] seasons' upcountry

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[1] The Dry Zone (D) is the area, which receives a mean annual rainfall of less than 1,750 mm with a distinct dry season from May to September. The Intermediate Zone (I) demarcates the area, which receives a mean annual rainfall between 1,750 to 2,500 mm with a short and less prominent dry season and the Wet zone (W) receives a mean annual rainfall of more than 2,500 mm with no distinct dry season. Further, a sub-division based on the altitude takes into account the temperature variation in these climatic regions. In this delineation, the Low-country (L) is demarcated as the land below 300 m in elevation and the Mid-country with elevation between 300 - 900 m and the Up - country is demarcated as the area where elevation is more than 900m. Three major climatic zones are indicated by the first upper case letter of the code (W-Wet, I-Intermediate and D-Dry). The second upper case letter of the code (L-Low country, M-Midcountry and U-Up country) denotes three categories of elevation. The numerical character in the third place of the code represents a more detailed moisture regime (rainfall and evaporation combined) with a degree of wetness on the scale of 1 to 5 where 1 being the most favorable (Punyawardena, 2004).

[2] *Maha* - Major growing season in Sri Lanka extending from mid - October to mid - March

[3] *Yala* - The other growing season in Sri Lanka extending from mid - June to mid - September

vegetable cultivation, on average. Except Nuwara Eliya, the most important upcountry district for vegetable cultivation, the other three midcountry districts, namely Badulla, Kandy and Matale accounted for 40% for *Maha* seasons' upcountry vegetable cultivation and 37.5%*Yala* seasons' upcountry vegetable cultivation, on average (Department of Census and Statistics, 2010-2013).

Table 1.2: Contribution of Nuwara Eliya, Badulla, Kandy and Matale Districts in Up-Country Vegetable Cultivation in Most Recent Seasons

	Total extent (As at the end of the season) (ha)	**Nuwara Eliya (%)**	**Badulla (%)**	**Kandy (%)**	**Matale (%)**	**Total (%)**
2010/11 *Maha*	15,852	31.2	28.3	10.4	4.3	[a]74.2 [b]43.0
2011 *Yala*	16,248	35	21	9.9	7.9	[a]73.8 [b]38.8
2011/12 *Maha*	17,534	30.8	25.7	8.6	4.6	[a]69.7 [b]38.9
2012 *Yala*	14,454	38.1	19.3	10.2	6.8	[a]74.4 [b]36.3
2012/2013 *Maha*	16,942	28	23	11.2	4.0	[a]66.2 [b]38.2

*a = % value of sum of Nuwara Eliya, Badulla, Kandy and Matale districts
*b= % value of sum of Badulla Kandy and Matale districts
Source: Department of Census and Statistics, 2010-2013

On the other hand, considering the cultivated low country vegetable types, the contribution of Nuwara Eliya, Badulla, Kandy and Matale districts were 14% and 16.8% in consecutive *Maha* and *Yala* seasons' respectively. Regarding midcountry districts, Badulla, Kandy and Matale, the contributions were 11% and 14.4% in consecutive *Maha* and *Yala* seasons respectively (Table 1.3).

Table 1.3: Contribution of Nuwara Eliya, Badulla, Kandy and Matale Districts for Low-country Vegetable Cultivation in most Recent Seasons

	Total extent (As at the end of the season) (ha)	Nuwara Eliya (%)	Badulla (%)	Kandy (%)	Matale (%)	Total (%)
2010/2011 *Maha*	33,828	3.9	6.6	2.9	2.4	[a] 15.8
						[b]11.9
2011 *Yala*	28,382	2.3	6.0	3.2	5.5	[a] 17.0
						[b]14.7
2011/12 *Maha*	36,945	3.6	5.4	2.4	3.1	[a] 14.5
						[b]10.9
2012 *Yala*	25,068	2.6	6.2	3.4	4.5	[a] 16.7
						[b]14.1
2012/2013 *Maha*	38,508	1.6	3.1	3.0	4.2	[a]11.9
						[b]10.3

*a = % value of sum of Nuwara Eliya, Badulla, Kandy and Matale districts
*b= % value of sum of Badulla Kandy and Matale districts
Source: Department of Census and Statistics, 2010-2013

Similar to other seasonal crops such as paddy, vegetable cultivation is also mainly practiced in two seasons, *Maha* and *Yala.* However, demarcation of the seasons is not as clear as for paddy for other field crops, as shorter crop durations allow cultivation of 1- 4 rotations within the same field during one season, under favorable weather conditions. Monthly wholesale price movements in vegetables are characterized by a cycle of two instances of price increase followed by two price drops during a period of a year.

If the normal weather condition prevailed, *Maha* cultivation for both up and low country vegetables commences in early October to mid November, with the North eastern monsoonal rains. In upcountry and midcountry areas, *Maha* vegetable cultivation is mainly practiced in highlands hence, this season is known as *'kandukannaya'*(cultivated in highlands). As supply of irrigation is difficult in hilly areas, land preparation and establishment of seedlings are generally practiced after receiving monsoonal rains. Therefore, if the rain is delayed, commencement of the season is delayed accordingly, in highlands. However, in certain parts of the lowcountry, e.g. Anuradhapura, Kalpitiya and Hambantota, there is a possibility of commencing cultivation without waiting for the rain, by using groundwater as the main source. Under normal circumstances, the supply of *Maha* production starts to reach the market from mid-January and continue still the last week of March. If inter-monsoonal rain continues in March and April, 3rd and 4th cycles of crops are practiced immediately by up-rooting the earlier establishments.

During the peak *Maha* harvesting period, average wholesale prices of upcountry vegetables decrease by 30%-35% compared to the annual average price, while observed price drops for lowcountry varieties are generally in the range of 30% - 40%. Establishment of *Yala* crops begins with south-west monsoon rain in May while wholesale prices of vegetables reached its peak in mid-June to mid-July, just before the *Yala* harvest reaches the market. As the lean season for vegetables reaches its peak, supply drops hence average prices are increased by around 35% and 25% - 35% for up country and lowcountry vegetables respectively, compared to annual average. The average price hike observed in the lean period is confined to 25% - 35% margin, mainly due inter-seasonal cultivation in mid-March to mid-April period. If an extreme weather condition such as drought or flood affects the inter-seasonal cultivation of vegetables, average monthly prices generally increase by more than 50% of the annual average (HARTI, 2013-2014).

With the receiving of peak *Yala* supply to the market in August-September, prices drop by around 20% - 30% for both upcountry and lowcountry varieties. Peak of the second lean season is observed in mid-November to mid-January in which the margin of price increase is heavily dependent upon the inter-seasonal cultivation, generally practiced during mid-September to mid-October (HARTI, 2013-2014).

If farmers are producing for the local or international market, these types of price fluctuations become a significant risk that they have to cope with. From the farmers' point of view, the principal difficulty is to assume the selling prices, at the time of planting. In accurate price predictions can be potentially detrimental for the farmers' income. The result has created farmer-indebtedness among small scale vegetable farmers. Then, farmers become unable to invest in their next season's production and further get trapped in the vicious cycle of indebtedness. It is clearly identified that, agricultural price fluctuations have negative effects on welfare, food security, and economic growth for the farmer community especially, in developing countries (Mitra and Boussard. 2011). From a more macro-perspective, these price fluctuations can give rise to multiple negative consequences to the country's economic stability, especially affecting the economies of the countries which are heavily reliant on agricultural produce. Further, high price instabilities can have a negative impact on the government's fiscal revenue, public expenditure, foreign reserves and its creditworthiness, which are regarded as important sectors of domestic economy. Therefore, some economists argue that there are links between volatility and crisis; higher volatility leads to economic crisis.

Thus, this research attempts to identify the nature of price fluctuation, its magnitude, and recent trends in the fresh vegetable sector, a pre requisite for any policy intervention aiming for less variable prices in the Sri Lankan vegetable market.

1.4 The Research Problem

Researchers have defined seasonality as month to month (or season to season) price fluctuations may represent normal seasonal cycles which are determined by the seasonal calendar (harvest and lean season) (WFP, 2010). However, severe price fluctuations go beyond the seasonality effect. Price volatality is described as excessive month-to-month (or season to season) changes that are not explained by seasonality or normal trend. The main reason behind price fluctuation in agriculture sector is explained as supply variability (WFP, 2010).

In recent past, an issue surfaced with severe declining of prices of several vegetable types. In 2011, farm gate price of a kilo of leeks dropped to Rs.5/= (the estimated cost of production of a kilo of leek was Rs.20.50) (Department of Agriculture, 2009) and many farmers in Nuwara Eliya, refused to sell at that price and finally composted the harvest. A similar issue was experienced with regard to radish, where the farm gate price of a kilo declined to Rs.2/= (informal discussions with farmers). In the 2011/2012 *Maha* peak harvesting period (February), the situation aggravated with over 50 tones of vegetables namely cabbage, cucumber, leek and beans being dumped at the Manning Market, Colombo. Farm gate price of a kilo of tomato dropped to Rs.5/= at the Dambulla Economic Centre at the same time. However, in the same year, average wholesale prices in *Maha* and *Yala* seasons were recorded as Rs.74.52 and Rs.82.87 for beans, Rs.38.28 and Rs.83.90 for leek, Rs.75.50 and 73.43 for tomatoes and Rs.32.84 and Rs.33.78 for cabbages. This high volatility of vegetable prices severely affected the profitability in the event of even a marginal increase in supply. The result has created farmer-indebtedness among small scale vegetable farmers. Then, farmers become unable to invest in their upcoming season's production and further entrapped in the vicious cycle of indebtedness.

However, in Sri Lanka, a few studies have been conducted to investigate how farmers make decisions on crop selection. Among the multiple decisions that farmers have to make, determining the type of crop to grow in the next season is the most important one. This decision greatly impacts the variation in the supply in next season, which finally gives rise to excessive price fluctuations. Therefore, one has to study the farmer decision making criteria to gain a good understanding about the reasons behind the price fluctuations in the vegetable sub-sector of Sri Lanka.

1.5 Research Objectives:

1. To study the farmers'decision making process regarding selection of crops (type of vegetable)
2. To measure the degree of price instability and fluctuation in vegetables grown in midcountry areas and to select a forecasting method to predict future prices

3. Make policy recommendations to reduce price fluctuations in vegetables grown predominantly in midcountry areas.

CHAPTER TWO

Conceptual Framework and Literature Review

2.1 Introduction

This chapter presents an overview of the factors affecting the price fluctuations and its consequences on agriculture sector with special reference to developing economies.

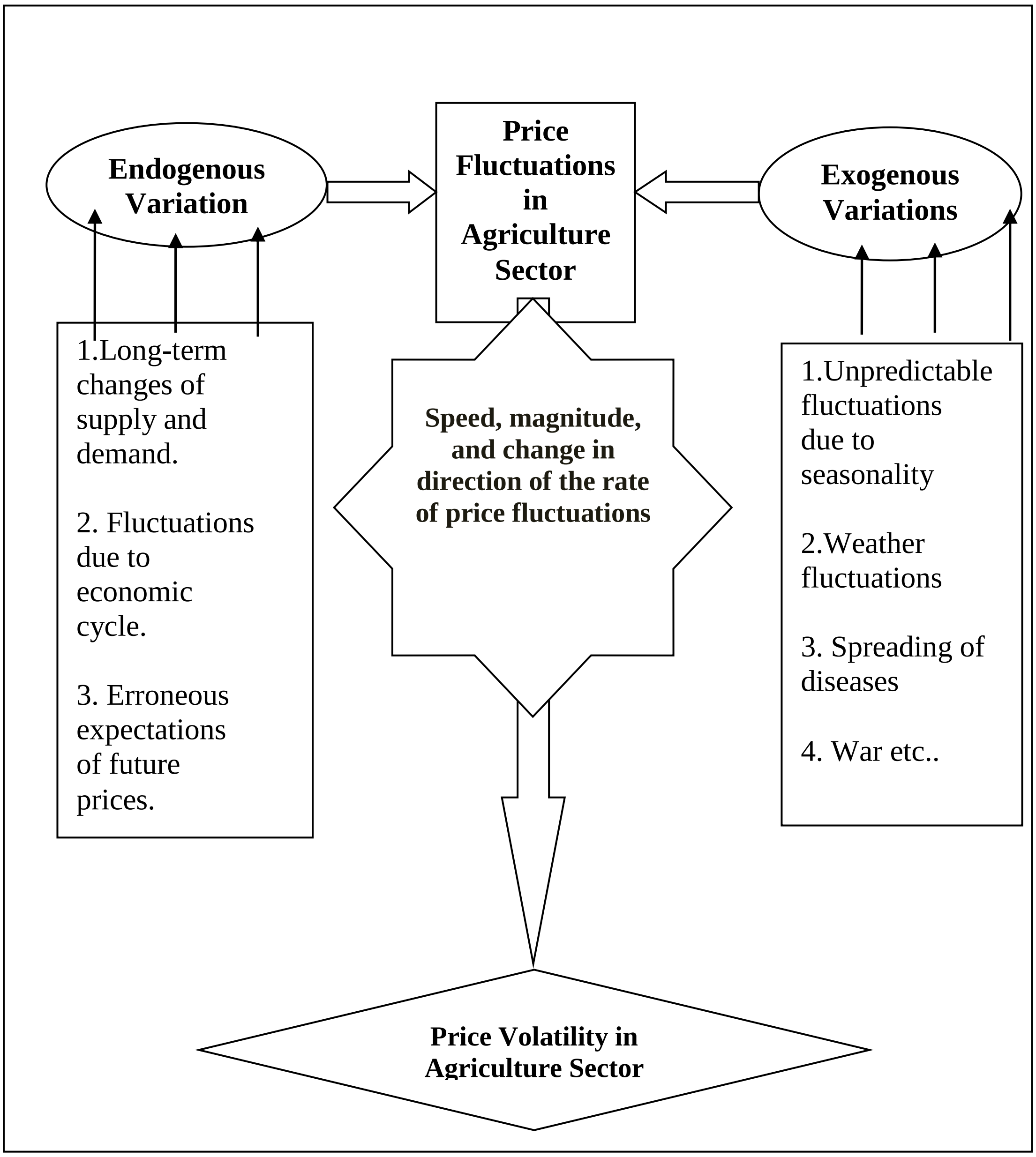
2.2 Price Fluctuations in Agriculture Sector

In all the developing countries, the food and agriculture sector is undergoing significant changes. In such contexts importance of grains and staple food is relatively declining while that of high value agricultural products such as fruits, vegetables, milk, meat and egg is significantly increasing. Income growth, demographic factors such as urbanization, changed trade policies and increasing foreign direct investment were found to be the main reasons behind this transformation (Gulati *et al*, 2005). As high value agricultural products are comparatively more perishable in nature, it requires greater coordination in the way the food is produced, processed, marketed and consumed (Ali, 2011).

Before finding out an instrument to stabilize agricultural prices, it is necessary to distinguish between various types of price changes occurring in agricultural sector such as:

- Long-term changes, resulting from changing character of supply and demand;
- Fluctuations resulting from general economic cycle;
- Unpredictable, coincidental fluctuations;
- Seasonal variations during the year;
- Price fluctuations as a result of long term character of production cycle of most agricultural products (Grega, 2002).

It is clearly identified that, agricultural price fluctuations have many negative effects on welfare, food security, and economic growth (Myers, 2006) for the farmer community especially, in developing countries. Some economists argue that there are links between fluctuation and crisis, higher fluctuation leading to economic crisis. However, there has been much discussion among policy formulators, all around the world, on most suitable food policies that can reduce fluctuations. The design of a policy response to agricultural price fluctuations requires an understanding of how fluctuations arise in the first place. Therefore, two main types of explanations have been proposed on this basis, and one is exogenous variations, meaning weather shocks or any other factor outside the economic environment that gives rise to supply variations (Mitra. S, 2011) (Figure 2.1).The other explanation is endogenous factors which mean changes occur within the economic environment such as erroneous expectations of future prices lead to over or under supply. In both cases, it is assumed that demand remains in elastic. In the exogenous case, all methods such as insurance schemes, future markets, widening markets are efficient to alleviate price fluctuation. Under the endogenous explanation, price stabilization strategies may be in the form of government interventions such as production quotas and national supply management is regarded as effective (Mitra & Boussard 2011).



Source: Compiled by author based on Myers (2006) and Grega (2002)

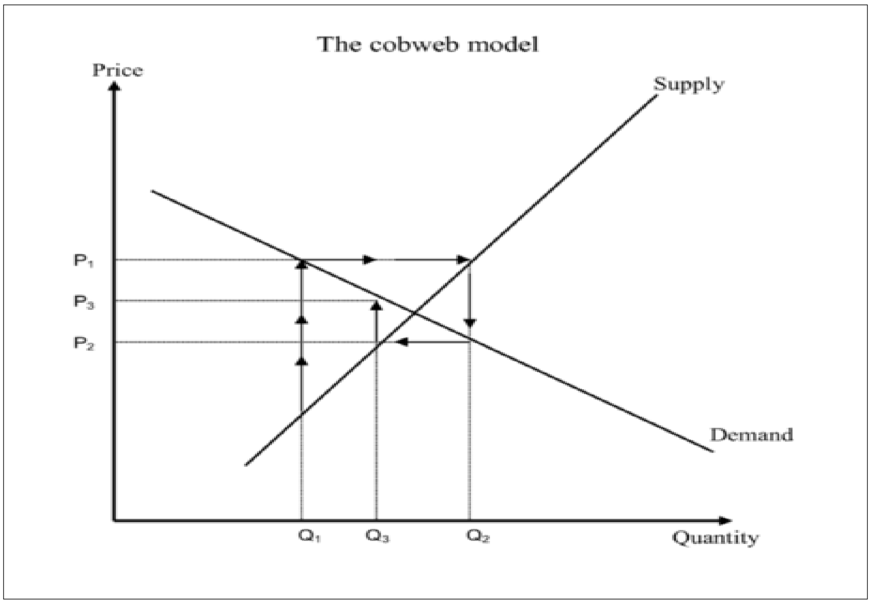
Figure 2.1: The Conceptual Framework

In the endogenous explanation, fluctuations are endogenous to agricultural markets and resulted from the behavior of agents or characteristics of the market. The cobweb model, proposed by Ezekiel (1938), is often used to illustrate this explanation on fluctuations arising primarily due to erroneous expectations that lead to over or under supply.

2.3 Application of Linear Cobweb and its Critiques

The cobweb theory is an economic model that explains why prices might be subject to periodic fluctuations in certain types of markets. It describes cyclical supply and demand in a market where the amount produced must be chosen before prices are observed. e.g. (producer has to take the production decision based on the expected price for the next season). The model explains that producers' expectations about prices are based on observations of previous prices (Chiarella,1988).

The cobweb model is based on a time lag between supply and demand decisions. Agricultural markets are a situation where the cobweb model might apply, since there is a lag between planting and harvesting.



Source: Mitra & Boussard (2011)

Figure 2.2: The Cobweb Model

The equilibrium price is at the intersection of the supply and demand curves. A poor harvest in period 1 means supply falls to Q_1, so that prices rise to P_1. If producers plan their period 2 production under the expectation that this high price would continue, then the period 2 supply will be high, at Q_2. Prices therefore fall to P_2 when they try to sell all their output. The theory assumes that as this process repeats itself, oscillating between periods of low supply with high prices and then high supply with low prices, the price and quantity spiral inwards and the economy converges to the equilibrium price where supply and demand cross.

The cobweb model can have two main types of outcomes:
If the slope of the supply curve is greater than the slope of the demand curve (in absolute value), then the fluctuations decrease in magnitude with each cycle, as a plot of the prices and quantities over time would look like an inward spiral, as shown in the diagram. This is called the stable or convergent case (Ezekiel. 1938, cited in Chiarella.1988).

If the slope of the supply curve is less than the slope of the demand curve (in absolute value), then the fluctuations increase in magnitude with each cycle, so that prices and quantities spiral outwards. This is called the unstable or divergent case.
However, some researchers have argued that this model assumes that producers are extremely shortsighted by assuming farmers study the most recent prices in order to forecast future prices.

2.4 The Food Price Volatility

Volatility is determined by the speed, magnitude, and change in direction of the rate of variation in prices (ECLAC/FAO/IICA Newsletter. 2011).

From a statistical point of view, greater the magnitude of its rate of change (up or down), greater the speed of such change and more changes in opposite directions, price becomes more volatile. Moledina *et al.* (2003) proposed that the predictable and seasonal components of the price process should not be considered a part of price fluctuation. Once the predictable components have been removed, only the stochastic or unpredictable component remains. According to Moledina *et al*. (2003), the stochastic or unpredictable component of the price process is the appropriate measure of fluctuation. However, Just and Pope (2002) cited in Jordaan *et al* (2007) stated that "it is, both logically inconsistent and statistically inefficient to use volatility measures that are based on the assumption of constant fluctuation over some period when the resulting series move through time". Thus, it is important that the techniques used to quantify fluctuation account for both the predictable and unpredictable components of the price process and that they allow for changes in fluctuation over time. A number of different methods have been used to measure fluctuation, including the standard deviation of prices and the coefficient of variation.

Many researchers have defined the term 'price volatility' and calculated price fluctuation in relation with the world grain market, as it is the most important food commodity in ensuring the food security across the globe. Gilbert and Morgan.(2010), have calculated the fluctuation of grain prices in the world grain market applying generalized autoregressive conditional heteroscedasticity (GARCH) model and concluded that variability of world grain prices over the most recent period has been high but, with the important exception of rice. They further elaborated on the following consequences of food price fluctuation. Volatile world food prices have created major import bill uncertainty in net food importing countries. This food insecurity has created hunger and revolt in poorest nations where poverty levels are high and food expenditure constitutes 70% - 80% of the per capita income, increased government expenditure and increased consumer price index. In producers' perspective, it can pose greater risks for producers, especially small-scale producers, due to uncertainty regarding expected levels of income (ECLAC/ FAO/IICA Newsletter, 2011).

Starleaf, 1982 (cited in Sekhar, 2004) stated that fluctuation in agricultural prices can occur due to three main reasons; first, price and income elasticity of agricultural products, inherent unstable agricultural production as a result of unforeseeable exogenous weather shocks and nature of agricultural planning process, where production decision for most farm products are made much in advance of the product is marketed. Sekhar (2004) compared the fluctuation of agricultural prices in International and Indian markets by applying the ratio method. In this study, he has calculated the variability of prices by measuring the standard deviation of log (P_t/P_{t-1}) over a period, where, P_t is the price in period 't' and P_{t-1} is the price in period *t*-1. Sekhar (2004) has found that inter-year variability in domestic market was lower than in the international market.

However, only few studies related to price fluctuation analysis in perishables have been conducted, compared to the number of studies on non perishables. Alboiu (2011) has evaluated the vegetable price fluctuation in Romania, by calculating the coefficient of variation (CV) for each and every type of considered vegetable. He further found that tomato and cabbage had the highest price fluctuation among considered vegetables (56% and 42% respectively). Kumar *et al.* (2005) studied the behaviour of market arrivals and prices of selected vegetable crops with reference to metropolitan markets in India. They have analyzed the price fluctuation by calculating the coefficient of variation and found out that the extent of variability in the market arrivals of tomato across different months was very high in all the considered markets. They have further confirmed the negative relationship between market arrivals and prices over years in all the considered metropolitan markets. Kumar *et al*(2005) explained that the variations in the output of horticultural crops have led to wild fluctuations in their prices, exposing the vegetable growers to more risk as compared to the growers of other crops. In addition, they have identified that horticultural based diversification has another set of marketing-related problems. Since most of the vegetable and fruit crops are perishable, they require marketing immediately after harvesting to ensure freshness and quality to the consumers and remunerative prices to the growers. Therefore, researchers have suggested that vegetable farmers should be assisted in adjusting their cropping pattern in a way they could sell their produce at a time when the prices are reasonably high in the market.

An analysis of price behavior of selected upcountry vegetables namely beet, cabbage, carrot, leeks and tomato in Sri Lanka applying Box-Jenkins method revealed that annual, island wide rainfall has not affected much directly on vegetable prices. Rather, price prevailed during the establishment stage and during the same time period of the previous year has influenced the vegetable prices to a considerable level (Wickramasinghe. 2012).

2.5 How Farmers Make Decisions in a Risky Environment?

As Siegel *et al* (2008) pointed out, risks[44] and uncertainties that result from it are inherent qualities of agriculture. Farmers make decisions in a risky environment. The consequences of their decisions are generally not known when the decisions are made. Further, wide fluctuations in food commodity prices due to the seasonality of crop production are a common phenomenon experienced in the farming sector. In general, agricultural commodity prices have been more volatile than those of manufactured goods all over the world (Kang and Mahajan. 2006). According to Ramaswami *et al.* (2003) there are three types of risks such as production risks, price risks and input risks that exist in agriculture.

Among them, production and price risks are two major risks in agriculture that farmers are confronted with. Further, technology changes, legal and social concerns and the human factor also contribute to the risky environment of agricultural producers.

Due to seasonal nature of agricultural product, bulk supply comes to the market within a shorter period of time. If a change in price alters the demand in a significant margin, the phenomenon is regarded as elasticity of demand. It is well known that demand for agricultural commodities, especially for food, a commodity is characterized by low price elasticities (typically less than 1). Low price elasticities sequentially magnify the impact of supply shocks on prices. For instance, Ramaswami *et al.* (2003) have indicated that when the price elasticity was reported as 0.3 for a particular agricultural commodity in India, it will generally gives rise to nearly a 5% increase in supply which ultimately results in nearly a 16% drop in price.

Therefore, decisions made by farmers could have a considerable influence beyond the farm boundary to the national level. Jones (2006) has found that farmers' decisions are influenced by a range of factors such as socio-demographics of the farmer, psychological make-up of the farmer, the characteristics of the farm household, structure of the farm business and the wider social setting beyond the farm boundaries, when adopting new farm technologies.

[4] Risk is the fact that the result of any action is not certain but may take more than one value, that the outcome's actual cause is not known, but it is expected that it will be determined as the result of a random drawing from a set of possible outcomes where probability distribution is known. Uncertainty means an agent has lack of knowledge about the present fact and future possibility that the probability distribution is unknown (Siegel, Jaffee, and Andrews, 2008).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The process of data collection and analysis methods are discussed in this chapter. It mainly focuses on the process of selecting variables and measuring the constructs that are developed in the questionnaire. Further, applied time series forecasting methods and techniques in predicting price fluctuation are discussed here.

3.2 Survey Design

A pre-tested semi structured questionnaire was administrated to the farmers who had cultivated at least one type of midcountry vegetable for commercial purpose, either in 2012/13 *Maha* season or 2013 *Yala* seasons in Matale, Badulla and Kandy districts for collecting primary data. As the first step, three divisional secretariat divisions (DSDs) were selected from Matale district and Badulla districts and two DSDs were selected from Kandy district purposively, based on the prevalence of vegetable cultivation (extent). Next, farmers' lists were obtained from the respective Agrarian Services' Divisional offices and 40 respondents from each selected DSD were chosen randomly from the list thereafter. A semi-structured, pre-tested questionnaire was administrated, either to the head of the household or to the decision maker who has made the decision in crop selection in the current season. For the analysis of farmer decision making process, 15 variables were developed and farmers were asked to choose one from each answer constructed as five point Likert scale (Table 3.2). After checking the questionnaires for the completion, 243 questionnaires were selected for the final analysis.

3.2.1 Data Collection

Table 3.1: Study Location and Sample Size

District	Number of Farmers Selected	Percentage (%)
Badulla	85	35.0
Kandy	65	26.7
Matale	93	38.3
Total	243	100.0

Source: Field survey, 2013

Before commencing the cropping in each season, a farmer has to make an important decision that is to select which crop to grow as operational requirements generally follow this decision. It is clearly recognized that crop recommendation is primarily based on the agro - ecological factors. Based on this fundamental principal, the Department of Agriculture – Sri Lanka has recommended five types vegetables for the midcountry wet and intermediate zone, namely tomato (*Lycopersicon esculentum),* beans (*Phaseolus vulgaris)*, carrot (*Daucus carota*), cabbage*(Brassica oleracea)*and beetroot (*Beta vulgaris*) (Department of Agriculture, 2012).The three midcountry districts, (Badulla, Kandy and Matale) accounted for 37.7% of *Maha*and *Yala* seasons' upcountry vegetable cultivation and 12.7% *Maha* and *Yala* seasons' lowcountry vegetable cultivation on average (author's estimation based on Department of Census and Statistics, 2010-2013 database). As farmers have no control over the climatic condition, it is assumed that farmers in midcountry areas are selecting one or few varieties out of these recommended varieties for cultivation. At the next step, farmers had to prioritize one or few varieties out of the recommended varieties.

As Grega (2002) explained, price fluctuations occur as a result of long term character of production cycle of most agricultural products that are inherent to the agriculture sector. This is further explained by the cobweb theory proposed by Ezekiel (1938) that producers' expectations about prices are based on observations of previous prices. Therefore, an assumption was made that price signals of the previous seasons' prices have much influence on selecting the crops to be cultivated in the upcoming season. Further, Kurukulasuriya and Mendelsohn (2008) found that African farmers' choice of crops were extremely sensitive to the climate change. They have further indicated that depending on whether precipitation increases or decreases, African farmers had shifted towards drought tolerant or water loving crops, respectively. Based on above evidence, it is hypothesized that, increasing incidence of climate change is an important factor of consideration in the crop selection process. Next, it is well established that extension agent plays a significant role in introducing new technology to the farming community (Rogers,1983). Farmers are generally depending on extension agents' advice on selection of crops and varieties that are more suitable to the area. On the other hand, with the development of the private sector's involvement in seed business, their agents started to visit the farm fields and provide on call extension services. Based on these evidence, a hypothesis was developed since the combined effects of the external agents' influence also play a vital role in crop selection. Other than that, it is assumed that farmers' own preference and input availability as the other major factors which could have some influence over choice of crops.

Thus, the study attempts to measure the degree of influence of identified factors over the decision of crop selection. It is assumed that farmers' crop selection decisions are affected mainly by five factors such as

1. Price signals of the previous season
2. Increasing incidence of climatic extremes
3. Influence of the other people/parties

4. Farmers' preferences
5. Input availability

In order to measure the degree of the influence of five identified factors, 15variables have been identified (Table 3.2)

Table 3.2: Selected Variables in Measuring the Farmer Decision Making Process

	Variable	**Degree of Influence on Crop Selection** **0 1 2 3 4**
1	Last season's market prices of the cultivated vegetable (Rs/kg)	
2	Last season's profit from the particular vegetable (Rs/kg)	
3	Types which had higher market prices in the last season (type)	
4	Cultivating mixture of crops as a coping strategy for price fluctuation (yes/no)	
5	Cost of production (Rs/kg)	
6	Potential harvesting frequency (times/year/plant)	
7	Disease resistance of the selected crop (high/low)	
8	Easy/low cost post-harvest handling (yes/no)	
9	Resistance to the climate change/ variability (yes/no)	
10	Ability of supplying alternative water sources (yes/no)	
11	Influence of external parties (e.g AI, Government policy change, private seed/ agrochemical agents)	
12	Influence of neighbour farmers (yes/no)	
13	Personal preference (yes/no)	
14	Past experiences(yes/no)	
15	Availability of inputs(yes/no)	

0 - No influence/ No idea/ Not relevant, 1- Very low influence, 2 - Low influence,
3 - Some influence, 4 - Greater influence

3.3 Data Analysis

3.3.1 Application of Principal Component Analysis (PCA) Method

Social scientists have used factor analysis extensively, for examining the patterns of interrelationships, data reduction, classification, data transformation, hypothesis testing, exploring relationships in new domains of interest and mapping constructs in multi-dimensional space (Rummel, 1970). Exploratory factor analysis (EFA) is a widely utilized and applied statistical technique in social sciences. The aim of factor analysis is to reveal any latent variables that cause the manifest variables' covariance. During factor extraction, the shared variance of a variable is partitioned from its unique variance and error variance to reveal the underlying factor structure; hence only shared variance appears in the solution (Armstrong, 2008).

Although a variety of factor extracting models are available, they can be categorized broadly into two groups as either a common factor model (CFM) or a components model. Of components models, the most popular one is the principal component analysis (PCA). Among CFMs, maximum likelihood and principal axis factoring with estimated communalities are popular. Due to their different purposes, CFMs and PCA models differ in how they conceptualize sources of variance in measured variables. Common factor models assume that factors are imperfectly reflected by the measured variables and differentiated between variance in measures due to the common factors (factors that influence more than one measure) and variance due to unique factors (factors that influence only one measure). PCA makes no such distinction, and the components therefore contain a mixture of common and unique variance (Rummel, 1970).

Methodologists have argued that PCA as a reasonable substitute for analysis of common factors. They have noted that PCA is much simpler in concept but generally produces similar results (Krishnan, 2010). According to the literature, PCA is regarded as projection techniques that can be used to handle multivariate data, that consist of many inter- related variables. The central concept of PCA is representation or summarization of multi-dimensional data system using lesser dimensional space. PCA replace a larger set of variables by a smaller set which best summarizes the larger set, by reducing the dimension of system. In PCA, it explains the variance covariance structure of the set of response variables through a new set of components which are linear combination of original response. Thus the main objective of the PCA is to find whether we can explain all the variation of the observed data with fewer uncorrelated variables and to visualize this uncorrelated plane in multi-dimensional space. However, one limitation of PCA is that it creates new artificial variables which may not be directly meaningful. Therefore, the researcher has to make these variables meaningful by giving them suitable names, in conclusion (Krishnan, 2010; Armstrong. 2008;Williams *et al.* 2012).

Krishnan (2010) has applied PCA in constructing an area-based socio-economic status index for mapping the childhood development in Canada. Further, Hiraishi *et al*. (1998) have used PCA in type analysis of the agriculture information system in Japan.

3.3.2 Application of Time Series Techniques in Forecasting Future Prices

A) Trend Pattern

The trend component accounts for the gradual shifting of time series to relatively higher or lower values over a long period of time. Trend is usually the result of long-term factors such as changes in the population, demographics, and technology or consumer preferences.

B) Seasonal Pattern

The seasonal component accounts for regular patterns of variability within certain time periods, such as in a year. Month to month price fluctuations may represent normal seasonal cycles which are determined by seasonal calendar, (harvest, lean season) particularly useful in a monitoring context to signal possible abnormalities in supply or demand.

C) Application of Smoothing Techniques

The objective of each of these methods is to "smooth out" the random fluctuations in the time series.

1. Moving Average

The moving averages method uses the average of the most recent data values in the time series as the forecast for the next period.

$$\text{Moving Average} = \frac{\Sigma\ (\text{Most recent } n \text{ data items})}{n}$$

2. Single Exponential Smoothing

Exponential smoothing is a weighted average technique of past time series values as a forecast, hence higher weight for the most recent observation is applied in this method. The weights for the other data values are computed automatically and become smaller as the observations move farther into the past.

Single exponential smoothing $A_{t+1} = \alpha Yt_{-1} + (1 - \alpha)\ A_t$

A_{t+1} = forecast of the time series for period $t + 1$

αYt_{-1}= actual value of the time series in period t

F_t = forecast of the time series for period t

α = smoothing constant ($0 \leq \alpha \leq 1$)

3. Double Exponential Smoothing

Current level estimate $A_t = \alpha Y_t + (1- \alpha) (A_{t-1} + T_{t-1})$

The trend estimate $T_t = \beta(A_t – A_{t-1}) + (1- \beta)T_{t-1}$

Forecast *p* periods into the future $Y'_{t+p} = A_t + pT_t$

Where,

A_t= new smoothed value (estimate of current level)

Y_t= new actual value at time *t*.

T_t = trend estimate

Y'_{t+p}= forecast for *p* periods into the future.

α= smoothing constant for the level ($0 \leq \alpha \leq 1$)

β= smoothing constant for trend estimate ($0 \leq \alpha \leq 1$)

4. Forecast Accuracy Measurements

Forecast accuracy measurements are used to determine how well a particular forecasting method is able to reproduce the observed time series data. By selecting the method that has the best accuracy, likelihood can increase in obtaining better forecasts for future time periods.

Forecast error = Actual value – forecasted value

4.1 Mean Absolute Percentage Error

MAPE (Mean Absolute Percentage Error) measures the accuracy of fitted time series values. It expresses accuracy as a percentage.

$$\text{MAPE} = \frac{\sum [(y_t - y_t')/ y_t]}{n} \times 100\%$$

Where, y_t is the actual value, y_t' is the fitted value and *n* is the number of observations

4.2 Mean Absolute Deviation

MAD (Mean Absolute Deviation) expresses accuracy in the same units as the data which helps conceptualize the amount of error.

$$\text{MAD} = \frac{\sum [y_t - y_t']}{n}$$

Where y_t is the actual value, y_t' is the fitted value and n is the number of observations.

4.3 Mean Squared Deviation

MSD (Mean Squared Deviation) is a more sensitive measure of an unusually large forecast error than MAD.

$$\text{MSD} = \frac{\sum [y_t - y_t']^2}{n}$$

Where y_t is the actual value, y_t' is the fitted value and n is the number of observations.

3.3.3 Price Fluctuation Analysis

A) Calculation of Coefficient of Variation (CV)

As the first step, standard deviation of the price series is calculated and then CV is calculated by dividing the standard deviation by mean/ average value.

$$\text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^{n}(xi - \bar{x})^2}{n - 1.}}$$

xi= Terms given in the data
$\bar{x}$ = Mean
n = Total number of terms

B) Calculation of Historical Fluctuation and Monthly Fluctuation Indices

Calculation of historical fluctuation and monthly fluctuation index were widely adopted techniques in measuring food price fluctuation (Von Ledebur and Schmitz, 2012; Dvir and Rogoff, 2009, cited in ECLAC/FAO/IICA, 2011).Therefore, this research applied the same technique of calculation of annualized fluctuations as the standard deviation of the logarithms of the price ratio is between pairs of successive periods (Months) for a given period of time (Year).

Price returns (R) correspond to the difference of the logarithms of prices and reflect the percentage deviation of prices for a time *t* at the price of the previous period *t*-1. (Von Ledebur and Schmitz, 2012).

$$\mathrm{R_t} \ = \ln\left(\frac{P_t}{P_t - 1}\right) \quad = \ln(P_t) - \ln(P_t - 1)$$

$P_t = \text{Monthly avarage price of month t}$
$P_t - 1 = \text{ Monthly avarage price of month t} - 1$
Based on monthly returns, the historical fluctuation (*s*) for a given year can be determined.

$$s = \sqrt{\frac{1}{12-1}\sum_{t=1}^{12}\left(ln\left(\frac{P_t}{P_{t-1}}\right) - \bar{R}\right)^2}$$

This fluctuation index refers only to the observed period length. To facilitate comparison, these values are annualized. Based on price returns of several months, the annualized fluctuation index as_j is calculated. It corresponds to the standard deviation of logarithmic price change within the year.

$$as_j = \sqrt{\frac{1}{11}\sum_{t=1}^{12}\left(ln\left(\frac{P_{j,t}}{P_{j,t-1}}\right) - \bar{R_J}\right)^2} * \sqrt{12}$$

$\bar{R}$ = arithmetic mean

As there are twelve months per year, $\sqrt{12}$ term is used to scale the standard deviation of the twelve months of the year.

CHAPTER FOUR

Results and Discussion

4.1 Introduction

This chapter presents the primary data on socio-economic background of the respondents, in all three selected districts, namely Badulla, Kandy, and Matale (Table 4.1), collected using a pre-tested questionnaire. Further, factors that are considered in crop selection were analyzed using PCA in this chapter.

4.2 Socio – Demographic Characteristics of the Midcountry Vegetable Farmers

4.2.1 District-wise Composition of the Sample

All the farmers in the sample have cultivated at least one type of midcountry vegetable, for commercial purpose, either in 2012/13 *Maha* season or 2013 *Yala* season, and sold the harvest at least once and obtained income. However, there were incidents of farmers having totally abandoned the cultivation due to spreading of disease or due to personal reasons such as illness or indebtedness and could not get any income from the cultivation. On the other hand, there were incidents which farmers delaying planting by one to one and half months, so that their cultivation had not reached the harvesting stage at the time of survey. As both these groups have taken the decision of cultivating' certain types of vegetables, this group also has been considered (N = 271) at the analysis of farmer decision making process, by applying the PCA (Chapter 4, Table 4.15).

Table 4.1: District-wise Composition of the Sample

District	Number of Farmers Selected	Percentage (%)
Badulla	85	35.0
Kandy	65	26.7
Matale	93	38.3
Total	243	100

Source: Field survey, 2013

4.2.2 Land Use Pattern of the Midcountry Vegetable Cultivation - *Yala* Season

Of the surveyed sample, 60 farmers in Badulla district (71% of the total number of farmers in the district), 58 farmers in Kandy district (89% of the total number of farmers in the district) and 67 farmers in Matale district (72% of the total number of farmers in the district) were engaged in vegetable cultivation in 2013 *Yala* season.

As the Table 4.2 illustrates, out of the farmers who cultivated vegetables in 2013 *Yala* season, majority (52%, 88% and 84% for Badulla, Kandy and Matale districts respectively) have utilized low land (paddy land) for vegetable cultivation. Further, use of paddy land for vegetable cultivation in Badulla district was comparatively lower than that of other two districts, due to use of paddy land for potato cultivation.

Table 4.2: Land Use Pattern of the Midcountry Vegetable Cultivation - 2013 *Yala* Season

District	Only in Highland		Only in Lowland		Both Highland and Lowland		Total	
	Number	%	Number	%	Number	%	Number	%
Badulla	21	35	32	53	7	12	60	100
Kandy	2	3	51	88	5	9	58	100
Matale	8	12	58	87	1	1	67	100

Source: Field survey, 2013

If potato marked a high price in the last season, more farmers are inclined to grow potato in the forthcoming season, expecting the same high market price, hence the extent of vegetable cultivation decreases accordingly, at the earlier stage of the season. After the uprooting of potato, they had normally opted for short duration vegetables, such as radish (Informal discussion with farmer leaders, ARDAs, DOs). On the other hand, some farmers in Badulla district have preferred mixed cropping of vegetable with potato and the most famous vegetable was beans in the mixed cropping lands (Figure 4.1 and 4.2).

Figure 4.1: Uprooting Potato in a Bean - Potato Mixed Cropping Land

Figure 4.2: Remaining Vines of Beans, after Uprooting *Potato*

Table 4.3: Land Use Pattern of the Midcountry Vegetable Cultivation – 2012/2013 *Maha* Season

District	Only in Highland		Only in Lowland		Both Highland and Lowland		Total	
	Number	%	Number	%	Number	%	Number	%
Badulla	26	50	16	31	10	19	52	100
Kandy	6	11	36	68	11	21	53	100
Matale	27	41	38	58	1	1	66	100

Source: Field survey, 2013

4.2.3 Land Use Pattern of the Midcountry Vegetable Cultivation *Maha* Season

Majority of farmers in all the districts, such as Kandy (N=53, 81.5% of the total number of farmers in the district), Badulla (N=52, 61% of the total number of farmers in the district) and Matale (N= 66, 71% of the total number of farmers in the district), have engaged in cultivation of vegetables, in the *Maha* season (Table 4.3). Among them, majority of farmers have utilized only low land for vegetable cultivation, even in the *Maha* season. However, as revealed in the discussions with farmers, around 90% of the farmers in Badulla and Kandy districts practiced paddy cultivation only for consumption purpose, and the remaining paddy fields were utilized for the vegetable cultivation, as it was more profitable than paddy.

4.2.4 Distribution of Midcountry Vegetable Farmers by Age

Distribution of midcountry vegetable famers by age is illustrated in Table 4.4. As it was revealed in the survey, the highest percentage of midcountry vegetable farmers (66.3%) belonged to 41- 60 years. The younger generation's (below age 40) involvement in agriculture was low as 12.7% of the total sample. Damayanthi and Rambodagedara (2013) found that full time involvement in agriculture by youth (age 15-29) was 39.5%, in Sri Lanka. However, among midcountry vegetable farmers, the youth involvement was considerably lower than that.

Table 4.4: Distribution of Midcountry Vegetable Farmers by Age

Source: Field survey, 2013

Age Categories	Badulla (%)	Kandy (%)	Matale (%)	Total (N =243) (%)
<40 year	16.4	9.2	11.8	12.7
41-60 year	71.7	67.7	60.2	66.3
>61 year	11.7	23	27.9	21.0
Total	100.0	100.0	100.0	100.0

4.2.5 Level of Education of the Sample Respondents

Among midcountry vegetable farmers, the literacy rate was 97.2 percent, while the highest literacy rate was recorded from Matale district (the value was exactly 100 percent) and the lowest literacy rate was reported from Badulla district as 95.3 (Table 4.5). On the other hand, the highest percentage of vegetable farmers (47.3%) has completed the education up to Grade 6 – 11. Similar findings have been obtained by Damayanthi and Rambodagedara (2013) in their research on factors affecting low youth participation small scale agriculture in Sri Lanka.

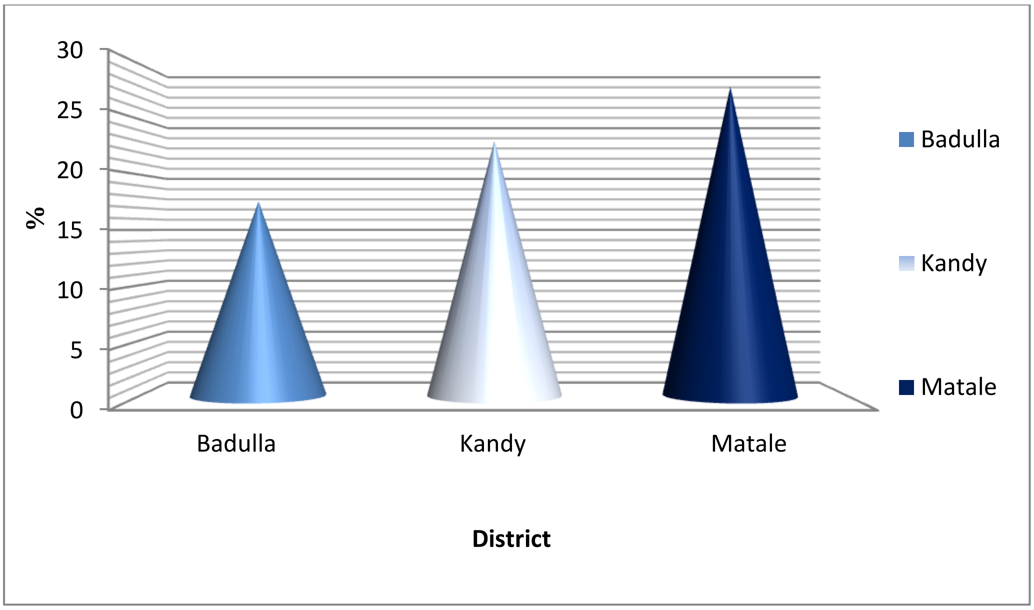
Table 4.5: Level of Education of the Sample Respondents

Level of Education	Badulla (%)	Kandy (%)	Matale (%)	Total (N=243) (%)
Illiterate	4.7	4.6	0.0	2.8
No formal education but literate	0.0	1.5	1.0	1.0
Grade 1-5	5.8	15.4	22.6	14.8
Grade 6-11	41.2	67.7	38.7	47.3
Passed O/L	37.6	10.8	26.8	26.3
Passed A/L	10.6	0.5	7.5	6.6
Undergraduate	0.0	0.0	1.0	0.4
Graduate or above	0.0	0.0	1.0	0.4
Diploma	0.0	0.0	1.0	0.4
Total	100.0	100.0	100.0	100.0

Source: Field survey, 2013

4.2.6 Engagement in Secondary Occupation among Midcountry Vegetable Farmers

The highest percentage of involvement in secondary occupation was reported in Matale (28%), followed by Kandy as 23.1% and Badulla 17.6%. On the other hand, 72% of the vegetable farmers in Matale district, 76.9% in Kandy, and 82.4% in Badulla district respectively, were full time farmers. The highest percentage of full time farmers were recorded from Badulla district (82.4%). This might be due to the high cropping intensities, practiced in the district.



Source: Field survey, 2013

Figure 4.3: Vegetable Farmers' Engagement in Secondary Occupation

Table 4.6: Distribution of Vegetable Farmers by Their Secondary Occupation

Secondary Occupation	Badulla %	Kandy %	Matale %	Grand Total %
Farming	40.0	20.0	15.4	23.2
Farming assistant	0.0	6.7	0.0	1.8
Livestock management	6.7	0.0	15.4	8.9
Agricultural labourer	0.0	0.0	3.9	1.8
Non- agricultural labourer	0.0	13.33	0.0	3.6
Government employee	6.7	0.0	7.7	5.4
Private employee	0.0	6.7	3.8	3.6
Self-Employment	26.7	0.0	19.2	16
Skilled labourer	0.0	6.7	7.7	5.4
Businessman	13.33	33.33	7.7	16
Other	6.7	13.33	19.2	14.3
Grand Total	100.0	100.0	100.0	100.0

Source: Field survey, 2013

Next to farming, both self - employment and business (16%) were the most popular types of secondary occupations among midcountry vegetable farmers. Further, engagement in livestock management (8.9%) was low, among vegetable farmers in midcountry districts.

4.2.7 Distribution of Total Land Extent under Vegetable Cultivation

Table 4.7: Distribution of Total Land Extent under Vegetable Cultivation

Total Land Extent (Ac)	Badulla (%)	Kandy (%)	Matale (%)	Total (N=243) (%)
<0.5	21.1	30.7	18.2	22.6
0.5 - 1	37.6	21.5	24.7	28.3
1-1.5	23.5	23.1	30.1	25.9
1.5-2	2.35	7.7	10.7	6.9
2-2.5	5.8	12.3	9.7	9.0
2.5-3	3.5	4.6	1.1	2.8
3-3.5	3.5	0.0	5.4	3.2
>3.5	2.3	0.0	0.0	0.8
Total	100.0	100.0	100.0	100.0

Source: Field survey, 2013

The highest percentage of farmers in Kandy district (30.7%) had the land extent less than 0.5Ac. On the other hand, the highest percentage of farmers in Badulla district (37.6%) cultivated vegetables in a land of 0.5-1Ac and the highest percentage of farmers in Matale district had cultivated vegetables in 0.1Ac -1.5 Ac of land. In line with the World Bank's Rural Development Strategy (2003) report, a small holder is defined as one with a low asset base and operating less than 2 hectares. Therefore, based on that definition, 99% of the surveyed vegetable farmers in midcountry area are smallholders, by land size. However, in the Sri Lankan context, if the land extent is less than 40 perches (0.10 Hectares, 0.25 Ac) and its agricultural produce is mainly targeting domestic consumption, such farming lands are considered as smallholders. Next**,** either land extent is more than 40 perches (0.10 Hectares, 0.25 Ac) or producing agricultural output mainly for commercial purpose, irrespective of the extent land is considered important for commercial scale farmers (Department of Census and Statistics, 2001). As only the commercial scale farmers were surveyed, apparently the latter definition is more appropriate for the midcountry vegetable farmers in Sri Lanka. Even though the operational holdings were small, farmers must have used more resources in order to continue the commercial scale production.

4.3 Sources of Seed

Table 4.8: Distribution of Respondents According to Source of Seed

Source	Badulla		Kandy		Matale		Total	
	Number	%	Number	%	Number	%	Number	%
Self produced	16	19	0	0	1	1	17	7
Purchased from farmers	4	5	0	0	1	1	5	2
Purchased from private dealers/ companies	57	67	59	91	81	87	197	81
Purchased from DOA	8	9	6	9	9	10	23	9
Purchased from FOs	0	0	0	0	1	1	1	0
Total	85	100	65	100	93	100	243	100

Source: Field survey, 2013

As revealed by the survey, 81% farmers in midcountry districts have used hybrid seed varieties purchased from private dealers/companies. Regarding tomato, *'Padma'* and *'Markis'* were the most popular hybrids imported from India. These varieties are developed with thick pericarp, to minimize damages and bruises in handling. According to farmers' views, these hybrid varieties produce not only a higher yield per harvest but also a prolonged harvesting duration. If weather interruptions did not occur, there were incidents that farmers obtained harvest for 12 – 14 rounds from the same plot. Regarding cabbage, the most popular hybrid varieties were *'Oxillus'* and *'Hercullis'.* Regarding beans, the most popular were pole - bean hybrid varieties were imported from Malaysia. Using of varieties released by the DOA was minimal due to low availability, low yield, high post-harvest losses in transportation and poor promotional campaigns.

4.4 Marketing of Vegetables

Keppetipola and Dambulla DECs were situated in Badulla and Matale districts respectively. As described in the Table 4.9, 67% farmers in Badulla district and 89% farmers in Matale district preferred to sell at the DECs situated in respective districts. However, farmers in Kandy district preferred to sell through mobile collectors, rather than selling at Katugastota wholesale market. This is due to comparatively minor scale of operation in Katugastota wholesale market compared to other two DECs.

This study found that 95 percent of farmers in Matale district sell their vegetables on spot cash at Dambulla DECs. However, only 11% farmers in Badulla district could obtain cash on the same day of sale, as Keppetipola DECs have mainly adopted the credit basis selling. Therefore, farmers who sell at Keppetipola DEC complained that they had to wait for 5-7 days to receive cash.

Table 4.9: Marketing of Vegetables

Ways of Marketing		Badulla		Matale		Kandy	
		No.	%	No.	%	No.	%
Economic centers	Keppetipola	67	78.82	-	-	-	-
	Dambulla	-	-	89	95.7		
Village outlet		3	3.53			10	15.3
Wholesale outlet		7	8.24	7	7.63	12	18.0
Mobile collectors		5	5.88	-	-	16	24.6
Direct marketing in road-side outlets		-	0.00	-	-	2	3.0
Colombo Manning market		3	3.53	-	-	15	23.0
Other		-	-	-	-	10	15.3
Total		85.0	100.0	93.0	100.0	65.0	100.0

Source: Field survey, 2013

4.5 Degree of Competitiveness in Vegetable Marketing

Table 4.10: Degree of Competitiveness in Vegetable Marketing

Competition	Badulla		Kandy		Matale		Total	
	No.	%	No.	%	No.	%	No.	%
Low (Always to a selected buyer)	51	60	27	42	39	42	117	48
High (No selected buyer)	34	40	38	58	54	58	126	52
Total	85	100	65	100	93	100	243	100

Source: Field survey, 2013

Majority of farmers in Badulla district (60%) have sold their products to a selected buyer all the time. According to the farmers credibility was the key reason for selling to a selected buyer. When delayed payment occurs frequently, farmers had to trust the dealer in the transactions. Out of 42 percent farmers who supplied to a selected buyer in Matale district, majority said they had received loans from the traders during the production period on the understanding that they will sell the harvest to those traders. However, there were no complaints about purchasing at lower prices than open market prices, by the dealers who supplied credit. Further, majority of farmers in the surveyed sample in three districts (52%) had no pre-determined buyer when selling their harvest.

4.6 Share of Income from Vegetable Farming of the Total Family Income

Table 4.11: Share of Income from Vegetable Farming of Total Family Income

Share of Income from Vegetable Farming	Badulla %	Matale %	Kandy %	Total %
More than 75%	25	35	44	34
50-75%	8	8	11	9
25-50%	20	9	13	14
Less than 25%	46	48	33	44
Total	100	100	100	100

Source: Field survey, 2013

As the Table 4.11 explains, 44% farmers in Kandy district, 35% farmers in Matale district and 25% farmers in Badulla district have obtained more than 75% of monthly family income through vegetable farming. Of the total sample, 43% have obtained more from 50% of family income through vegetable farming. However, Rupasena (1999) has conducted a research on production and marketing of vegetables in five districts, namely NuwaraEliya, Badulla, Kandy, Matale, Kurunegala and Anuradhapura and found different results. He pointed out that, income earned from vegetable farming had contributed as it is the major source of the income (>50% of the monthly family income) among 90% of surveyed farmers. Therefore, it shows that a share of income from vegetable farming had shown a decreasing trend over time.

4.7 Problems Related to Vegetable Cultivation and Marketing

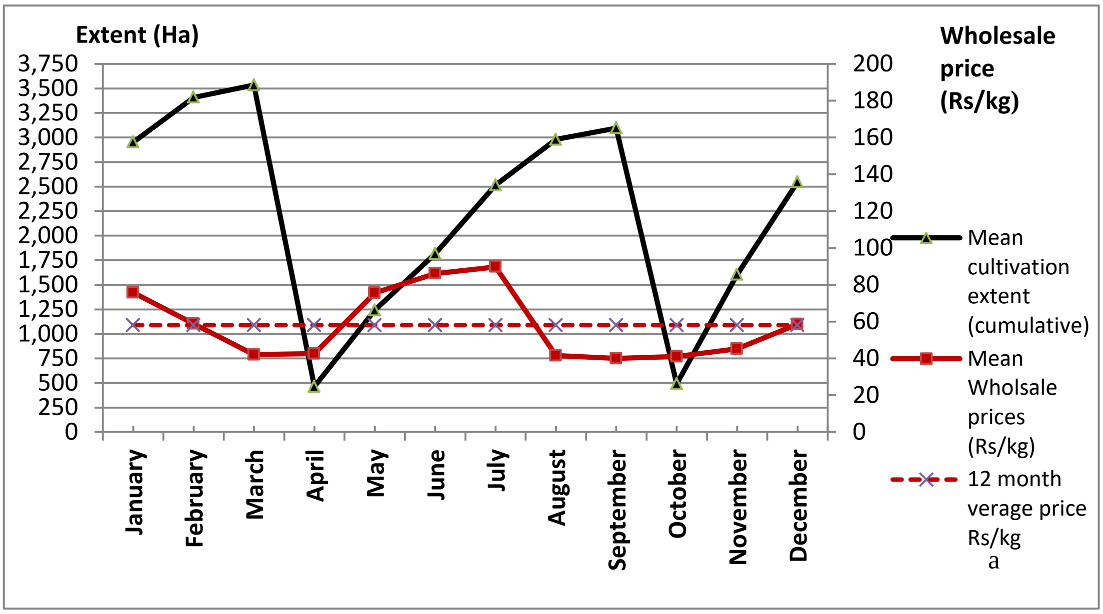
Table 4.12: Problems Related to Vegetable Cultivation and Marketing

Problem	Badulla District %	Matale District %	Kandy District %	Total (N=243) %
Difficulty of getting a fair price throughout the season	29	24	10	25.9
Ever increasing input cost	28	30	16	30.5
High price fluctuations	34	44	22	41.2
Scarcity of high quality inputs seeds at the beginning of the planting season	20	40	8	28.0
Low standards of the available inputs	17	6	9	13.2
Damages caused by animals	8	21	22	21.0
High frequency of pest and diseases	20	24	21	26.7
High occurrence of droughts	24	18	14	23.0
Insufficiency of the up-dated agricultural extension service	16	12	10	15.6

Note: Since multiple choice questions were asked, cumulative % can exceed 100%
Source: Field survey, 2013

As it is illustrated in Table 4.12, vegetable farmers in midcountry districts have encountered various obstacles related to both cultivation aspects as well as marketing aspects. Of the total number of responses given by vegetable farmers in the three selected districts, the highest percentage of farmers (41%) pointed out that high price fluctuation as the major obstacle they had to cope with in selling their vegetable harvest. Apparently even though majority of farmers in Matale district have access to Damabulla DEC, they also confront the problem of price fluctuation in the same manner as vegetable farmers in other districts. As the farmers further explained, tomato is the type of vegetable which suffered more in market price fluctuation than any other vegetable such as cabbage or beans. This is further confirmed in empirical studies of the pattern of price fluctuation in up country vegetables (Table 5.2). Since all the tomato fruits do not mature at the same time, harvest can be obtained from the tomato cultivation for 12-14 times in 3-5 day interval, during the crop life span, under preferable weather conditions. Generally, the peak harvest is reaped between 4^{th} to 7^{th}cycles of the harvesting, which occupies 70% of the total yield. According to the DOA, the yield from 1 Ac of land of tomato (over 70% of *Padma* variety - exotic hybrid) in Kandy and Badulla districts was 7.4mt and 6.7mt respectively (Department of Agriculture, 2012).

If the peak harvesting periods of major tomato producing districts coincided, it would produce around 70% of the of tomato production within a period of three weeks. As it was observed in 2012 and 2013, when the peak of the *Yala* cultivation was reached with 3, 125 ha of tomato in September, a price drop of more than 35% than annual average price was experienced (Figure 4.4).



Source: Compiled by the author based on data base of HARTI

Figure 4.4: Tomato Cultivated Extent vs. Price Behavior Mean Value for 2012-2013

The second most important obstacle faced by the vegetable farmers was, the ever increasing input cost. According to the vegetable farmers, the labour cost, cost of agrochemicals and seed cost have increased more than two fold during the last five years. The total cost of tomato cultivation in Badulla district in 2012 (excluding imputed cost), was Rs.92,136/ac which marked a 89% increase compared to 2006 value. However, if the cost of transport and marketing is incorporated into the cost of cultivation (Cost of production value), the study found that the total cost (excluding imputed cost) of production of tomato in Badulla district in 2013 was Rs.320,785.00 (Annex 6). Further, cost of cultivation (including imputed cost) of pole beans in Badulla district has increased by 1.5 fold in 2012 compared to 2006. The study further revealed the unit cost of production (including imputed cost) of tomato and beans in Badulla district (*Yala* season) in 2013 was Rs.36.95/Kg and Rs.43.59/Kg respectively. Therefore, whenever the price goes below this value, farmers were in danger of experiencing a net loss. Next, vegetable cultivators suffered from un-availability of high quality seeds (28%) onset of the season. As only the private sector is engaged in importing hybrid seeds, farmers had to buy whatever is available at the market as they have already shifted to cultivation of hybrid varieties than improved open pollinated varieties. On the other hand, farmers have encountered situations where the local venders and local agents of the importing companies engaging in adulterating of the seeds.

4.8 Measures Suggested by the Farmers to Overcome the Problems

Table 4.13: Measures Suggested by the Farmers to Overcome the Problems

Suggestions	Badulla District %	Matale District %	Kandy District %	Total (N=243) %
Establish a mechanism that enable farmers to get a stable and price	56	44	42	58
Enable farmers to get high quality input timely (seeds and fertilizer)	32	34	17	34
Increase access for water sources that enable off season cultivation	27	18	7	21
Take measures to reduce the ever increasing input cost	12	22	9	18
Provide updated technical advices in farming	13	22	1	15
Popularize disease resistant high yielding local varieties instead of imported hybrid seed varieties	8	4	10	10

Note: Since multiple choice questions were asked, cumulative % can exceed 100%
Source: Field survey 2013

As solutions for the above problems, majority of farmers (58%) have suggested to implement a price stabilization strategy through direct government intervention. However, farmers were not much clear about the way of implementing, as the considered commodities are perishable. Next, as mentioned in the problems section, inferior quality of the seeds has become high burden to the farmers. Therefore, 34% farmers have suggested guaranteeing the quality standard of the seeds, imported by the private sector agencies through government intervention. Next, 21% farmers have said that they are in need of irrigation facilities due to increased occurrence of droughts. Further, as explained by the Table 4.12 long term solutions for high incidence of crop and yield damage caused by animals (21%) has become a prior concern of all the vegetable farmers. Monkeys, wild boars, rabbits and peacocks have been identified as major pests causing a significant damage.

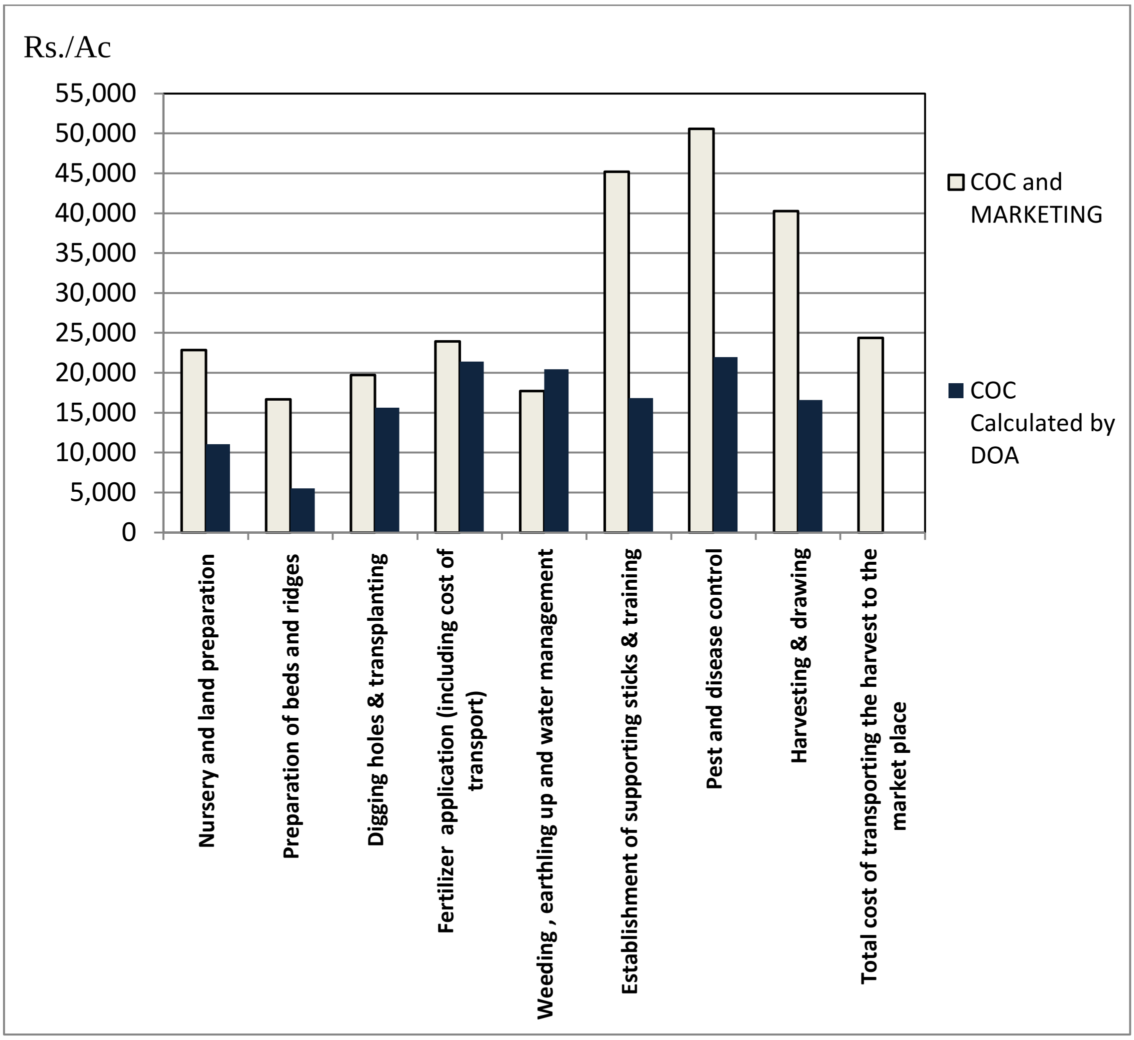
4.9 Cost of Cultivation and Marketing

It is needed to study the cost of cultivation and the return on selected vegetables so as to know the income earning capacity of the vegetable farmers. This section generally deals with examination of cost of cultivation of vegetable varieties of tomato and beans in Badulla, Kandy and Matale in 2013 *Yala* season. In certain studies, cost of cultivation is disaggregated in to crop cost, labour cost, land cost, machinery cost and livestock cost. However, the Department of Agriculture of Sri Lanka followed a slightly different procedure in calculating cost of cultivation. They have considered the total cost of cultivation as a combination of all inputs used in vegetable cultivation such as labour, power and machinery, seed, fertilizer and agro chemicals (pesticide, fungicides and weedicide) associated in different activities of vegetable farming. The labour input was calculated based on family and hired labour basis. Values of both own inputs (non cash costs, except value of land rent) as well as purchased inputs (cash costs) were taken into consideration and the imputed values were mentioned based on values of the purchased input.

However, the cost of cultivation (COC) calculated by DOA does not include marketing cost which comprised the cost of boxes or bags which are used to transport the final produce to the market place plus the transport cost. Therefore, in this study, transport cost is also included in calculation of cost of cultivation and marketing. Except the cost of marketing, the other components of cost of cultivation held almost similar to the components calculated by DOA. Further, the field data of the cost of cultivation and marketing of tomato - 2013 was compared with the cost of cultivation calculated by DOA-2012 (Figure 4.5 and Figure 4.6).

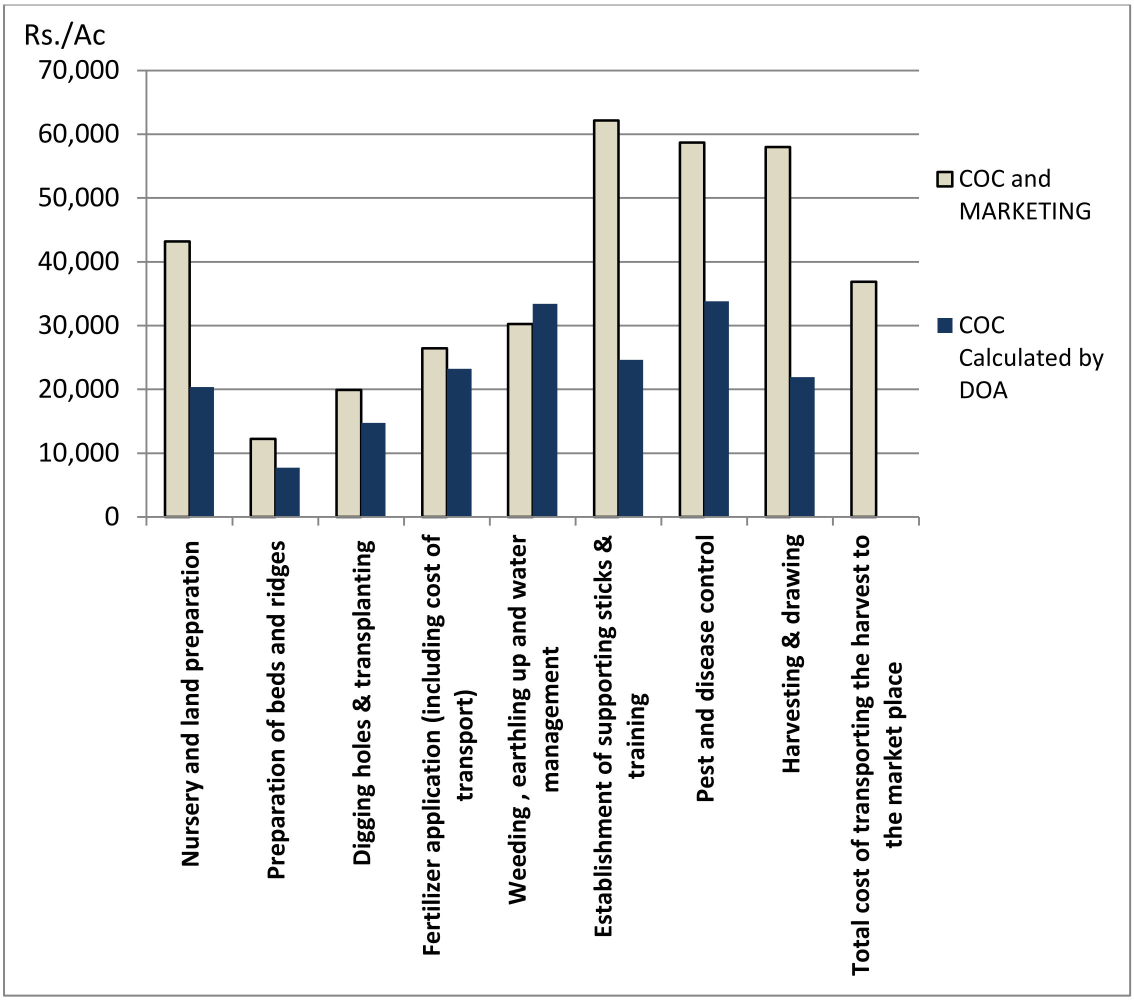
As the Figure 4.5 and Annex 5 indicated, the cost of harvesting, drawing and marketing of tomato was 31.6% of the total imputed cost of cultivation and marketing in Kandy district. At the same time, the cost of harvesting, drawing and marketing of tomato accounted for 37.8% of the total imputed cost of cultivation and marketing in Badulla district. Most of the vegetable cultivation in Kandy district is concentrated in Marassana and Thalathuoya DS divisions, while the vegetable cultivation is more or less evenly spread out in Badulla district. Therefore, farmers in distant villages in Badulla district had to bear a high transport cost compared to farmers in Kandy district. On the other hand, the highest gap between the values calculated by DOA and the COC & marketing was observed under the establishment of supporting sticks and training component which recorded Rs.28,327/Ac and Rs.37,514/Ac in Kandy and Badulla districts respectively. This is due to increasing labour cost, especially in the labour scarce period when the potato harvesting is practiced.

As Padmajani *et al* (2014) pointed out, overuse of pesticides was a common phenomenon observed among vegetable and potato farmers. Results of this study further emphasized the above finding as tomato farmers in Kandy and Badulla districts have spent more (Rs.28,596/Ac and Rs.24,891/Ac respectively) in application of pesticide, when compared to the findings of the DOA (2012).



Source: Field survey 2013

Figure 4.5: Cost of Cultivation and Marketing Tomato, Kandy



Source: Field survey 2013

Figure 4.6: Cost of Cultivation and Marketing Tomato, Badulla

4.10 An Analysis of Farmer Decision Making Process by Applying the Principal Component Analysis

All the variation in the observed data set (the factors influencing the farmer decision making) is summarized with fewer uncorrelated variables by applying PCA. Further it enabled visualization of uncorrelated planes in multi dimensional space.

In order to assess whether factor analysis is appropriate for the variables, Kaiser – Meyer – Olkin (KMO) measures of sample adequacy test and Bartlett's test of sphericity were carried out. The Bartlett's test of sphericity compares the correlation matrix with a matrix of zero correlations (technically called the identity matrix) zeros. The KMO test does not produce a *p* value but generally aiming for a value between 0.8 and 0.5. (Williams *et al.,* 2010)

Table 4.14: Results of KMO and Bartlett's Test

Test	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.670
Bartlett's Test of Sphericity	
Approx. Chi-Square	787.7
Df.	105
Sig.	.000

Note: N=271

As the Table 4.14 indicates, KMO value is above 0.5 for the selected variables. However, Bartlett's test of sphericity has an associated *P* value of less than 0.05. Therefore, from the above results, it was concluded that valid factor analysis can be performed with the data.

4.10.1 The Correlation Matrix

The first step of the factor analysis is the construction of correlation matrix. All factor analysis techniques try to bundle up sub groups of variables together based upon their correlations. Next, by observing the matrices, it can be determined whether a meaningful factor analysis is possible or not. As many statisticians suggests, if the correlation matrix has values more than 0.2 and less than 0.8, a meaningful factor analysis can be done.

Table 4.15: Correlation Matrix for the Variables

Variables	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*	*11.*	*12.*	*13.*	*14.*	*15.*
1.	1.000														
2.	.752*	1.000													
3.	.656*	.632*	1.000												
4.	.127	.096	.041	1.000											
5.	.038	.027	-.002	.010	1.000										
6.	.097	.198	.052	.155	.146	1.000									
7.	.108	.141	.104	.100	.130	.026	1.000								
8.	.216*	.208*	.172	-.035	.048	.127	.129	1.000							
9.	.045	.098	.096	-.089	.134	.033	.135	.092	1.000						
10.	.096	.098	.116	-.115	.149	.013	.233*	.149	.205*	1.000					
11.	.063	.046	.102	.129	.186	.117	.265*	-.066	.076	.149	1.000				
12.	.214*	.174	.187	-.018	.001	.147	.029	.277*	.143	.054	.088	1.000			
13.	-.052	.017	-.085	-.023	.073	-.021	.151	-.068	.070	.078	.075	-.150	1.000		
14.	-.056	.023	-.051	.001	.217*	-.064	.232*	.016	.142	.158	.075	-.195	.591*	1.000	
15.	.159	.206*	.171	.067	.183	.085	.058	.127	.082	.166	-.053	.157	-.009	.062	1.000

Source: Field survey, 2013

1. Last season's market prices of the cultivated vegetable
2. Last season's profit from the particular vegetable
3. Types which had higher market prices in the last season
4. Cultivating mixture of crops as a coping strategy of price fluctuation
5. Cost of production
6. Potential harvesting frequency
7. Disease resistance of the selected crop
8. Easy/low cost post harvest handling
9. Resistance to the climate change/variability
10. Ability of supplying alternative water sources
11. Influence of external parties (e.g AI, Government policy change, private seed/ agrochemical agents)
12. Influence of neighbour farmers
13. Personal preference
14. Past experiences
15. Availability of inputs

4.10.2 The Communalities Table

The communalities table (Table 4.16) shows the proportion of variance in each observed) variable, explained by all of the constructs. In the initial solution where the numbers of factors are equal to the number of observed variables, fifteen factors explain all of the variance in each of the observed variable.

Table 4.16: The Communalities Table

Variable	Initial	Extraction
1. Last season's market prices of the cultivated vegetable type	1.00	.813
2. Last season's profit from the particular vegetable	1.00	.804
3.Types which had higher market prices in the last season	1.00	.730
4. Cultivating mixture of crops as a coping strategy for price fluctuation	1.00	.563
5. Cost of production	1.00	.433
6. Potential harvesting frequency	1.00	.510
7. Disease resistance of the selected crop	1.00	.473
8. Easy/low cost post harvest handling	1.00	.382
9. Resistance to the climate change/variability	1.00	.368
10. Ability of supplying alternative water sources	1.00	.462
11.Influence of external parties (e.g.AI, government policy change, private seed/ agrochemical agents)	1.00	.712
12. Influence of neighbor farmers	1.00	.467
13. Personal preference	1.00	.660
14. Past experiences	1.00	.763
15. Availability of inputs	1.00	.494

Note: extraction method: principal component analysis.

Source: Calculated by the author

After extraction, smaller numbers of retained factors, lower proportions explained, of variance in each of the observed variable.

4.10.3 Total Variance Explained by the Extracted Factors

Table 4.17: Total Variance Explained by the Extracted Factors

Construct	Initial Eigen+Values		Extraction Sums of Squared Loadings		
	Total % of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.841	18.943	18.943	2.841	18.943
2	2.032	13.543	32.486	2.032	13.543
3	1.367	9.113	41.599	1.367	9.113
4	1.297	8.649	50.248	1.297	8.649
5	1.096	7.308	57.556*	1.096	7.308
6	.966	6.437	63.993		
7	.909	6.062	70.055		
8	.835	5.563	75.619		
9	.769	5.124	80.742		
10	.749	4.994	85.736		
11	.641	4.271	90.007		
12	.541	3.606	93.613		
13	.382	2.549	96.162		
14	.350	2.331	98.493		
15	.226	1.507	100.00		

Note: Extraction method: Principal component analysis
* Total variance explained by extracted factors.
Source: Calculated by the author

In PCA, it is regarded that the total variance (in all observed variables) is as equal as the number of observed variables in the analysis (15 in this case).

The Initial Eigen values present information about the Eigen values for all of the factors in the initial solution, while the extraction sums of squared loadings present the same information, only for the factors retained after extraction.

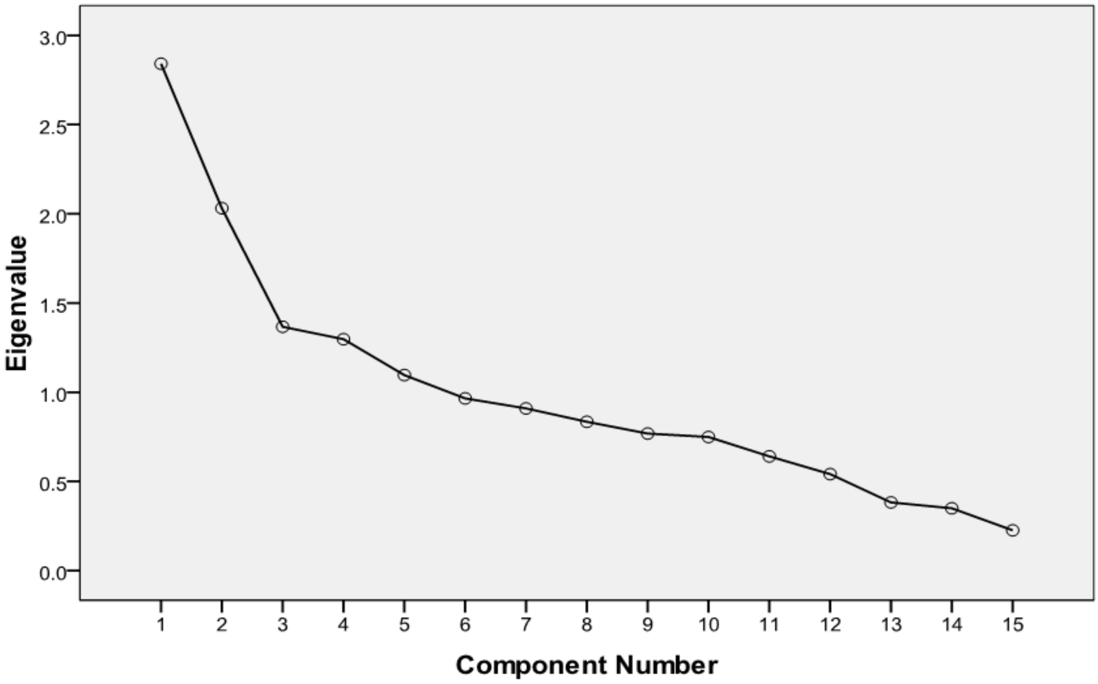
The Eigen values show the amount of variance (out of the total variance) explained by each factor.

In this case, (Table 4.17) five factors were retained after extraction (using the default cutoff criterion for extraction: Eigen values over 1), and the extracted factors explained approximately 57% of the total variance in the eight observed variables. The remaining factors from the initial solution had Eigen values smaller than 1, and were not regarded for the final factor analysis solution.

4.10.4 Application of Scree Plot Diagram in Factor Extraction

The scree plot can be used as an alternative criterion for determining the number of factors to retain after extraction. In this case, the scree plot suggests that a three factor solution is appropriate, thus the first and most prominent 'elbow' occurs at the fourth component, and the rest of the components placed above the elbow can be retained (figure 4.4). However, there a second 'elbow' at fourth factor and third 'elbow' occurs at fifth factor.

The two criteria for determining the number of factors to be extracted (the 'Eigen values over 1 and the 'elbow rule') will not always suggest the same number of factors to extract. In such cases, it should be decided theoretically and based on the results of a preliminary factor analysis, the number of factors to be extracted should be determined.



Source: Developed using SPSS 20by the author

Figure 4.7: The Scree Plot Diagram

The main objective of the research is to capture the highest number of factors which might affect the farmer decision making. On the other hand, if three factors are selected, it will explain less than 50% of the total variance (41.6% of total variance). Therefore, five factors with more than one Eigen value were selected.

4.10.5 Un-rotated Factor Loadings

The un - rotated factor loading is presented in Table 4.18. These values indicate comparatively high loading values for following constructs: last season's market prices of the cultivated types, last season's profit from the particular type and types which had higher market prices in the last season, under component 1. Then, comparatively high loading values were observed for the constructs: cost of production and potential harvesting frequency under component 2. Under component 3, none of the constructs showed a loading value more than 0.5. Under the component 4, constructs such as influence of neighbour farmers, personal preference and past experiences showed loading values over 0.5. Under component 5, the construct identified as availability of inputs has given higher loading values.

4.10.6 Rotated Component Matrix

The interpretability of factors can be improved with factor rotation. Rotation maximizes the loading of each variable on one of the extracted factors, while minimizing the loading on all the other factors. If the factors are assumed to be independent, one of the orthogonal rotation methods out of varimax, quartimax or equimax should be applied. As this research assumes independence of the factors, varimax rotation is applied. The results are presented in presented in Table 4.18.

As it is illustrated in Table 4.19, interpretability of factors has improved with factor rotation. As the loading values were improved, 0.6 is regarded as cut off value in the rotated factor loading matrix.

Table 4.18: Un-rotated Factor Loadings

Variable	Component				
	1	2	3	4	5
1. Last season's market prices of the cultivated vegetable	.821*	-.119	-.324		
2. Last season's profit from the particular vegetable	.812*	-.203	-.320		
3.Types which had higher market prices in the last season	.760*	-.188	-.263	-.150	-.156
4. Cultivating mixture of types as a coping strategy for price fluctuation	.422		.370	-.189	.171
5. Cost of production		.790*	-.254	-.179	.202
6. Potential harvesting frequency		.691*	-.355	-.165	.170
7. Disease resistance of the selected type	.317	.478		.183	-.332
8. Easy/low cost post harvest handling	.190	.428	.270	.258	.273
9. Resistance to the climate change/variability	.309	.397	.353	-.190	-.221
10. Ability of supplying alternative water sources	.409	-.246	.485		
11. Influence of external parties (E.g AI, government policy change, private seed/agrochemical agents)	.253	.309	.381	-.196	-.157
12. Influence of neighbour farmers	.143		-.313	.639*	.190
13. Personal preference	.212	.322		.554*	-.503
14. Past experiences	.282		.184	.517*	.358
15. Availability of inputs	.377		.221		.540*

Note: Extraction method: Principal component analysis.
Eigen value less than 0.1 are suppressed
*indicates the loading values more than 0.5

Source : Calculated by the author

Table 4.19: Rotated Factor Loadings

Variable	Component Matrix				
	Component				
	1	2	3	4	5
1. Last season's market prices of the cultivated vegetable	.896*				
2.Last season's profit from the particular vegetable	.884*			.139	
3. Types which had higher market prices in the last season	.840*		0.102		
4.Cultivating a mixture of crops as a coping strategy of price fluctuation			-.555	.378	.302
5. Cost of production		.212	.196	.547	.198
6.Potential harvesting frequency	.192	-1.50	-.146	.661*	.145
7. Disease resistance of the selected crop		.224	.260		.577
8. Easy/low cost post harvest handling		-1.54	.428	.301	-.167
9. Resistance to the climate change/variability	.143		.581		.145
10. Ability of supplying alternative water sources	.238	.120	.620*		.235
11. Influence of external parties (e.g AI, Government policy change, private seed/ agrochemical agents)					.839*
12.Influence of neighbor Farmers	.196	-4.76	.357	.273	
13. Personal preference	-.104	.849*			
14. Past experiences		.809*	.160	.104	-.278
15. Availability of inputs	.140		.211	.571	

Note: Extraction Method: Principal component analysis.
Rotation method: varimax with Kaiser normalization
Eigen value less than 0.1 are suppressed
* indicates the loading values more than 0.6

Source : Calculated by the author

The rotated factor loading indicated comparatively high loading values for following constructs: last season's market prices of the cultivated type, last seasons' profit from the particular type, types that had higher market prices in the last season, which are coming under component 1. Next, comparatively high loading values were observed for the constructs: cost of production and potential harvesting frequency were obtained under component 2. Under component 3, the construct that gave the highest loading value (more than 0.6)was disease resistance of the selected crop. Under the component 4, influence of the external agents showed loading values over 0.6. Under component 5, two constructs: availability of inputs and personal preference gave higher loading values.

This shows that the extracted five components are unrelated and they represent different planes in the multi-dimensional space.

By observing rotated component apparently the last season's market prices of the cultivated crop, last season's profit from the particular crop and crops which had higher market prices in the previous season have come under one component which can be named as 'Price expectation based on previous season's price'.

Next, personal preference and past experience have come under another component which can be called as 'Individual preference'.

The third component which vegetable farmers paid much attention to in crop selection was 'Water availability'.

Further, 'Potential harvesting frequency' had given more loadings under the forth component.

The last component was the influence of external parties (e.g AI, Government policy change, private seed/ agrochemical agents)

However, the constructs namely cultivating mixture of crops as a coping strategy of price fluctuation, cost of production, disease resistance of the selected crop, easy/low cost post-harvest handling, resistance to the climate change/variability, influence of neighbour farmers and availability of inputs did not show a comparative high loading on any of the factors.

Therefore, it can be concluded that price expectation based on previous season's price, individual preference, water availability, potential harvesting frequency and influence of external parties as the main factors which affected the farmer decision making in vegetable crop selection.

CHAPTER FIVE

Selecting the Best Fitted Method to Predict the Wholesale Prices

5.1 Introduction

A time series is a sequence of observations on a variable measured at successive points in time or over successive periods of time. First step to identify the underlying pattern in the data set was constructing a time series plot, a graphical presentation of the relationship between time on the horizontal axis and the time series values are shown on the vertical axis. Next, different patterns existing in the data set was identified, by applying different time series techniques.

5.2 The Pattern of Price Fluctuation in Up Country Vegetables

Coefficient of Variation (CV) is considered one of the primary measures of price fluctuation (Kumar *et al*, 2005).CV is defined as the ratio of a population's standard deviation to its mean. Table 5.1 summaries coefficients of variations (CV) of the monthly wholesale prices of upcountry vegetables grown in Sri Lanka from 2002 to 2012. Comparing coefficients of variations, it is evident that tomato marked the highest CV value for five times out of considered eleven year time period, followed by cabbage which hit the highest value for four times. Further, beans had the lowest CV value for six times out of considered eleven year time period. Therefore, in this research, more focus was given to the midcountry districts which had the highest extent of production of tomato, cabbage and beans.

Table 5.1: Coefficients of Variation (%) of the Monthly Wholesale Prices of Up-Country Vegetables

Type	2002 %	2003 %	2004 %	2005 %	2006 %	2007 %	2008 %	2009 %	2010 %	2011 %	2012 %
Beans	17.0	20.1	20.2	22.5	28.6	23.4	12.9	24.4	13.1	33.2	43.0
Carrot	36.7	37.9	38.8	30.2	31.2	32.9	48.1	22.5	*40.5	45.8	48.6
Leeks	30.9	16.7	30.0	25.1	20.9	26.0	16.9	33.8	23.4	65.4	33.4
Beetroot	37.7	28.3	38.1	*45.3	30.3	61.0	31.9	32.5	38.7	57.6	28.0
Knolkhol	26.9	28.2	35.2	30.6	44.6	46.5	31.5	21.9	22.6	44.4	39.0
Radish	37.5	29.6	40.4	16.3	45.6	30.5	43.8	18.3	15.9	44.5	52.4
Cabbage	*40.3	*44.7	39.9	25.9	34.8	*65.7	*55.7	28.3	18.1	54.0	49.7
Tomatoes	32.2	23.4	*46.2	40.9	*69.7	42.4	50.7	*46.8	28.3	*76.4	*62.3

Note :* indicates the highest value for each year
Source: Compiled by the author based on HARTI database (2002-2012)

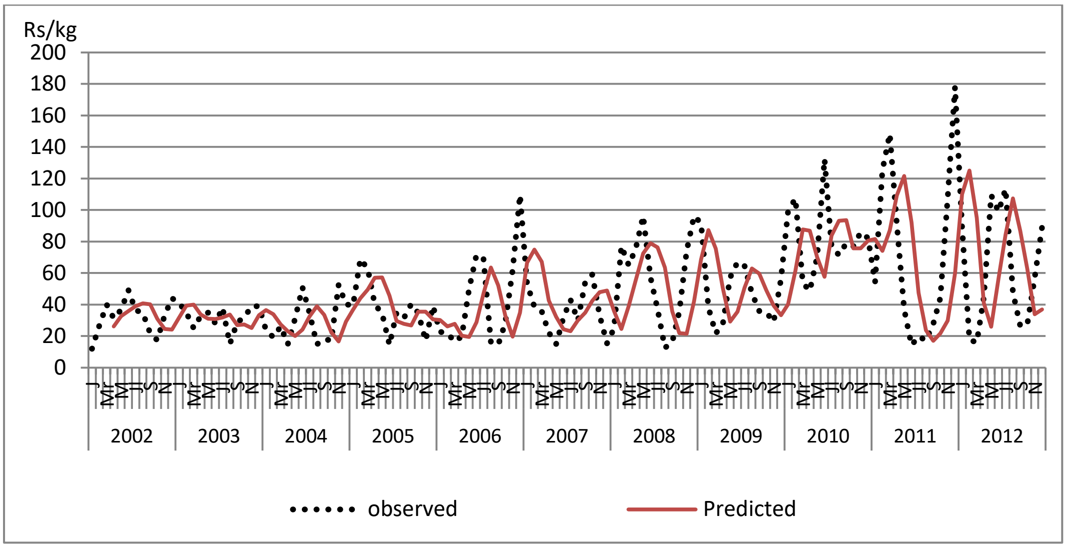
5.3 Selecting Best Fitted Method to Forecast the Wholesale Prices

5.3.1 Trend Analysis

Even though time series data generally exhibits random fluctuations, a time series may also show gradual shifts or movements to relatively higher or lower values over a longer period of time. If a time series plot exhibits this type of behavior, it is identified as a trend pattern. Linear regression analysis was generally applied for trend forecasting of the time series data. The behavior of monthly wholesale prices of tomato, beans and cabbage, from year 2000 to year 2012 was calculated and the linear trend line equations were estimated. The estimated linear trend line equations were $y = 0.377x + 22.88$ ($R^2 = 0.216$, $P \leq 0.05$),$y = 0.568x + 26.38$ ($R^2 = 0.539$, $P \leq 0.05$) and $y = 0.290x + 10.58$ ($R^2 = 0.364$, $P \leq 0.05$) for tomato, beans and cabbage respectively (Annex 4). The forecast values were obtained by applying the trend line equation and the forecast error was determined by subtracting each forecast value from observed value. Next, accuracy of the selected forecasting methods was evaluated based on Mean absolute percentage error (MAPE), Mean absolute deviation (MAD) and Mean squared deviation (MSD) and the best fitted method was selected. For all three measures, the smaller the value, the better the fit of the model is. The obtained MAPE, MAD and MSD values for the fitted linear trend line were summarized in Table 5.2. As it was revealed in the trend line equations, less than 50% of the price variation was explained by the linear upward trend line equations ($R^2 < 0.5$) in relation to wholesale prices of all the selected vegetables. Therefore, it was necessary to select alternative methods which can capture more variation in order to increase the predictability.

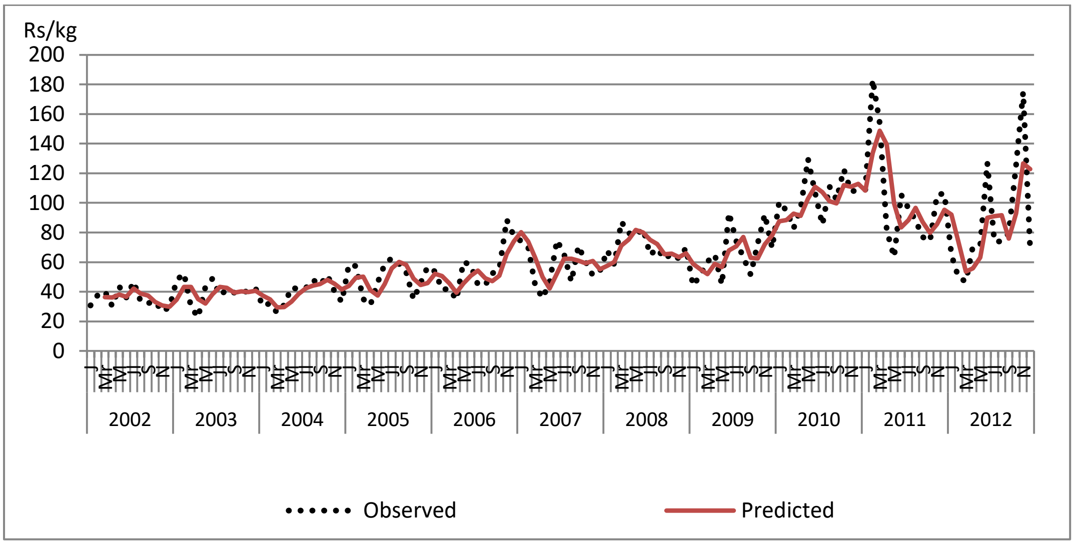
5.3.2 Application of Smoothing Techniques in Forecasting

Smoothing of time series data is carried out in order to eliminate some of the short-term fluctuations and to understand the general pattern of variation of the data over considered time period. Moving averages are used for reducing the variability of the observed series and to forecast the future values. Single moving average is the simplest of moving average techniques. Three year single moving average of the tomato, beans, and cabbage wholesale prices (Figure 5.1, 5.2 and 5.3) were calculated and the error term was evaluated calculating MAPE MAD and MSD values (Table 5.2).



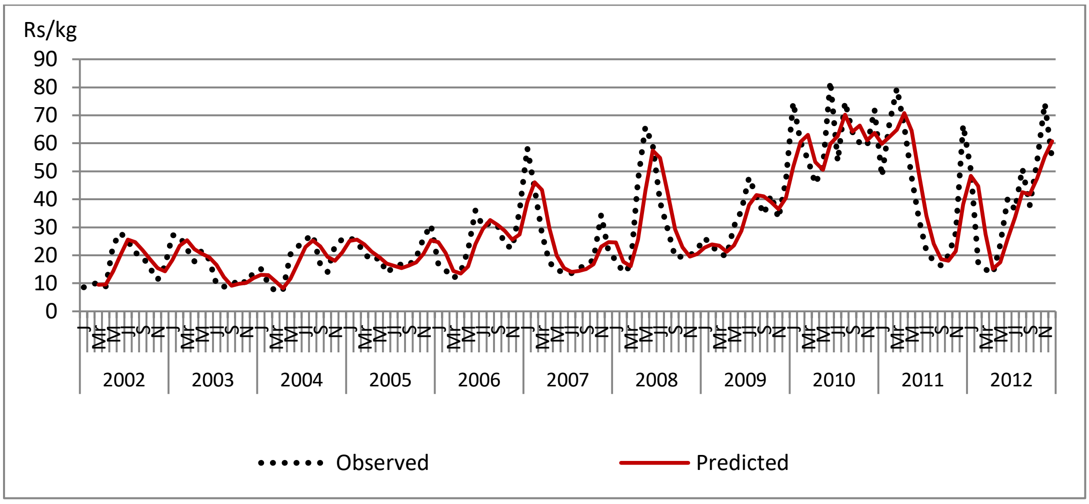
Source: Produced by the author based on HARTI database (2002-2012)

Figure 5.1: Three Year Moving Average Wholesale Prices of Tomato



Source: Produced by the author based on HARTI database (2002-2012)

Figure 5.2: Three Year Moving Average Wholesale Prices of Beans



Source: Produced by the author based on HARTI database (2002-2012)

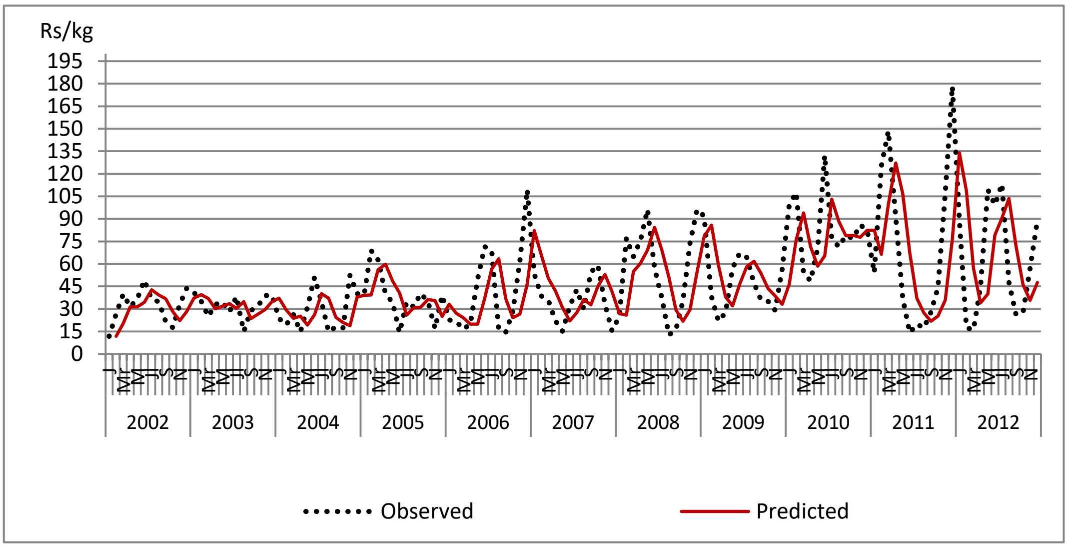
Figure 5.3: Three Year Moving Average Wholesale Prices of Cabbage

However, the single moving average method is generally regarded as best suited for a data set, which does not exhibit trend. As *ANOVA* is significant (Annex 4) for the estimated upward trend lines for tomato, cabbage and beans wholesale prices, it can be concluded that original data exhibit an upward trend. Therefore, single exponential smoothing method is applied as the next step of forecasting.

Single exponential smoothing $A_{t+1} = \alpha Yt_{-1} + (1 – \alpha) A_t$

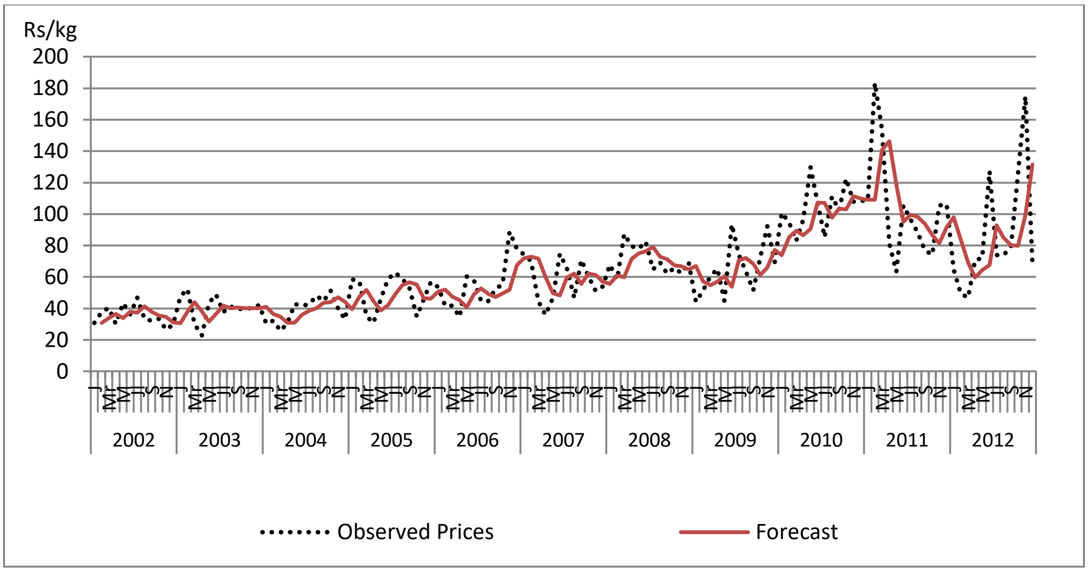
A_{t+1} = forecast of the time series for period $t + 1$
αYt_{-1} = actual value of the time series in period t
F_t = forecast of the time series for period t
α = smoothing constant ($0 \leq \alpha \leq 1$)

As the next step, the predicted values of tomato, beans and cabbage wholesale prices were calculated applying single exponential smoothing method (Figure 5.4, 5.5 and 5.6) and the error term was evaluated calculating MAPE MAD and MSD values, (Table 5.1). The results was optimized by calculating the optimum alpha level, which gives minimum MAPE MAD and MSD values of the single exponential smoothing function.



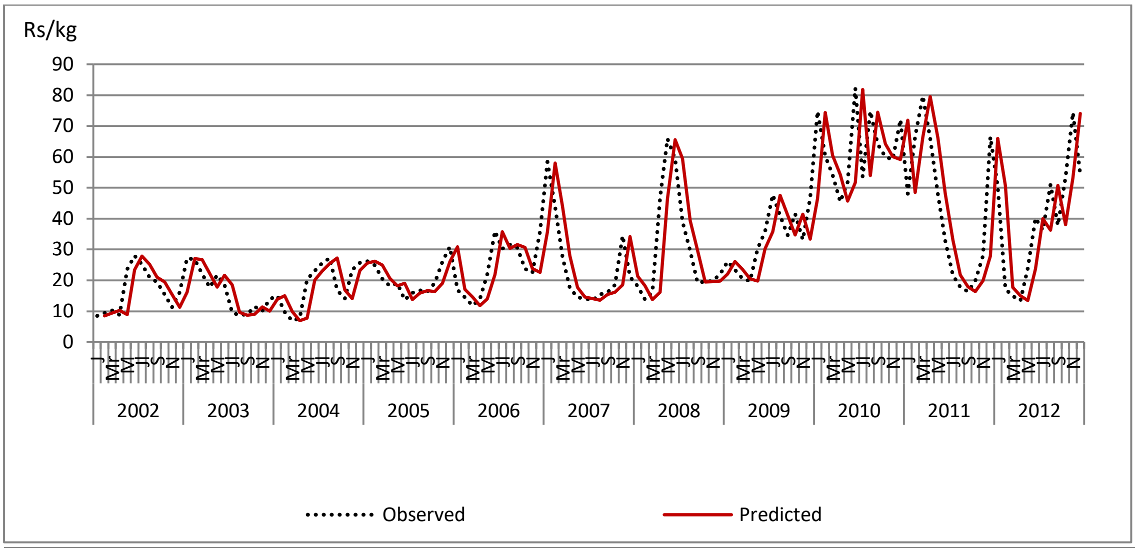
Source: Produced by the author based on HARTI database (2002-2012)

Figure 5.4: Single Exponential Smoothing Method (at alpha level 0.105) - Wholesale Prices of Tomato.



Source: Produced by the author based on HARTI database (2002-2012)

Figure 5.5: Single Exponential Smoothing Method (at alpha level 0.425) - Wholesale Prices of Beans



Source: Produced by the author based on HARTI database (2002-2012)

Figure 5.6: Single Exponential Smoothing Method (at alpha level 0.99) - Wholesale Prices of Cabbage

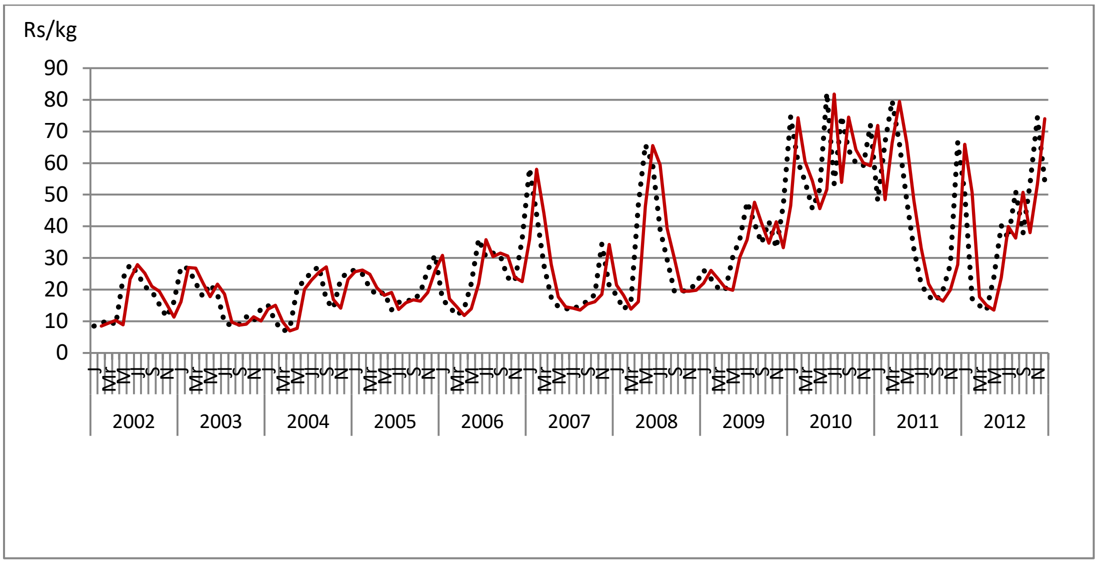
The results were optimized by calculating the optimum alpha level, which give minimum MAPE MAD and MSD values of the single exponential smoothing function. (Table 5.2)

Single exponential smoothing is further developed by incorporating trend effects and developed the double exponential smoothing techniques. As there is an upward trend, current slope and the current level is estimated at each and every point.

Current level estimate = $A_t = \alpha Y_t + (1-\alpha)(A_{t-1} + T_{t-1})$
The trend estimate = $T_t = \beta(A_t - A_{t-1}) + (1-\beta)T_{t-1}$
Forecast *p* periods into the future = $Y'_{t+p} = A_t + pT_t$

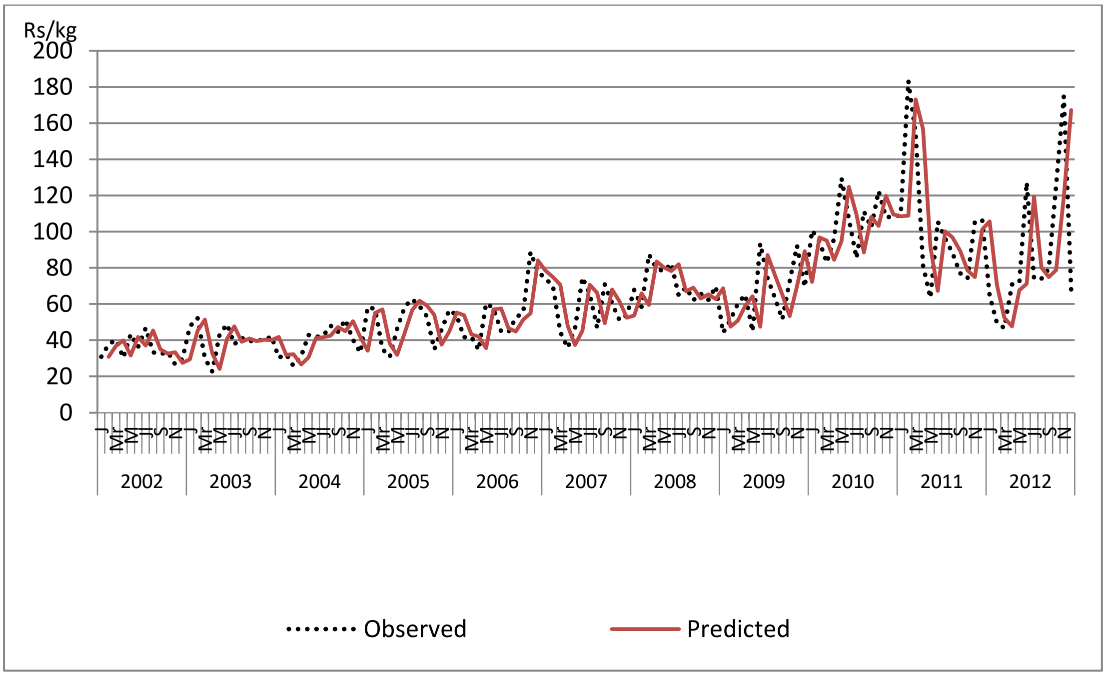
where
A_t = new smoothed value (estimate of current level)
Y_t= new actual value at time *t*.
T_t= trend estimate
Y'_{t+p} = forecast for *p* periods into the future.
α= smoothing constant for the level ($0 \leq \alpha \leq 1$)
β= smoothing constant for trend estimate ($0 \leq \alpha \leq 1$)

The predicted values of the tomato wholesale prices were calculated applying double exponential smoothing method, (figure 5.7) and the result was optimized by calculating the optimum alpha and beta level, which gives minimum MAPE MAD and MSD values of the double exponential smoothing function.



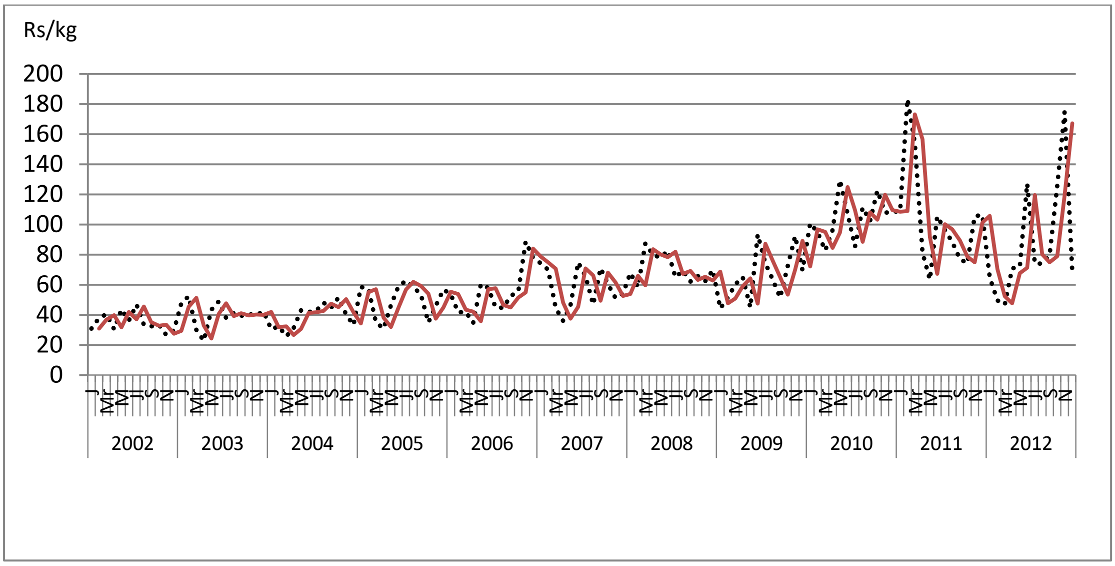
Source: Produced by the author based on HARTI database (2002-2012)

Figure 5.7: Double Exponential Smoothing Method (Alpha at 0.99 and Beta at 0.033) - Wholesale Prices of Tomato



Source: Produced by the author based on HARTI database (2002-2012)

Figure 5.8: Double Exponential Smoothing Method (at Alpha Level 0.395 and Beta Level 0.062) Wholesale Prices of Beans.



Source: Produced by the author based on HARTI database (2002-2012)

Figure 5.9: Double Exponential Smoothing Method (at alpha level 0.982 and Beta at 0.010) Wholesale Prices of Cabbage.

Likewise, the trend analysis, three year moving average, single exponential smoothing and double exponential smoothing techniques were applied to select the best fitted method for forecasting the beans and cabbage wholesales prices. (Table 5.2)

Table 5.2: Summary Table - Application of Time Series Analysis Techniques

	Trend Analysis	Three Year Moving Average	Single Exponential Smoothing	Double Exponential Smoothing
Tomato Prices				
MAPE	62.60	70.51	59.5	53.8*
MAD	20.95	25.18	21.41	20.81*
MSD	750.61	1169.56	821.4	795.8*
Beans Prices				
MAPE	22.803	23.332	21.13*	24.74
MAD	14.276	14.658	12.95*	14.44
MSD	400.429	464.231	363.03*	426.72
Cabbage Prices				
MAPE	47.543	36.99	26.04*	27.0
MAD	11.447	9.89	7.93*	8.19
MSD	212.941	182.26	124.39*	128.71

Note : The lowest combination of MAPE, MAD and MSD values are highlighted
Source: Produced by the author

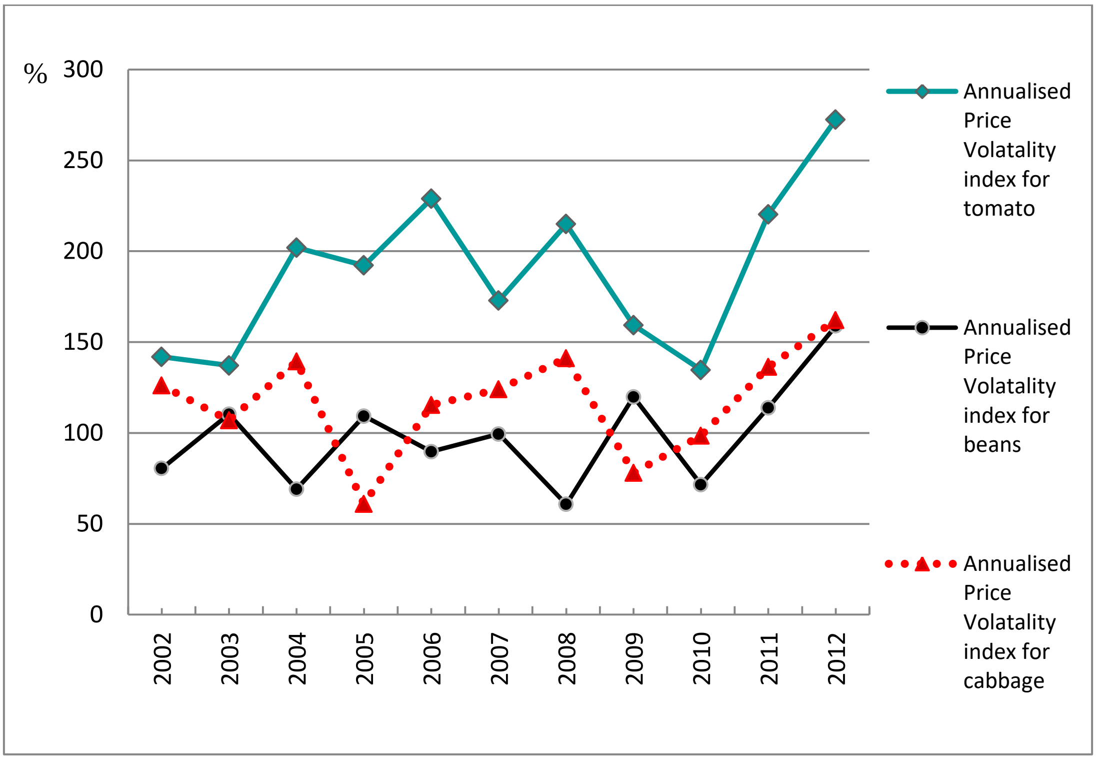
Accuracy of the selected forecasting methods was evaluated based on Mean absolute percentage error (MAPE), Mean absolute deviation (MAD) and Mean squared deviation (MSD). For all three measures, the smaller the value, the better the fit of the model is.

Before selecting a suitable accuracy measure in comparing wholesale price data of selected vegetables, the inherent advantages and disadvantages of each accuracy measure need to be considered. The MSD, as the name implies squares and subsequently averages the various errors. Such squaring gives considerably more weight to large errors than smaller ones. Therefore, some researchers argued that (Chatfield, 1988) MSD alone is not to be considered as appropriate in forecasting accuracy measurements as few large observations can dominate the measurement.

On the other hand, a conceptually easier way to understand measure of goodness of fit is Mean Absolute Deviation. The MAD is the mean of the absolute value of the deviation between each model prediction and its corresponding data point. One advantage of the measure is that it provides a value that is easy to understand. For example, a model fit with a MAD of 10.5 units means that the model's predictions were off from the data on average by 10.5 units. Unlike MSD, both MAD and MAPE place equal weightage on all deviations. Since these measures are not of quadratic nature, like the MSD, these are influenced less by outliers. However, Mean Absolute Percentage Error (MAPE) has the advantage of being scale - independent and is frequently used to compare forecast performance between different data sets. Another advantage of this measure is that it provides a value that is very easy to understand. A disadvantage of the MAPE is that it is relevant only for ratio-scaled data (i.e., data should have a meaningful zero) (Makridakis and Hibon, 1995). In this research, only ratio scale data is compared (prices are considered as ratio scale) across different models. Therefore, we have selected MAPE as the main decisive criteria in selecting best fitted method in predicting the behaviour of wholesale prices in selected vegetables.

As the Table 5.2 explains, in all the instances, combination of smallest values for all accuracy measures MAPE, MAD and MSD were observed related to a particular single technique. Therefore, it was concluded that, Double Exponential Smoothing is the best fitted technique in forecasting the wholesale prices of tomato whilst Single Exponential Smoothing was more appropriate in forecasting the wholesale prices of cabbage and long beans.

5.4 Calculation of Annualized Volatility Indices



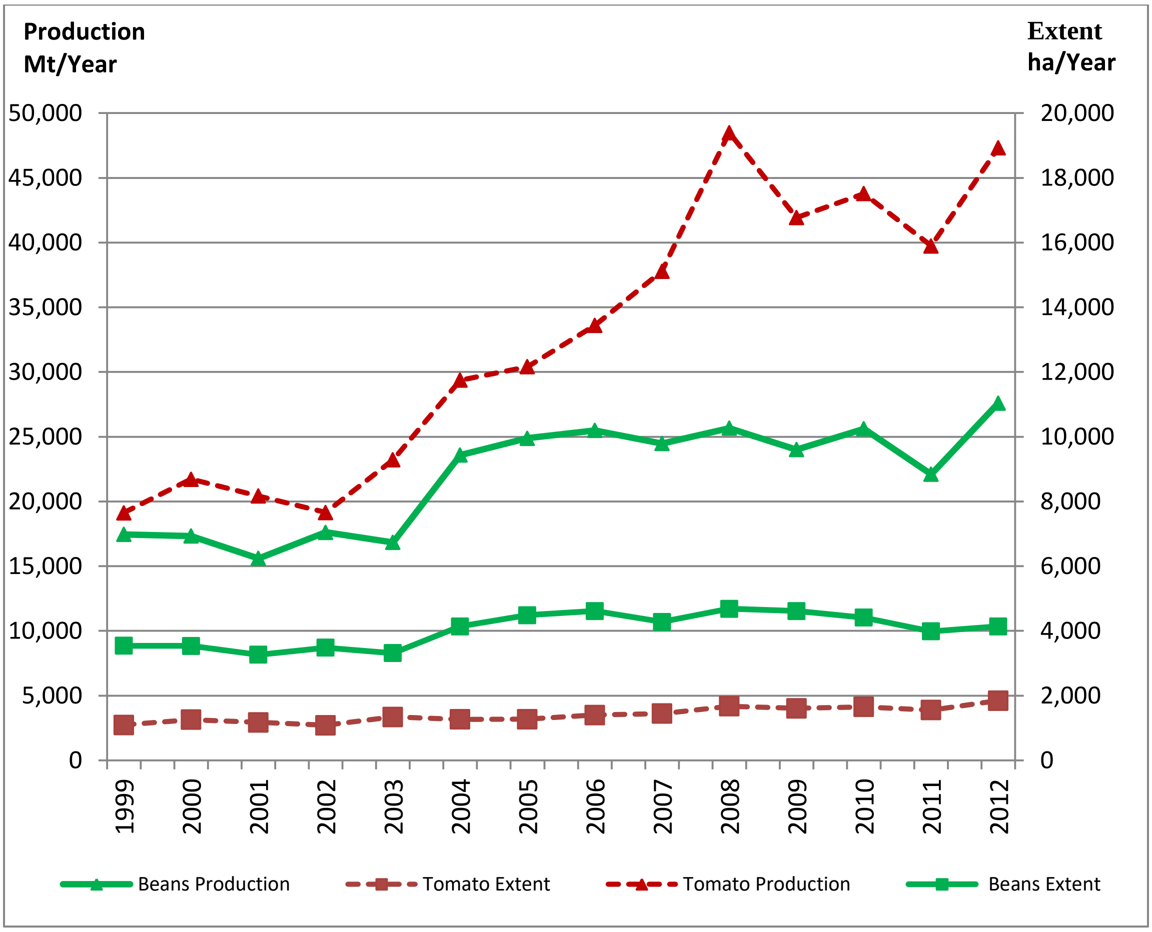
Source: Produced by the author

Figure 5.10: Annualized Volatility Indices Wholesale Price Behaviour of Three Selected Upcountry Vegetables

As it is described in chapter 5, (5.2) annualized volatility indices were calculated in explaining the wholesale price behaviour of three selected upcountry vegetables namely tomato, beans and cabbage which marked the highest CV % of the monthly wholesale prices and for the beans which marked the lowest CV % of the monthly wholesale prices. Historical volatility was calculated as the standard deviation of the logarithms of the price ratio between pairs of successive periods (Months) for a given period of time (Year). As it is depicted in Figure 5.10, the highest volatility index throughout the considered eleven year time period was recorded for tomato. On the other hand, it marked the all time highest value of 272.43% in 2012. The second highest volatility index was reported for cabbage and it also marked the highest value of 162% in 2012. Even though the lowest price fluctuation index throughout the period was reported for beans, it also followed the same pattern by marking the highest ever value in 2012. It was evident that price fluctuation has followed an increasing trend during 2010 to 2012 period.

Many researchers have calculated annualized fluctuation indices to describe the price movement in relation to the staple food items such as wheat, rice and maize and the obtained values were considerably lower than our values. As described in ECLAC/FAO/IICA. 2011, the recorded price volatility indices in cereal such as wheat, rice and maize in the international market was in a range of 4% - 17%, during the period of 1999-2010. However, the volatility of tropical food items such as coffee, banana and sugar reported much higher volatility indices than cereals, ranged between 10% - 22.5% during the period of 1999-2010.

5.5 The Relationship between Productivity and Price Fluctuation



Source: Produced by the author based on the Department of census and statistics database

Figure 5.11: The Variation of Extent and Production (consecutive *Maha* seasons) *(1999-2012)*

The variation of extent and production of tomato and beans over the period of last 14years was depicted in Figure 5.11. As explained by the figure 5.9, both vegetables had shown a slight extent wise increase within the period of 1999 to 2012. In 1999, the total area under bean cultivation was 3,056 ha, which was increased to 3,451 ha, in 2012, by 13%. Similarly, the total area under tomato cultivation was 2,615 ha in 1999 which increased to 3,304 ha in 2012, by 26%.

However, the rate of growth in total production has well exceeded the rate of growth in extent, which signified the inevitable improvement in productivity. In 2012, the total production (mt/year) of tomato has improved by 70% followed by beans as 38%, when comparing with the situation in 1999. The productivity of tomato has been increasing at a rate of y = 0.199x + 7.58 (R^2=85%) every year, while the productivity of beans has been increasing at a rate of y = 0.024x +4.793 (R^2=16%) every year.

Further, Figure 5.11 indicates the prevalence of two phases in variation of the productivity over time. The period from year 1999 to 2003 can be identified as the first phase and the period from year 2004 to 2012 can be identified as the second phase, based on the nature of the extent – production relationship. Within the first phase, the variation of production is more or less parallel to the extent increase and the ‘production jumps’ were not evident. The first production increase ‘jump’ was evident in 2003-2004 period for both vegetables. This is the period in which imported hybrid varieties were introduced and gained its popularity throughout the country. As Senarathna *et al.* (2012) pointed out, nine tomato varieties out of 16 tested exotic hybrid tomato varieties were superior in relation to agronomical character such as yield and fruit quality. Further, three exotic tomato varieties had higher pericarp thickness which enabled high resistance to bruises and damages occurred during rough handling and transportation. Therefore, many farmers have shifted towards the exotic hybrids instead of locally bred open pollinated varieties after 2004. Further Senarathna *et al.* (2012) found that, except three tomato varieties, all the others out of 16 tested, exotic hybrids were susceptible to either blight or both bacterial wilt and blight. Hence, application of insecticides and pesticides also had to be increased as these varieties became more susceptible to diseases than local varieties. Therefore, it seemed that combined effect of these factors might have impacted the observed ‘yield jumps’ occurred after 2003 and simultaneously magnified the effect of fluctuation. Therefore, it appears that, increasing trend in productivity has contributed to the magnified effect of fluctuation in cultivated extent.

CHAPTER SIX

Summary of Findings, Conclusions and Way Foreword

6.1 Summary of Findings and Conclusions

1. Even though the vegetable sub–sector is a key segment of the other food sector, its contribution to the national GDP has stagnated over the recent five years, despite the increased extent and productivity. The government focused on increasing the extent under vegetable cultivation by two fold in 2016 to ensure the nutrition security of the nation.

2. However, the sector is currently experiencing high price instability which can be viewed as price fluctuation. Among up-country vegetables, the highest price fluctuation was observed for tomato followed by cabbage and the lowest was observed for beans.

3. The reasons behind these price fluctuations can be divided into two categories as endogenous (within the economic environment) causes and exogenous (outside the economic environment) cause. This research attempted to find out the effect of one of the endogenous causes, erroneous expectations of future prices in creating price fluctuation among upcountry vegetables.

4. The results revealed that price expectation based on previous season's price was the main factor considered by farmers in selecting the type of vegetable/s to grow in the next season. The other main factors were individual preference, water availability and potential harvesting frequency.

5. In both *Yala* and *Maha* seasons, majority of midcountry vegetable farmers have cultivated vegetables in paddy lands. Further, usage of paddy land for vegetable cultivation in Badulla district was comparatively lower than that of Matale and Kandy districts, due to use of paddy land for potato cultivation in Badulla.

6. If the potato marked a high price in the last season, more farmers were inclined to grow potato in the next season, expecting the same high market price, hence the extent of vegetable cultivation decreases accordingly, at the earlier stage of the season. On the other hand, some farmers in Badulla district have opted for mixed cropping of vegetable with potato and the most popular vegetable was beans, in the mixed cropping lands.

7. The highest percentage of midcountry vegetable farmers belonged to 41-60 year age category. The younger generation's (below age 40) involvement in agriculture was as low as 12.7% of the total sample and the literacy rate was reported as 97.2 percent among midcountry vegetable farmers. The highest

percentage of farmers in Kandy district (30.7%) had the land extent less than 0.5Ac. On the other hand, the highest percentage of farmers in Badulla district (37.6%) cultivated vegetables in a land of 0.5-1Ac and the highest percentage of farmers in Matale district cultivated vegetables in a land of 0.1Ac. -1.5 Ac.

8. Majority of farmers (81%) have cultivated imported hybrid varieties purchased from private dealers/companies. The respective dedicated economic centers situated in Matale and Badulla districts were the most popular means of marketing the vegetables in those districts.

9. Time series analysis techniques were applied to select best fitted method to forecast the wholesale prices of selected upcountry vegetables. Results revealed that monthly wholesale prices of all the considered vegetables namely, tomato, cabbage and beans had shown an upward trend during the period of 2002-2012.

10. The smoothing techniques suggested that Double Exponential Smoothing as the best fitted technique in forecasting the tomato wholesale prices, whilst Single Exponential Smoothing was more appropriate in forecasting the wholesale prices of beans and cabbage.

11. Among considered vegetables, the highest annualized price fluctuation index was recorded for tomato, as in the range of 142% -272%. The calculated annualized fluctuation indices for tomato, cabbage, and beans in Sri Lanka were considerably higher than reported price fluctuation of tropical food items such as coffee and banana in the international market.

12. In 2012, tomato cultivation in Sri Lanka had shown a 26% extent - wise increase and 70% quantity wise – increase, compared to the situation in 1999. Further, every year, the productivity of tomato has been increasing at a rate of $y = 0.199x + 7.58$ (R^2=85%) while the productivity of beans has been increasing at a rate of $y = 0.024x + 4.793$ (R^2=16%). Therefore, apparently increasing productivity has magnified the effect of fluctuation in extent which occurs as a result of the erroneous expectation of future prices.

6.2 Way Forward

1. Majority of farmers have suggested to implement a price control strategy (similar to the one for rice), with the direct involvement of the government. However, it does not seem particle for perishables such as vegetables. According to the view of the subject specialists, the establishment of cold stores to store the excess supply cannot be considered as a viable solution either, due to high cost of electricity, lack of a central processing unit, and refrigerated transport facilities. On the other hand, majority of Sri Lankans prefer consuming vegetables in the fresh form than in chilled form.

Therefore, price control strategy may not be a practical solution for the price fluctuation in the upcountry vegetable sector - Sri Lanka.

2. The other way of managing excess supply is by processing. The most popular processed product is tomato sauce. Currently1,250 mt of tomato pulp or paste is imported to Sri Lanka for producing tomato sauce. However, at the prevailing wholesale prices, it is not economical to buy from the wholesale market and process within the country. On the other hand, majority of farmers in midcountry area had cultivated *'Padma'*, and *'Markis'* , hybrid varieties imported from India, which have a very high pericarp thickness to ensure easy handling during transportation and low soluble solid content (Brix value). For processing of tomato, the soluble solids content should be at least over 5.5%, thus suitable varieties which fulfill this requirement are rare in Sri Lanka. The existing variety with the highest *brix* value content is Lanka server *(goraka)* with value around 3.8%. However, farmers have moved away from cultivating these varieties, mainly due to difficulty in post harvest handling. Therefore, converting the excess tomato production to the processed form may not be a viable solution.

3. However, there may be a possibility of processing with the pre - planned cultivation, especially targeted for processed product.

4. Except for tomato, regarding other vegetables such as beans and cabbage, the scope of processing is very less. Therefore, attention should be paid to reducing the excess supply, rather than managing the excess supply, once it is generated.

5. As managing excess supply is difficult, we have to find other avenues such as preventing excess production to reduce price fluctuation. Planning the production based on market is the most suitable measure.

6. According to the market based food production plan developed by the Ministry of Agriculture, it is recommended to reduce the cultivation extent of tomato in midcountry districts by 25%, in May, June, October, November, December and January in 2013. Further, it is recommended to increase the extent of cabbage production by 10 ha in midcountry districts in March, April August and September in 2013. However, as found by this study, farmers make cultivation decisions individually, mainly focusing on price prevailed in the previous season. On the other hand, farmers' decision making is not much influenced by government officers operating within the area such as AI and ARDAs. Rather than government officers, the influence of the agents of the private seed companies was high among the surveyed farmers. In this background, finding an effective ways and means of influencing the farmer decision making remains a problem.

7. As 81% farmers have used imported hybrid seed varieties for cultivation, controlling, and regulation of importation and distribution of seeds seem possible ways of controlling farmers' decision.

8. An effective price forecasting model need to be developed based on weather forecasts and price behavior of the previous seasons and the results should be made available to the farmers before commencing the cultivation season.

9. Making the farmers aware of the nature of price fluctuation in vegetable sector may be an effective measure in reducing the price fluctuation. They should be made aware of the effect of each and every individual decision on creating excessive price fluctuations.

10. Further, relevant officers of the Department of Agriculture can assist farmers in selecting alternative crops to grow during the season.

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Annex 1

WHOLESALE PRICES OF TOMATO (Rs/Kg)												
MONTH **YEAR**	J	F	Mr	A	M	Ju	Jl	A	S	O	N	D
2002	11.88	26.78	39.91	31.33	36.77	49.13	36.51	34.77	21.66	17.54	33.14	44.02
Time period	1	2	3	4	5	6	7	8	9	10	11	12
2003	41.11	34.98	24.93	32.98	34.92	27.95	38.18	14.98	28.77	31.95	38.89	39.01
Time period	13	14	15	16	17	18	19	20	21	22	23	24
2004	23.75	19.26	26.21	14.86	31.26	51.05	34.75	14.76	18.16	17.26	52.56	40.16
Time period	25	26	27	28	29	30	31	32	33	34	35	36
2005	39.4	68.97	62.63	40.13	34.34	14.39	34.65	31.47	40.31	34.77	16.95	39.19
Time period	37	38	39	40	41	42	43	44	45	46	47	48
2006	22.67	21.83	16.53	19.87	50.05	71.6	68.8	16.15	14.53	28.33	61.83	109.58
Time period	49	50	51	52	53	54	55	56	57	58	59	60
2007	53.47	38.64	35.72	22.25	15.11	31.88	43	29.88	54.48	59.08	33.06	15.52
Time period	61	62	63	64	65	66	67	68	69	70	71	72
2008	24.92	77.19	64.88	75.65	96.18	57.31	37.14	12.68	16.22	35.43	74.15	96.23
Time period	73	74	75	76	77	78	79	80	81	82	83	84
2009	91.78	38.26	21.8	27.62	57.31	67.09	64.5	47.25	35.9	35.04	28.97	56.34
Time period	85	86	87	88	89	90	91	92	93	94	95	96
2010	99.25	107.5	53.8	48.75	70.4	132.38	77	71.4	79	76.88	85.93	82.29
Time period	97	98	99	100	101	102	103	104	105	106	107	108
2011	54.11	125.17	148.51	91.11	36.97	14.18	19.93	17.33	27.83	44.31	107.59	178.3
Time period	109	110	111	112	113	114	115	116	117	118	119	120
2012	89.2	17.59	15.99	44.6	109.44	99.17	113.4	47.69	26.29	27.6	56.97	89.14
Time period	121	122	123	124	125	126	127	128	129	130	131	132

Annex 2

WHOLESALE PRICES OF BEANS (Rs/Kg)												
MONTH / **YEAR**	**J**	**F**	**Mr**	**A**	**M**	**Ju**	**Jl**	**A**	**S**	**O**	**N**	**D**
2002	30.81	37.78	40.29	30.29	43.5	36.23	46.77	33.33	32.3	33.47	26.58	29.73
Time period	1	2	3	4	5	6	7	8	9	10	11	12
2003	47.71	52.32	29.93	22.79	43.32	48.84	37.76	41.29	39.39	40.31	39.94	42.12
Time period	13	14	15	16	17	18	19	20	21	22	23	24
2004	30.31	32.32	25.7	31.15	42.86	41.78	42.61	48.09	44.67	51.36	40.24	33.1
Time period	25	26	27	28	29	30	31	32	33	34	35	36
2005	58.44	57.25	35.07	30.87	46.35	58.68	62.68	58.79	53.19	34.88	45.94	56.85
Time period	37	38	39	40	41	42	43	44	45	46	47	48
2006	53.62	41.63	41.88	34.64	60.38	57.75	44.81	44.58	52.42	55.44	88.69	77.85
Time period	49	50	51	52	53	54	55	56	57	58	59	60
2007	74.28	70	44.43	35.82	46.44	74.78	65.48	46.71	70.92	60.42	51.07	53.93
Time period	61	62	63	64	65	66	67	68	69	70	71	72
2008	67.85	58.4	87.42	79.66	78.02	82.5	64.79	69.3	62.16	65.73	62.33	69.69
Time period	73	74	75	76	77	78	79	80	81	82	83	84
2009	44.19	51.35	60.28	65.15	44.84	93.43	74.16	63.46	51.49	72.57	92.25	69.49
Time period	85	86	87	88	89	90	91	92	93	94	95	96
2010	100.75	94.75	82.8	96.25	129.6	107	85.25	111.2	102.33	122.5	107.93	108.33
Time period	97	98	99	100	101	102	103	104	105	106	107	108
2011	108.97	183.34	153.94	81.27	63.42	105.44	96.25	88.22	77	74.2	105.42	106.32
Time period	109	110	111	112	113	114	115	116	117	118	119	120
2012	64.8	49.52	46.86	70.8	71.84	127.17	73.93	74	79.5	125.73	174.9	67.94
Time period	121	122	123	124	125	126	127	128	129	130	131	132

Annex 3

WHOLESALE PRICES OF CABBAGE (Rs/Kg)												
MONTH	J	F	Mr	A	M	Ju	Jl	A	S	O	N	D
2002	8.53	9.44	10.29	8.87	23.62	27.97	25.14	20.92	19.48	15.41	11.27	16.21
Time period	1	2	3	4	5	6	7	8	9	10	11	12
2003	27.2	26.74	22.12	17.77	21.75	18.52	9.52	8.73	9.06	11.47	10.05	13.94
Time period	13	14	15	16	17	18	19	20	21	22	23	24
2004	15.05	9.77	6.89	7.8	20.33	23.09	25.55	27.26	16.76	14.08	23.39	25.67
Time period	25	26	27	28	29	30	31	32	33	34	35	36
2005	26.21	24.9	20.55	18.16	19.09	13.69	15.94	16.75	16.41	19.15	26.14	30.9
Time period	37	38	39	40	41	42	43	44	45	46	47	48
2006	16.91	14.56	11.8	14.03	21.95	35.99	30.3	31.58	30.6	23.77	22.53	35.98
Time period	49	50	51	52	53	54	55	56	57	58	59	60
2007	58.38	43.85	27.68	17.53	14.54	14.1	13.57	15.47	16.2	18.54	34.48	21.19
Time period	61	62	63	64	65	66	67	68	69	70	71	72
2008	18.18	13.77	16.23	46.86	65.87	59.38	39.04	29.56	19.32	19.54	19.83	22.11
Time period	73	74	75	76	77	78	79	80	81	82	83	84
2009	26.15	23.46	20.49	19.8	30.38	35.85	47.77	40.9	34.63	41.56	33.18	46.69
Time period	85	86	87	88	89	90	91	92	93	94	95	96
2010	74.75	60.25	54.2	45.5	51.8	82.25	53.5	74.8	64.08	60	59.13	72.08
Time period	97	98	99	100	101	102	103	104	105	106	107	108
2011	48.1	66.64	79.7	66	47.91	32.85	21.63	17.87	16.37	19.94	28.02	66.53
Time period	109	110	111	112	113	114	115	116	117	118	119	120
2012	50.41	17.19	14.97	13.47	23.91	40.21	36.23	51.02	37.86	53.48	74.38	54.22
Time period	121	122	123	124	125	126	127	128	129	130	131	132

Annex 4

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.73
R Square	0.54
Adjusted R Square	0.54
Standard Error	20.16
Observations	132.00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	61826.84	61826.84	152.06	0.00
Residual	130.00	52856.61	406.59		
Total	131.00	114683.45			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	26.38	3.53	7.47	0.00	19.40
Time period	0.57	0.05	12.33	0.00	0.48

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.465
R Square	0.216
Adjusted R Square	0.210
Standard Error	27.607
Observations	132.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.000	27295.752	27295.752	35.814	0.000
Residual	130.000	99081.085	762.162		
Total	131.000	126376.837			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	22.889	4.833	4.736	0.000	13.327	32.451
Time period	0.377	0.063	5.984	0.000	0.253	0.502

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.60
R Square	0.36
Adjusted R Square	0.36
Standard Error	14.70
Observations	132.00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	16140.09	16140.09	74.65	0.00
Residual	130.00	28108.21	216.22		
Total	131.00	44248.31			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	10.59	2.57	4.11	0.00	5.49	15.68
Time period	0.29	0.03	8.64	0.00	0.22	0.36

Annex 5

Tomato - Kandy

Operation	Labour	Machinery	Input	Transport	Total
Land Preparation	22,838.10				22,838.10
Preparation of beds & ridges	4,666.67	12,000.00			16,666.67
Seeding/Transplanting	7,771.43		11,958.73		19,730.16
Fertilizer application (Including COT)	5,295.24		18,636.36		23,931.60
Weeding	17,714.29				17,714.29
Establishment of supporting sticks & training	23,047.62		22,132.00		45,179.62
Pesticide application	17,485.71		33,082.79		50,568.50
Harvesting & drawing (Including COT & Boxes)	40,266.67		26,400.22	24,360.00	91,026.89
Including inputed cost	**139,085.71**	**12,000.00**	**112,210.10**	**24,360.00**	**287,655.81**
Excluding inputed cost	**86,240.00**	**12,000.00**	**74,585.71**	**24,360.00**	**197,185.71**

YIELD & RETURNS	Per Ac
Average yield (Kg)	10,140.95
Price of produce (Rs./Kg)	49.58
Gross income (Rs.)	502,773.93
Profit including imputed cost (Rs.)	**215,118.12**
Profit excluding imputed cost (Rs.)	**305,588.22**
Unit Cost including imputed cost (Rs.)	28.37
Unit Cost excluding imputed cost (Rs.)	19.44

Annex 6

Tomato-Badulla

Operation	Labour	Machinery	Input	Transport	Total
Land Preparation	21,700.00	21,500.00			43,200.00
Preparation of beds & ridges	12,266.67				12,266.67
Seeding/Transplanting	7,950.00		11,958.73		19,908.73
Fertilizer application (Including COT)	6500		19925		26425
Weeding	30,250.00				30,250.00
Establishment of supporting sticks & training	40,000.00		22,132.22		62,132.22
Pesticide application	25,600.00		33,082.73		58,682.73
Harvesting & drawing (Including COT & Boxes)	58,000.00		26,400.00	36,900.00	121,300.00
Including inputed cost	**202,266.67**	**21,500.00**	**113,498.68**	**36,900.00**	**374,165.35**
Excluding inputed cost	**128,600.00**	**21,500.00**	**133,785.00**	**36,900.00**	**320,785.00**

YIELD & RETURNS	Per Ac
Average yield (Kg)	16,125.00
Price of produce (Rs./Kg)	48.09
Gross income (Rs.)	775,410.94
Profit including imputed cost (Rs.)	**401,245.59**
Profit excluding imputed cost (Rs.)	**454,625.94**
Unit Cost including imputed cost (Rs.)	23.20
Unit Cost excluding imputed cost (Rs.)	19.89