RESEARCH REPORT

IMPORT BAN ON CHEMICAL FERTILIZERS AND OTHERS AGROCHEMICALS : SHORT TERM IMPACTS ON VEGETABLES

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Hector Kobbekaduwa Agrarian Research and Training Institute

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FOREWORD

In the ever-changing landscape of global agriculture, governmental decisions on import and export regulations wield significant influence, sending reverberations through the fields and farms that sustain entire communities. The recent fertilizer policy changes in Sri Lanka serve as a poignant example of how shifts in government directives can profoundly impact the lives of those engaged in agriculture.

Following this policy adjustment, the Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) conducted a thorough survey among vegetable-growing farmers to assess the immediate effects on the vegetable sector. The findings presented in this report provide a window into the challenges faced by these farmers and illuminate the complexities that arise when agricultural policies undergo rapid transformations.

The study's insights underscore critical aspects related to the policy shift, revealing its impact on farmers' decisions regarding land and resource allocation in agriculture. It draws attention to the adverse effects on yields resulting from the scarcity of chemical fertilizers and the inadequate availability of required quantities of organic fertilizers at the appropriate times. The survey also captures diverse perspectives among farmers regarding plant nutrient management. Additionally, the documented obstacles shed light on challenges encountered by farmers in adopting organic farming practices, including the scarcity of quality organic fertilizers, a lack of information, and unregulated prices.

This report serves as a compelling call to policymakers, urging them to carefully consider the profound impact of fertilizer policy changes on the lives and livelihoods of farmers. The adverse effects on productivity, coupled with challenges such as limited availability, increased costs, and uncertainty in the agricultural sector, necessitate a thoughtful and strategic response.

Navigating the intricate terrain of agricultural policy requires a prioritization of the well-being of those who cultivate the land. The insights presented herein contribute significantly to the ongoing dialogue about sustainable agricultural practices, emphasizing the need for support mechanisms, improved access to affordable fertilizers, technical training, and stable policies to safeguard the resilience of Sri Lanka's agricultural communities.

Dr. G. G. Bandula
Director/Chief Executive Officer

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This report represents a segment of a comprehensive research study conducted by the Environment Division of HARTI, and its completion owes much to the hard work and dedication of all research members in the division. We express our profound appreciation for their commitment and support. The research study was made possible through partial funding from the Australian Government Department of Foreign Affairs and Trade (DFAT), with invaluable technical assistance from the United Nations World Food Programme (WFP). Their unwavering support is deeply acknowledged.

Our thanks extend to the District Commissioners, as well as other officials, especially the Divisional Officers (DOs) of the Agrarian Services Centres (ASCs) under the Agrarian Development Department (DAD) in the selected districts where the study was conducted. Their cooperation and endorsement were essential to the success of the project. Heartfelt gratitude is also conveyed to the farming communities within the respective Agrarian Services Center areas for their collaboration during the data collection phase.

Ms. Imasha De Silva, Statistical Assistant, and the diligent Investigators involved in this study deserve commendation for their tireless efforts in gathering essential field data. We acknowledge the exceptional assistance provided by Management Assistants Ms. Uthpala Jinadari Ranasinghe and Ms. Gayathri Rathwaththe of HARTI, whose involvement in tasks such as typesetting, page layout, and manuscript preparation is highly appreciated. Our gratitude extends to Ms. Suharshi Perera, Editor, for the meticulous editing of the final report, and to Mr. S.A.C.U. Senanayake for his thorough proofreading. Special thanks are offered to Mr. W. H. A. Shantha, Head of the Information and Communication Division at HARTI, and his dedicated team.

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EXECUTIVE SUMMARY

The government of Sri Lanka implemented Import and Export Regulations No. 7 of 2021 on May 6, 2021, which prohibited the importation of chemical fertilizers and agrochemicals into the country. However, on November 30, 2021, the Finance Ministry issued Extra Ordinary Gazette No. 2256/23, lifting the ban on chemical fertilizers. In response to this policy change, the HARTI conducted a survey among vegetable-growing farmers to understand its short-term impact on the vegetable sector. The survey included 788 farmers cultivating major vegetables (beans, cabbage, tomato, luffa, okra, and brinjal) in nine districts, of Anuradhapura, Badulla, Nuwara Eliya, Kandy, Kurunegala, Hambantota, Moneragala, Polonnaruwa, and Puttalam. The survey was conducted from August to September 2022, and data from the *2020/21 Maha* season before the policy change was used as the baseline for comparison with that of the *2021/22 Maha* season.

The survey has revealed five key findings that carry significant weight for decision-makers. The sudden shift in fertilizer policy has resulted in a statistically significant reduction in the extent of land cultivated with vegetables during the *2021/22 Maha* season, as compared to the *2020/21 Maha* season. Notably, 21 percent of farmers reported a reduction in the extent of cultivation due to fertilizer concerns, while redundant cultivation of certain land plots was also reported.

It was observed that regardless of the vegetable type or location, there has been a significant reduction in the average vegetable yield. Estimated yield loss in the *2021/22 Maha* season in proportion to the normal season average yield shows a production loss varying from 0 to 100 percent. Despite farmers using a combination of chemical and organic fertilizers, with quantities below the recommended levels, they still encountered a significant average yield loss of over 57 percent per acre.

The majority (66 percent) of respondents believed that the most effective and sustainable plant nutrient management method is a combination of both organic and inorganic fertilizers. In contrast, 33 percent believe that applying only chemical fertilizer is the most suitable way while less than one percent believe that the required nutrients can be provided by organic fertilizers alone.

Farmers are grappling with various issues such as the unavailability of quality organic fertilizers at the required time, lack of information and knowledge to transition to organic farming, and unregulated quality and prices of fertilizers, which are adversely affecting them. Even before the chemical fertilizer import ban, 64 percent of the vegetable farmers applied organic fertilizers to their crops to improve the soil and help moisture retention. However, the majority (61 percent) of vegetable farmers could not make the organic fertilizer by themselves and resorted to purchasing it from the market.

Overall, the fertilizer imports policy changes in Sri Lanka have had an adverse effect on the productivity levels of vegetable cultivation. Limited availability, increased costs, and introduction of alternative fertilizers, combined with the uncertainty and instability in the agricultural sector, have significantly hindered the farmers' ability to achieve optimal yields. It is crucial for policymakers to consider the impact of these changes on farmers' livelihoods and provide support mechanisms, such as improved access to affordable and appropriate fertilizers, technical training, and stable agricultural policies, to mitigate the negative consequences and ensure sustainable agricultural practices in the country.

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LIST OF ABBREVIATIONS

ARPA	-	Agriculture Research Production Assistant
ASC	-	Agrarian Services Center
CES	-	Constant Elasticity of Substitution
COP	-	Cost of Production
DAD	-	Department of Agrarian Development
DOA	-	Department of Agriculture
DS	-	Divisional Secretariat
FAO	-	Food and Agriculture Organization
FO	-	Farmer Organization
HARTI	-	Hector Kobbekaduwa Agrarian Research and Training Institute
LCWZ	-	Low Country Wet Zone

CHAPTER ONE

Introduction

1.1 Background

Vegetable production plays a pivotal role in the agricultural sector of Sri Lanka, contributing significantly to the country's food and nutrient security. The sustainable and efficient operation of the vegetable sub-sector is crucial not only from an agricultural standpoint but also holds immense socio-economic and political significance. Beyond ensuring a stable food supply, the vegetable sub-sector directly impacts the livelihoods of numerous farm households involved in cultivation, processing, and distribution, thereby influencing the overall economic landscape. Moreover, the interconnection between vegetable production and consumer well-being underscores the importance of a robust and sustainable vegetable sub-sector in fostering broader socio-economic and political stability within the country. Implementing scientifically informed agricultural practices is essential to optimize yield, nutritional content, and environmental sustainability, addressing the multifaceted challenges associated with vegetable production in Sri Lanka.

Vegetable production in Sri Lanka faces significant challenges due to the shrinking of arable land, a direct consequence of rapid urbanization. This reduction in available land occurs against the backdrop of a continually rising demand for food driven by the country's exponentially growing population. Currently, Sri Lanka's major commercial vegetable cropping systems are heavily reliant on traditional production methods that use agrochemicals extensively. Research indicates that farmers often use fertilizers and agrochemicals in quantities exceeding recommended levels (Padmajani, Bandara, & Aheeyar, 2014). In response to the potential health risks and environmental issues linked to conventional farming practices, there is a growing trend towards sustainable vegetable production. This shift is particularly evident in organic farms, home gardens, and peri-urban areas, where organic methods are increasingly adopted (Weerakkody & Mawalagedara, 2020).

Vegetable cultivation is characterized by its intensive and commercial nature. Vegetables, known for their ability to generate substantial biomass rapidly, necessitate regular replenishment of soil nutrients through fertilizers and other amendments to maintain long-term productivity. Successive governments of Sri Lanka have consistently implemented fertilizer subsidies as a strategic measure to enhance agricultural productivity. To achieve this, a significant portion of the chemical fertilizers used in Sri Lanka is imported. This reliance on imported fertilizers underscores the government's commitment to providing farmers with the necessary resources to improve crop production, despite the associated costs and logistical challenges of importing these inputs. The subsidy programs are designed to make fertilizers more affordable and accessible to farmers, thereby promoting higher agricultural output and contributing to food security. In 2020, the Sri Lankan

government allocated approximately USD 188.51 million (LKR 34,966 million) for fertilizer subsidies for food crops, which represented 53.6 percent of the total government expenditure on agriculture (Finance Ministry of Sri Lanka, 2020).

In response to the escalating health and environmental concerns arising from the intensive utilization of chemical fertilizers and pesticides, coupled with the substantial fiscal burden associated with the importation and subsidized provision of these agrochemicals to farmers, the government of Sri Lanka has proactively transitioned towards a paradigm of chemical-free agriculture. This strategic shift is underscored by the enactment of the Import and Export (Control) Regulation No. 7 of 2021, wherein the importation of chemical fertilizers and agrochemicals into the country is prohibited. This regulatory measure not only reflects a commitment to mitigating the adverse health and ecological effects linked to chemical-intensive farming practices but also signifies a broader governmental initiative aimed at fostering a more sustainable and ecologically responsible agricultural landscape.

Transitioning from conventional fertilizers to organic farming methods is a commendable approach for advancing environmental sustainability and mitigating the ecological impact of agriculture. Nonetheless, the success of this shift largely hinges on the careful management of both the pace and scale of its implementation. In Sri Lanka, most chemical fertilizers were imported, and there was virtually no established market for organic fertilizers. As a result, a sudden import ban led to a nationwide shortage of fertilizers.

The abrupt prohibition on agrochemicals caused significant uncertainty and unrest among farming communities that had long relied on input-intensive agricultural practices. In response to the growing concerns, the government subsequently relaxed restrictions, allowing the private sector to import chemical fertilizers through a licensing system. Although the ban was officially lifted on November 30, 2021, the fertilizer importation process has yet to return to its previous state. Challenges such as a shortage of foreign exchange and high international prices for fertilizers continue to affect the availability and affordability of these essential agricultural inputs.

1.2 Rationale of the Study

Both organic and inorganic fertilizers aim to supply essential nutrients (mainly N, P, and K) that are deficient in the soil. Organic fertilizers release nutrients slowly and require heat and moisture to break down, which helps reduce nutrient leaching and provides a steady supply over time. In contrast, inorganic fertilizers deliver nutrients quickly in a form readily available to plants, but this can lead to increased leaching if not applied carefully. While both types can meet plant nutrient needs, the timing and amount of application are crucial for effectiveness and minimizing environmental impact. In organic farming, the absence of agrochemical inputs restricts access to essential nutrients for plant growth and complicates the management of pests and diseases. This typically results in lower yields compared to conventional agriculture. The current import ban on agrochemicals is intended to encourage farmers to adopt

alternative methods such as using organic soil nutrients and non-chemical pest and disease control measures. However, there appears to be a lack of awareness among relevant stakeholders, and many farmers have not fully integrated alternative organic practices like composting, improved manure management, the use of nitrogen-fixing plants, and biodiversity management for biological control.

Food production aims to be economically viable to ensure that farmers can earn a livelihood while providing affordable food to consumers across all income levels. The sudden shift in fertilizer policy is likely to have both immediate and long-term socio-economic impacts on a significant portion of Sri Lanka's population, including producers, consumers, and investors in agriculture and related sectors. Therefore, it is crucial to carefully examine the effects, challenges, and potential strategies to effectively implement the government's green agriculture policy.

To address this gap, this research involves an island-wide survey to assess the state of vegetable production soon after the agrochemical importation ban , the direct and indirect effects on farmers' household economies, food security, and the overall well-being of farming communities. The study will provide valuable insights into the repercussions of the agrochemical policy changes and help develop effective strategies to manage the challenges associated with the ban, thereby supporting the successful continuation of the government's green agriculture initiative.

1.3 Research Questions

1. What are the short-term impacts of the fertilizer and agrochemical import ban on the supply and usage of inputs in vegetable farming?
2. What alternatives to agrochemicals have emerged following the import ban, and what is their availability and accessibility?
3. How did agricultural production and productivity change before and after the import ban?
4. What were the costs associated with fertilizers and agrochemicals before and after the import ban?
5. What is the level of farmers' awareness regarding substitutes for fertilizers and agrochemicals, and how effectively are these substitutes being used?
6. What is the farmers' perception of the import ban on fertilizers and agrochemicals?
7. How have farmers adapted to the reduced availability of fertilizers and agrochemicals?
8. What impact has the import ban had on household food security, and what coping strategies have farmers employed?

1.4 Objectives

The general objective of the study is to identify the short-term effects of Sri Lanka's fertilizer and agrochemical import policy changes on vegetable production farming households and related farming communities.

Specific Objectives.

The specific objectives of the study were to;

1. Assess the short-term effects of recent policy changes regarding the importation of fertilizers and agrochemicals on the supply and use of inputs for vegetable production.
2. Analyze the impact of these policy changes on vegetable production, including productivity and quality of produce.
3. Examine the implications of the policy shift on the food security of farming households and communities.
4. Evaluate the impact of the ban on household food security within the farming community.

CHAPTER TWO

Methodology

2.1 Conceptual Framework

The theoretical framework used in this study is set to find straightforward answers to the research questions of; what are the rewards and penalties of imposing a ban on importing agrochemicals to the country? What are the attitudes and perceptions of agriculture sector stakeholders (farmers, traders, consumers, bureaucrats) towards and operationalizing organic agricultural practices as a replacement to conventional chemical agriculture? What would be the most appropriate fertilizer policy considering every aspect of synthetic and organic fertilizers and different policy approaches?

The summarized conceptual framework of the study is given in Figure 2.1. The diagram illustrates the ripple effects of a policy change on the banning of the import of fertilizers and agrochemicals in Sri Lanka, focusing on the agricultural sector. The process begins with the policy change, influences on key inputs like land, fertilizers, seeds, water, labor, and machinery. These inputs affect availability, accessibility, prices, and market channels, leading to output changes such as variations in yield quantity, production quality, and market scale. These changes also affect socio-economic dynamics at the farmer level, influencing livelihoods, food security, and labor migration. The diagram further highlights external factors, such as government interventions and media, as well as how farmers adapt by altering attitudes, behaviors, skills, and coping mechanisms. The overall flow demonstrates the interconnectedness between policy, production, and socio-economic outcomes.

2.2 Sample Selection

In Sri Lanka, vegetables can be classified into two main categories— up-country and low-country vegetables. The selection of vegetables to be studied was based on the extent of their cultivation in the 2019/20 Maha season, with a focus on three main crops from each category. The selected crops from the up-country category are Beans, Tomato, and Cabbage, whereas Brinjal, Ladies Fingers, and Luffa are from the low-country sector.

The study aimed at covering the entire country by conducting a survey that encompasses all respective districts. However, due to the absence of a well-established national level database containing information on the number of growers under each crop type in the country, the total population was considered unknown during sample calculation.

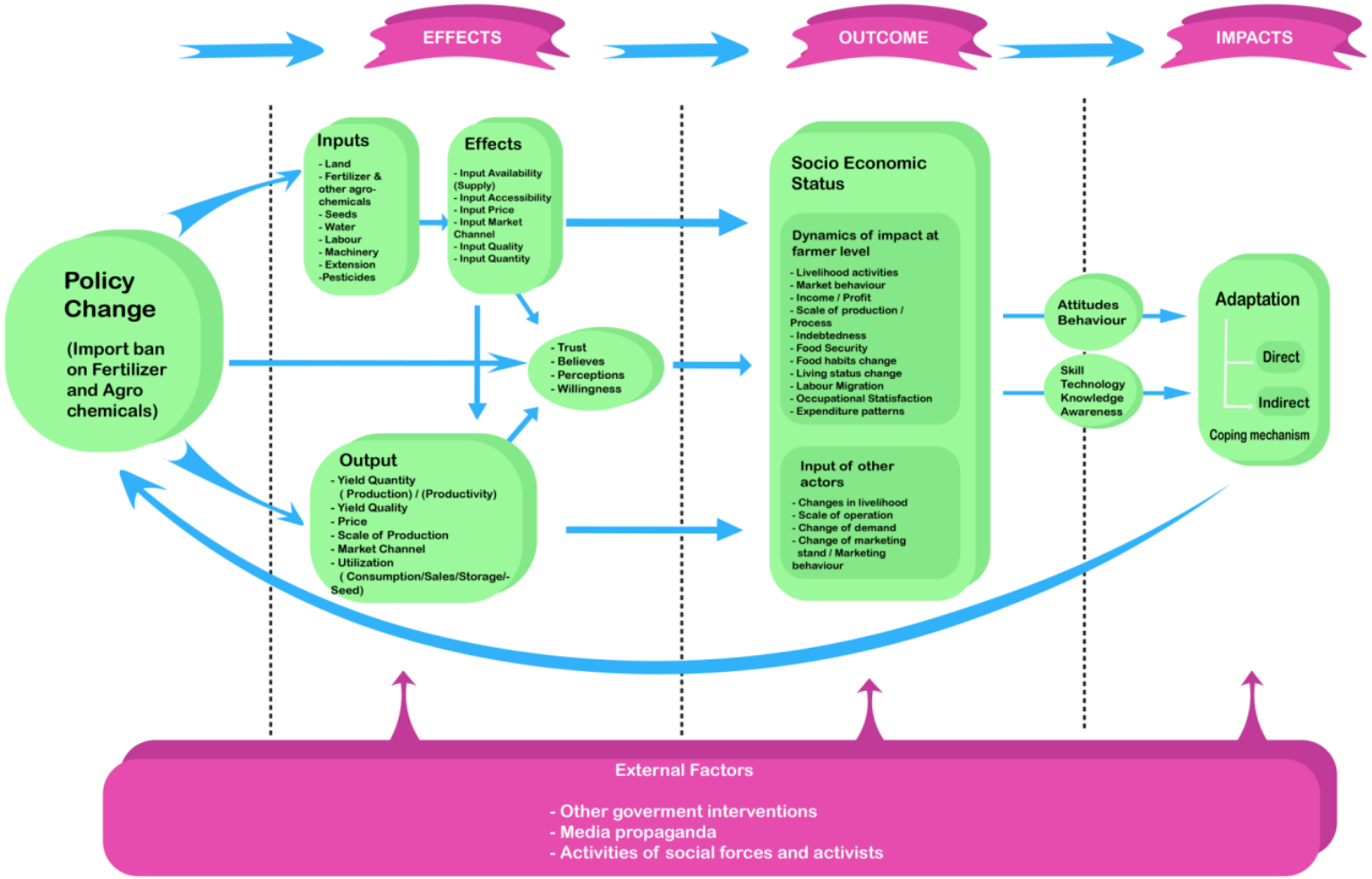


Figure 2.1: Conceptual Framework for the Study

In order to determine the appropriate sample size for the present study, the Cochran formula was utilized, taking into account the desired level of precision, confidence level, and estimated proportion of the attribute present in the population (Piran-Qeydari, Heidarabadi, and Farzaneh, 2022). This formula is particularly well-suited for situations involving large populations. For the current study, a margin of error and confidence level of 5% and 95%, respectively, were chosen. This resulted in a total sample size of 788 farmer households.

To ensure representative sampling, the sample for each vegetable was allocated proportionally among the various districts, taking into account the variability of the cropping system within each district. At field level, the sample was randomly distributed among representative DS divisions in proportion to the overall sample size. The selected sample locations are provided in Table 2.1.

Table 2.1: Sample Distribution

Crop	District						Total
	Beans	Tomato	Cabbage	Brinjal	Okra	Luffa	
Badulla	52	80	77	26			235
Nuwara Eliya	38	68	134				240
Kandy		41					41
Anuradhapura				25	33	50	108
Hambantota				18		31	49
Kurunegala						39	39
Moneragala				8			8
Polonnaruwa					38		38
Puttalam					30		30
Total	90	189	211	77	101	120	788

2.3 Data and Methods of Data Collection

Data

To address the research questions, the study utilized a combination of secondary and primary data. Secondary data consisted of documentary evidence with both direct and indirect relevance to the study's objectives.

Primary data collection focused on the 2020/21 Maha season, serving as baseline data prior to the policy change, and the 2021/22 Maha season, representing the post-policy period. This approach facilitated a comparative analysis between the two seasons, enabling a before-and-after assessment of the policy's impact.

Data collection methods

For this study, primary data was obtained through Computer-assisted personal interviewing (CAPI) techniques, which involved a structured questionnaire. In addition, Focus Group Discussions (FGDs) were conducted, allowing participants to

collectively provide insights into ground-level conditions and the direct and indirect impacts of the policy change. Guidelines for the FGDs were developed based on the research objectives and identified variables and attributes related to the study focus. Key Informant Interviews (KIIs) were also conducted, involving a small group of individuals who were likely to provide important information, ideas, and insights on the specific topic of the study. In this study, representatives of Farmer Organizations, key-value chain actors/representatives, and ground-level officers involved in the production process were mainly considered as key informants.

2.4 Operationalization of Variables

Specific Objective 1: To assess the effects of recent change in policy on import of fertilizer and agrochemicals on supply and use of vegetable production inputs

Table 2.2: Variable Operationalization for Objective One

Dimensions	Elements / Indicators	Measures	Source of Data
Input supply and use before and after import ban	Land	Quantitative and qualitative data on Land extent cultivated Type of land ownership Land use	Farmer survey
	Chemical fertilizer	Quantitative and qualitative data on Type of fertilizer used Form of fertilizer used Time of application Quantity used Awareness on recommendation rate (Likert) Unit price Source of supply Availability (Likert) Sufficiency (Likert) Fertilizer usage behavior Opinion on cost of fertilizer (Likert: Reduced; no change; increased) Quality (Likert)	Farmer survey
	Organic fertilizer availability, use and quality	Quantitative and qualitative data on Type of fertilizer used Form of fertilizer used Time of application Quantity used Source of knowledge Unit price Source of supply Availability (Likert) Level of adequacy for the cultivation (Likert) Quality (Likert)	Farmer survey

	Organic fertilizer production and marketing	Quantitative and qualitative data on Types of raw materials used Availability of raw materials (Likert) Quantity produced Quantity sold Unit price Sufficiency for self-cultivation Training & awareness on production (Likert) Constraints for production	Farmer Survey, KII with ground level officers
	Other agrochemical (Pesticide, Weedicide)	Quantitative and qualitative data on Type of other agrochemical used Time of application Quantity used Awareness on recommendation rate (Likert) Unit price Source of supply Availability (Likert) Level of adequacy for the cultivation (Likert)	Farmer survey
	Labour	Quantitative data on Type of labour Gender Wage rate Labour duration	Farmer survey
	Technical knowhow related to organic agriculture	Number of training/awareness programmes Frequency of meetings/visits Introduction of relevant new technologies Availability & accessibility	Farmer survey, KII with ground level officers

ctive 2: To assess the effects of recent change in policy on import of agrochemicals on agricultural productivity, production and quality of

Table 2.3: Variable Operationalization for Objective Two

Dimensions	Elements /Indicators	Measures	Source of Data
Productivity/production before and after import ban	**Output**	1. Yield per unit of land 2. Total production	Farmer survey
	Issues in production	1. Yield reduction due to pest and disease (%) 2. Quality of yield	Farmer survey
Use of harvest before and after import ban	**Utilization**	1. Nature of utilization (consumption/sale/seeds/storage) 2. Quantity of utilization	Farmer survey
Marketing before and after import ban	**Sale**	Quantitative and qualitative data on 1. Quantity sold 2. Unit price 3. Marketing channel 4. Marketing issues	Farmer survey

Specific Objective 3: To assess the effects of recent change in policy on import of fertilizer and agrochemicals on household food security of the farming community

Table 2.4: Variable Operationalization for Objective Three

Dimension	Indicator	Variables/measures	Sources of data
Socio-economic	**Demographic Factors**	- Gender of the principal farmer/HHH), Age of the principal farmer/HHH, No of HH members, No of dependents, Number of children, Number of adults - Occupation - Type of farming (full time and part-time farmers)	**Questionnaire Survey**: Farmers
	Food Security **FCS -Food consumption score** **RCSI – Food coping strategies** **LCSI – Livelihood coping strategies** **FIES- Food insecurity experience scale**	**Food acquisition and consumption** **Food availability: *Sufficient quantities of food are available on a consistent basis.*** - Average daily or/weekly intake of carbohydrate per household member - Average daily or/weekly intake of proteins - Average daily or/weekly vitamins per household (FAO, 2007) - Level of farmer self-sufficiency in household food production (Rice and other essentials) (Likert scale)	**Questionnaire Survey,** FGDs, KIDs and Case studies Sample Farmers (Count and recall)

		Food access: ***Having sufficient resources to obtain appropriate foods for a nutritious diet*** - Level of food acquisition (Likert scale/qualitative data from FGD/FGS) Having sufficient resources to obtain appropriate foods for a nutritious diet (Likert scale/qualitative data from FGD/FGS) **Food use:** ***Appropriate utilization of the available food based on knowledge of basic nutrition and care, as well as adequate water and sanitation.*** - Level of taking nutritious diet for three meals (Likert scale/ qualitative data from FGD/FGS) - Access to clean water (drinking and fulfill sanitation conditions (Rheingans *et, al*,2014) (likert scale / qualitative date from FGD/FGS)	
	Perceptions and perspectives	- Perceptions on policy change (Likert scale/ Qualitative data) - Adaptation methods used to overcome consequences of policy change (economic/social aspects) - Farmers'/value chain actors' perspectives on future scenarios on their socio-economic situations (Qualitative data)	**Questionnaire Survey, FGDs, KIDs and Case studies** Sample farmers, agricultural laborers, value chain actors

2.5 Data Analysis

The effects of import ban on fertilizer and other agrochemicals on the agricultural sector in Sri Lanka was specifically analyzed, referring to two areas of interest from the economic and social perspectives. For the analysis three main types of approaches will be followed:

1. Descriptive analysis: consultation and review of existing literature, and of studies and existing documents; evaluation and description of information collected through questionnaires.
2. Quantitative analysis: elaboration of statistical data and of data collected through questionnaires and quantification of the phenomena of fertilizer responsiveness.
3. Qualitative analysis: expert assessments for the integration or substitution of quantitative evaluations.

2.5.1 Potential Impact of Import Ban of Fertilizer and Agrochemicals on Agricultural Commodity Production

The main factors explaining output variations due to the lack of chemical inputs are basically land area and land-use patterns and yields (Zanoli & Gambelli, 1999). Any comparison between organic and conventional yields depends on a certain number of variables like environmental conditions, farmers' skills, the level of input, the crop considered, farm location and structure but since this is short term evaluation all those variables are assumed to be constant for the period.

2.5.2 Output Variation for Specific Crops

As a basic approach, single crop output is measured multiplying the respective areas and yields. As the main objective here is to assess what would be the variation in output if the conversion to organic farming takes place according to different rates of adoption (Fully organic, conventional, combination of both), two main sources of output variation must be considered: difference in yields and different land-use allocation among crops for organic and conventional farming.

i. Potential economic impact of conversion to organic agriculture at farm-level

The aspects that may determine a variation in the profitability of a farm after conversion to organic both in positive and negative terms can be schematized in the following aspects:

- Potential yield loss;
- Change in land use due to rotational requirements;
- Price variation for organic products;
- Managerial difficulties;
- Cost variation for purchased input

The information collected refers mainly to:

- Structural data (i.e. land extent dedicated to each crop, geographical location, altitude, presence of irrigation, etc.)
- Technical data (yield loss, different input requirements, substitution of technical input with labour, etc.)
- Economic data (i.e. gross output, variable costs, fixed costs, profits, .)

Once the data for the representative different types of cultivation systems (i.e. fully organic, conventional and different combinations of organic and chemical) were collected, it was used to generate standard farm budget results, aiming to investigate gross farm income, net farm income and final profit. Both revenues and costs categories were described enabling in depth investigation into main factors influencing the final economic result.

ii. Assessment of the household level food security

Because of the possible uncertainties and risks associated with the crop productivity and farm income as a result of switching from conventional to organic agricultural

practices, the number of farm households confronting food insecurity situations may be on the rise. Therefore, this study so attempts to assess the food security status of the sample households particularly in rural and estate communities by using Consolidated Approach for Reporting Indicators (CARI) (WFP, 2021) tool used for rapid measurement of household food security and the impact of food aid programs in humanitarian emergencies by the World Food Programme (WFP). The rural, estate and urban communities representing different crop production sectors were covered in the study. Further, more details of calculation were indicated in chapter five with findings for more clarity.

CHAPTER THREE

Effects of Fertilizer and Agrochemical Import Ban on Vegetable Production

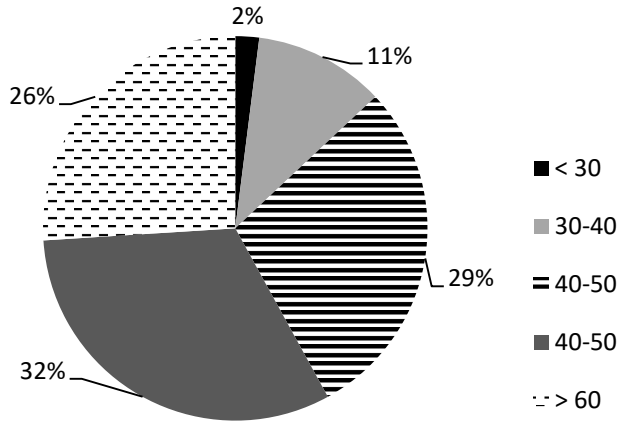
The global agriculture industry has undergone significant changes in recent years, driven by various factors such as environmental concerns, sustainability, and food safety. One notable development in this regard is the implementation of import bans on chemical fertilizers and other agrochemicals in certain regions (FAO,2017). These import bans aim at promoting organic and sustainable farming practices, reducing environmental pollution, and ensuring safety of food produced. This chapter focuses on examining the effects of a fertilizer and agrochemical import ban in Sri Lanka on vegetable production by providing a comprehensive understanding on changes which have taken place in cultivation practices, yield, quality, and overall productivity of vegetables in absence of chemical fertilizers and agrochemicals.

3.1 Demographic Features of the Sample

This section briefs the demographic features of a study sample as it helps in understanding the characteristics of the population being studied. This information can be used to identify potential biases and ensure that the results can be generalized to a broader population.

3.1.1 Age and Gender of the Household Head

Figure 3.1 demonstrates a distinct pattern where a significant majority of individuals engaging in farming activities are in the older age category . Approximately 60 percent fell within the range of 40 to 60 years, while nearly one-third belonged to the age group of above 60 years. A mere 13 percent of individuals were below 40 years. This observation reflects a prevailing trend observed across the Sri Lankan agricultural landscape.



Source: HARTI survey data, 2022

Figure 3.1: Age Distribution of the Household Head

In the majority of cases (90%) the person responsible for farming activities or the head of the household was male.

3.1.2 Education

Information on education is vital in designing training and awareness initiatives for the farming population. Table 3.1 summarizes the education levels of the household heads of the sample. The majority have completed secondary education (44%), followed by those who have passed the Ordinary Level (O/L) exams (29%). A smaller percentage have passed the Advanced Level (A/L) exams (17%). A minority of respondents have only completed primary education (9%), and a very small proportion have attained a diploma or higher qualification (1%). This distribution highlights that most respondents have at least a secondary education, with fewer reaching higher education levels. Furthermore, data suggests that the observed trend of educational attainment among household heads was consistent across districts.

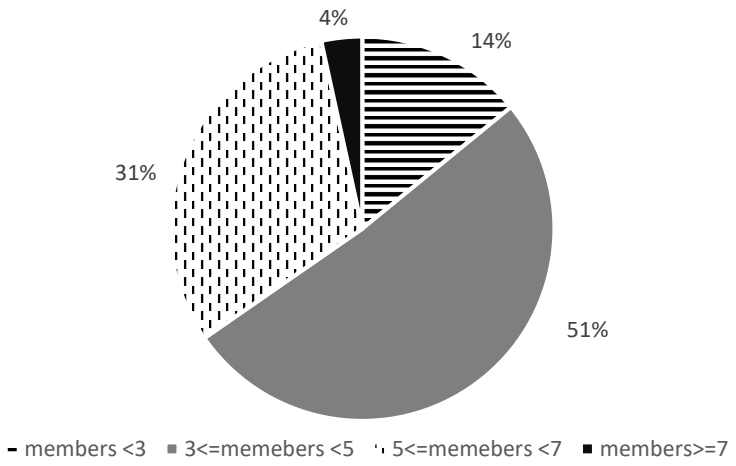
Table 3.1: Education Status of the Household Head

Education level	Frequency	Percentage
Primary	72	9
Secondary	342	44
O/L passed	232	29
A/L passed	133	17
Diploma or higher	8	1

Source: HARTI survey data, 2022

3.1.3 Household size and Involvement in Agriculture

Figure 3.2 shows the distribution of households in the surveyed sample based on the number of members in the household. The households are divided into four categories based on their size: those with less than three members, those with three to four members, those with five to six members, and those with seven or more members. Irrespective of the district the largest percentage of households have three to four members (51%), followed by households with 5 to 7 members (31%). There are relatively few households with less than three members (14%) or seven or more members (4%).



Source: HARTI survey data, 2022

Figure 3.2: Household Size

This data on the number of male and female household members involved in agriculture provides insights into availability of household labour in farming, which is also crucial for understanding gender dynamics in agriculture. According to the data, there are four percent of households with no male family members engaging in agricultural activities, whereas 15 percent of households have no female members involved. In 81 percent of the households only one male family member participates in agricultural activities, while in 78 percent of households one female member is engaged in the agricultural sector.

3.1.4 Income Sources

Table 3.2 provided information on the sources of income for households, categorized into two main categories as main income and other sources of income. In terms of the main income source, a large majority of 84 percent of the households depend on crop farming as the primary source of income.

In terms of other income sources, 47 percent households report having no additional income. However, 24 percent households have other income sources in addition to their main income from crop farming, including 14 percent households involved in animal husbandry, three households relying on non-agricultural labor, four households with other non-skilled labor, four households with private sector employment, five households with skilled labor, 13 percent households who are self-employed, and five households receiving income from pension. Furthermore, 31 percent households receive additional income from social security funds, and three households receive a monthly allowance from relatives. Only one household reports receiving income through foreign remittance.

Table 3.2: Income Sources

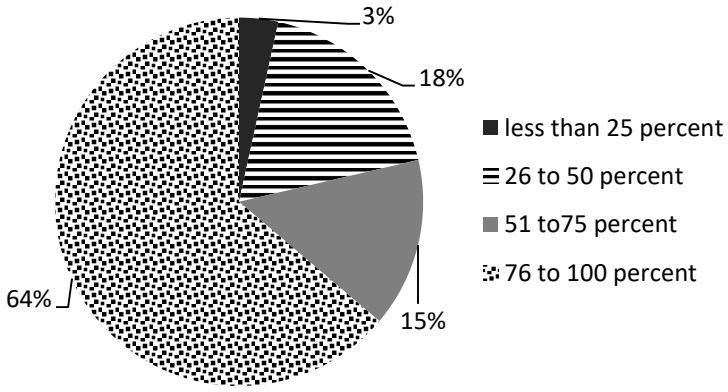
Income Source	Primary Income	Other Income*
None	0	47
Crop farming	84	24
Animal husbandry	1	14
Agricultural labour (non-skilled)	1	3
Non-agricultural labour (non-skilled)	0	4
Government employment	4	6
Private sector employment	2	4
Skilled labour	1	5
Self-employed	3	13
Pension	4	5
Social security funds	0	31
Monthly allowance from relatives	0	3
Foreign remittance	0	1

*Multiple responses

Source: HARTI survey data, 2022

3.1.5 Agriculture Income Share

The share of household income from agricultural activities is shown in Figure 5.3. Accordingly, 64 percent of households had earned more than three fourth of its total income from agricultural activities while another 15 percent of household share of agricultural income was 50 to 75 percent. This clearly shows that the majority of these vegetable farmers mainly depended on the agricultural activates as their main income source.



Source: HARTI survey data, 2022

Figure 3.3: Share of Household Income from Agricultural Activities

3.2 Impact of Fertilizer Policy Change on Land use

Fertilizer policy and land use are interconnected aspects of agricultural practices and environmental management. Fertilizers play a crucial role in increasing crop productivity by providing essential nutrients to the soil. However, improper use or overuse of fertilizers can have negative impacts on land use and the environment. This

subsection mainly summarizes the change that have taken place in the land use of the vegetable production with focus to mostly cultivating six upcountry and low country vegetables; Beans, Cabbage, Tomato, Brinjal, Okra, and Luffa.

3.2.1 Land Size

Land is a vital resource in agricultural production, and the farmer must make critical decisions on whether to cultivate the available land and, if so, which crops to grow and to what extent, based on the prevailing circumstances. In the present study, a majority of the interviewed farmers reported cultivating vegetables in uplands, although there were instances of farmers cultivating vegetables such as okra and brinjal in lowlands as well.

Notably, vegetable cultivation is characterized by small land plots that farmers typically possess. Table 3.3 provides the percentage of holdings for different land classes across various crops, including Beans, Tomato, Cabbage, Brinjal, Okara, and Luffa. More than 60 percent of the bean cultivating lands were equal or less than 0.5ac, and another 26 percent of the holdings came under the category of half to one acre. Only 12 percent of the farmers had more than 1 ac of land under bean cultivation.

Table 3.3: Land Size Distribution by Crop

Land class ac	Beans	Tomato	Cabbage	Brinjal	Okara	Luffa
	Percentage of holdings					
<0.25	20	7	12	5	3	8
0.25<=ext<0.5ac	42	32	30	27	34	30
0.5<=ext<1ac	26	41	37	26	28	41
1<=ext<=2ac	12	19	20	37	33	19
ext>2ac	0	1	1	5	2	2

Source: HARTI survey data, 2022

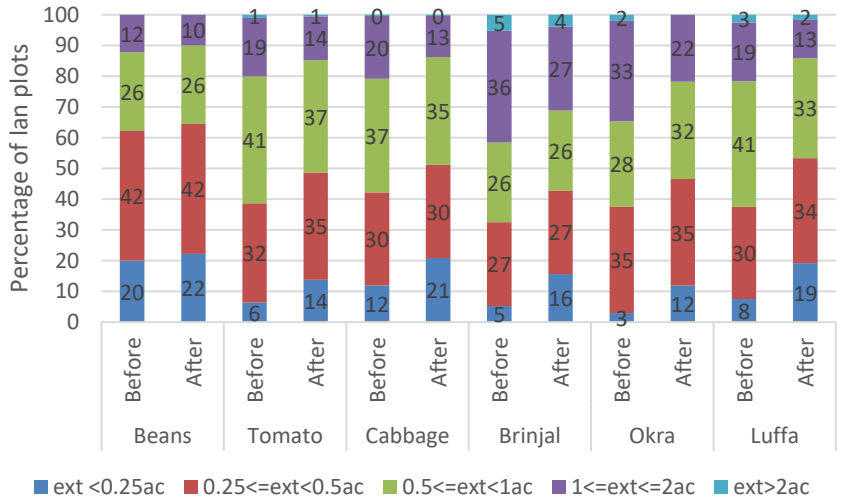
Except beans, all other five crops show the same pattern of land size distribution indicating more than 70 percent of the vegetable growers operated under the extent of less than one acre of land. Conversely, the smallest representation at less than two percent, a small fraction of vegetable farmers operate on land sizes larger than 2 acres and majority of them are brinjal farmers. Overall, these categories provide insights into the distribution of land sizes among vegetable growers, highlighting the diversity and varying scales of operations within the vegetable farming sector.

3.2.2 Changes in Land Used for Vegetable Production

In response to the fertilizer importation ban, farmers have adopted a risk minimizing strategy by reducing the extent of land under cultivation. Uncertainty surrounding the availability of chemical fertilizers has led authorities to advise farmers to cultivate fewer crops that are highly dependent on fertilizers. For instance, in Hanguranketha,

a major vegetable cultivation area in the Nuwara Eliya district, farmers have opted to cultivate paddy during the Yala season instead of vegetables as a coping mechanism. During the survey efforts were made to select farmers who cultivated the same plot with the same crop during two specific time periods to maintain consistency. However, this was not always successful. Under such circumstances, 76 percent of the respondents reported that the extent of cultivation on their selected land plot remained unchanged, but they had to abandon the cultivation of some plots due to the fertilizer issue. Another 21 percent of the surveyed farmers reduced their extent of cultivation due to fertilizer-related challenges.

Figure 3.4 in this survey illustrates the distribution of land sizes for various vegetables before and after the implementation of the chemical fertilizer import ban. Across all crop types, farmers have reduced the land under cultivation due to limitations in the availability of essential inputs and as a strategy to minimize risks associated with fertilizer scarcity.



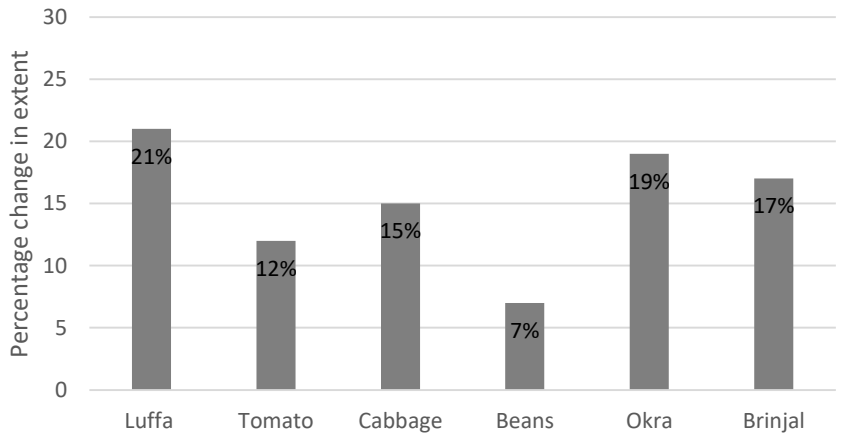
Source: HARTI survey data, 2022

Figure 3.4: Land Size Distribution Before and After the Policy Change

A t-test was conducted to examine the statistical significance of the change in land extent under vegetable cultivation between the 2021/22 Maha season and the 2020/21 Maha season, just before the fertilizer policy change. The t-test results indicate that there is a significant reduction in the land extent under cultivation in the 2021/22 Maha season compared to the previous normal season. On average, the difference in land extent is 0.105 acres. This finding suggests that the fertilizer policy change has had a noticeable impact on the land area dedicated to vegetable production, leading to a decrease in cultivation size during the specified time frame.

Figure 3.5 presents average changes in land extent during the 2021/22 Maha season, revealing notable variations across different crops. Among the crops analyzed, Luffa exhibited the highest reduction in land extent, followed by Okra and Brinjal.

Conversely, bean cultivation experienced the least reduction in land extent. This observation can be attributed to beans being predominantly cultivated in small land plots located in upcountry areas. Consequently, reducing the extent of land allocated to bean cultivation may not be a feasible solution for farmers engaging in its intensive cultivation. It is important to consider that, as discussed in the demographic section, a significant proportion of these growers are full-time farmers who rely on their crops for subsistence. Thus, they are compelled to engage in cultivation activities to meet their basic needs.



Source: HARTI survey data, 2022

Figure 3.5: Average Extent Reduction as a Percentage

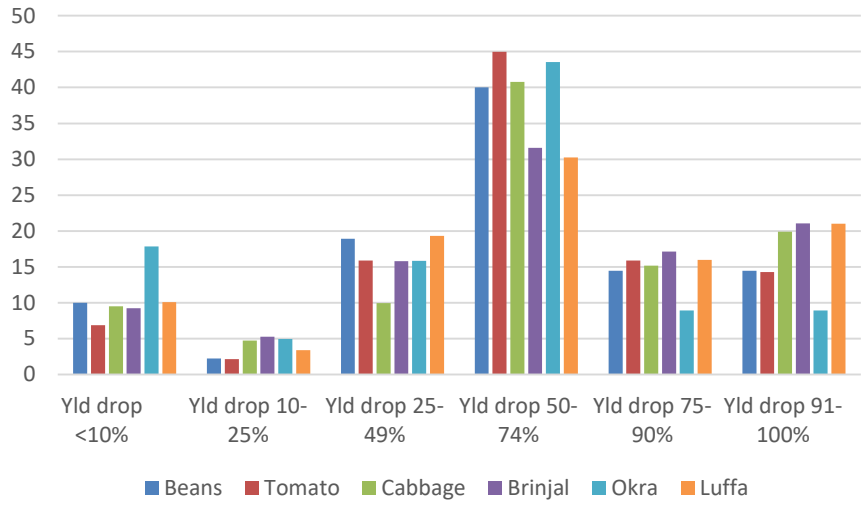
3.3 Vegetable Production Before and After Import Ban

3.3.1 Vegetable Production

Conventional vegetable farming systems in Sri Lanka rely heavily on chemical inputs such as fertilizers and pesticides. This study focuses on six main vegetables that are widely cultivated and represent two primary vegetable production systems in the country: (i) continuous vegetable cultivation in hilly areas like Nuwara Eliya and Badulla districts, and (ii) rice-based seasonal vegetable cultivation in mid and low-lying regions.

The study findings reveal a significant decrease in vegetable outputs during the 2021/21 Maha season, compared to the normal cultivation season of *2020/21 Maha* season. The estimated average yield loss in the *2021/22 Maha* season in proportion to the normal season's average yield ranged from 0 to 100 percent across different crops. This sentence has no meaning. Zero losses mean no losses and 100 percent mean completely losses. If it is true, there should be explanation. This sentence looks like a topic sentence.

Results indicate that the majority of farmers cultivating these six vegetables experienced over 50 percent reduction in yields due to fertilizer-related issues in the *2021/22 Maha* season. As a result, they resorted to using a combination of chemical fertilizers and organic fertilizers in an attempt to mitigate the yield decline. Figure 3.3 provides a visual representation of the categorized percentage yield loss for each crop.



Source: HARTI survey data, 2022

Figure 3.6: Yield Reduction as a Percentage

In terms of beans, the data shows that a minimal proportion of farmers experienced a yield drop of less than 10 percent. However, a notable portion, approximately 40 percent, reported a yield drop ranging from 50% to 74%. This indicates that a considerable number of bean farmers encountered substantial challenges and experienced significant decreases in their bean production during the *2021/22 Maha* season compared to previous average season.

For tomatoes, a similar trend is observed. Around seven percent of tomato farmers experienced a yield drop of less than 10 percent, indicating a relatively stable tomato production for a small group. However, a larger proportion, approximately 45 percent, reported a yield drop ranging from 50% to 74%. This suggests that a significant number of tomato farmers faced significant obstacles and encountered considerable reductions in their tomato yields during the specified season soon after the fertilizer and agrochemical import ban.

Data gathered from cabbage farmers also reveals that a small percentage of farmers, around 9 percent, experienced a yield drop of less than 10 percent. However, a significant portion, approximately 41 percent, reported a yield drop ranging from 50% to 74%. In the case of brinjal, a similar pattern emerges as approximately nine percent of farmers experienced a yield drop of less than 10 percent. However, around 32 percent reported a yield drop ranging from 50% to 74%. This indicates that a

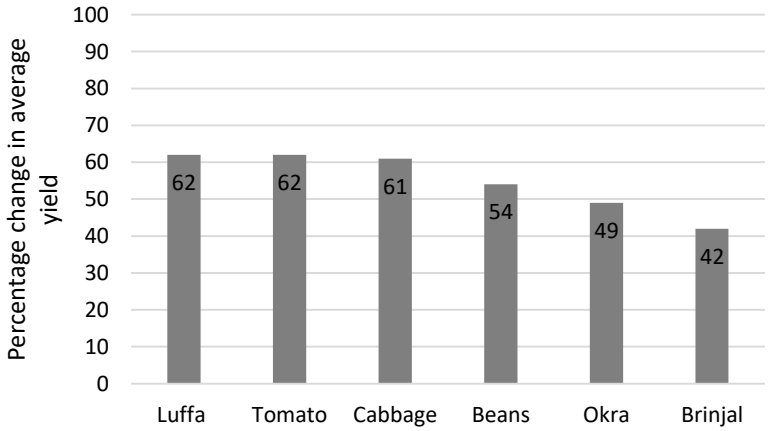
significant number of brinjal farmers encountered considerable difficulties and observed notable decreases in their brinjal yields during the specified season.

The data related to okra suggests that approximately 18 percent of farmers experienced a yield drop of less than 10 percent, signifying relatively stable okra production for a minority of farmers. However, a substantial proportion, about 44 percent, reported a yield drop ranging from 50% to 74%. Luffa farmers also exhibit the same pattern in the yield reduction related to fertilizer import ban. Majority of 30 percent reported a yield drop ranging from 50% to 74%.

Overall, the data reveals a significant variation in yield drops across different crops during the *2021/22 Maha* season. In each crop, except okra, there are nearly 30 percent of the farmers who have experienced more than 75 percent of the yield reduction compared with the average season. While some farmers managed to maintain relatively stable production levels, a substantial proportion experienced substantial yield reductions.

3.3.2 Vegetable Productivity

Fertilizers provide essential nutrients to plants, promoting growth and increasing yield. Without access to required fertilizers in required quantities in necessary time, vegetable crops may experience reduced productivity in the short term. This could lead to smaller harvests and lower overall crop quality. Survey findings revealed that up-country and low-country vegetable production productivity significantly declined in the 2021/22 Maha season when compared to average 2020/21 Maha season. Estimated average yield loss in the 2021/22 Maha season in proportion to the previous season average yield shows a production loss varying from 0 to 100 percent. On average, farmers experienced more than 57 percent average yield loss per acre. They experienced this yield reduction despite using some chemical fertilizers in combination with organic fertilizers. The Figure 3.7 illustrates the productivity loss in each vegetable studied.



Source: HARTI survey data, 2022

Figure 3.7: Average Yield Reduction as a Percentage

3.3.3 Reasons for Yield Reduction

As discussed in the previous section most of the vegetable farmers have experienced a yield reduction in the 2021/22 Maha season comparable to 2020/21 Maha season. Farmers were asked to prioritize three main reasons that they believed as the main reasons for yield drop that they have experienced in that particular season. The responses were based on the ranking presented in Table 3.4.

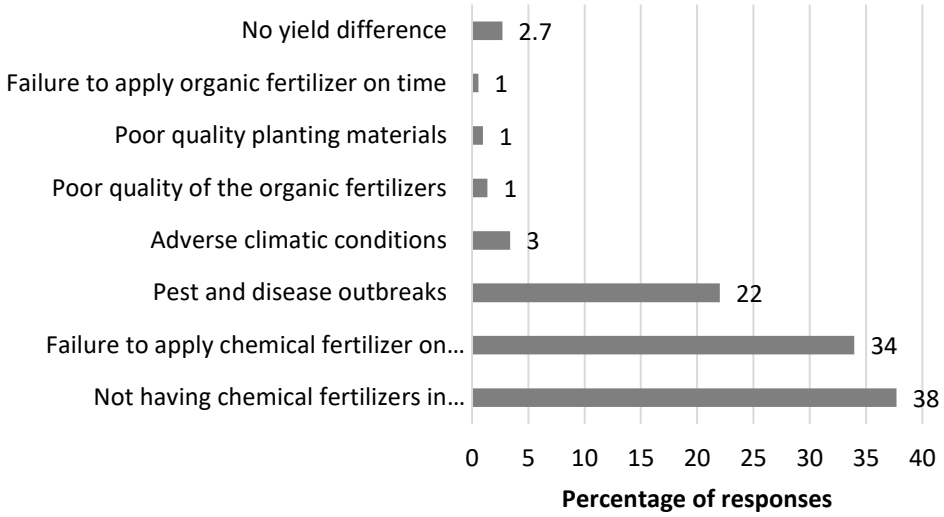
Top three causes identified are not having chemical fertilizers in required quantities, failure to apply chemical fertilizer in time and pest and disease outbreaks which were directly related to the import ban of chemical fertilizers and other agrochemicals.

Table 3.4: Main Three Reasons for Yield Reduction

Reason	1st Priority		2nd Priority		3rd Priority		Total	
	No.	%	No.	%	No.	%	No.	%
Not having chemical fertilizers in required quantities	335	45.6	251	39.0	70	18.1	656	34.3
Failure to apply chemical fertilizer on time	258	35.2	280	43.5	53	13.7	591	30.8
Pest and disease outbreaks	101	13.8	82	12.7	200	51.8	383	26.1
Adverse climatic conditions	12	1.6	17	2.6	30	7.8	59	4.0
Poor quality of the organic fertilizers	1	0.1	8	1.2	15	3.9	24	1.8
Poor quality planting materials	3	0.4	1	0.2	13	3.4	17	1.3
Failure to apply organic fertilizer on time	2	0.3	4	0.6	4	1.0	10	0.6
No yield difference	20	2.7						

Source: HARTI survey data, 2022

Figure 3.8 graphically represents the main causes summarized for the yield reduction as an average response. The most commonly reported reason is unavailability of chemical fertilizers in required quantities, as brought up by 38 percent of the respondents. This indicates that farmers faced challenges in obtaining an adequate supply of chemical fertilizers which are essential for promoting plant growth and increased yields. Another significant factor contributing to yield reduction reported by 34 percent is failure to apply chemical fertilizers on time. Timely application of fertilizers is crucial for providing essential nutrients to crops at specific growth stages. Another 22 percent expressed pest and disease outbreaks as a reason for yield reduction because these vegetables are highly susceptible to pest and disease outbreaks. In conventional farming systems farmers use a range of pesticides to avoid the pest and disease incidence as a precautionary measure. With the import ban of other agrochemicals farmers were not able to control pests and disease successfully. Adverse climatic conditions were mentioned in only three cases, indicating that unfavorable weather conditions such as drought, excessive rainfall, or extreme temperatures may have adverse impact on crop growth and yield.



Source: HARTI survey data, 2022

Figure 3.8: Main Reasons for Yield Reduction as a Percentage

CHAPTER FOUR

Nutrient Management and Pest and Disease Control

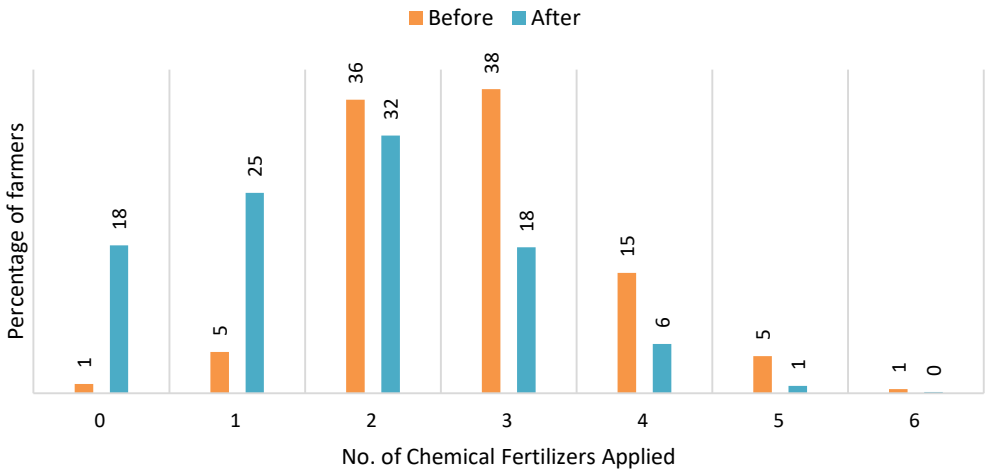
The vegetable cropping systems in Sri Lanka exhibit several notable features, including a high degree of cropping intensity, limited crop rotations involving short-duration crops, frequent tillage practices, and over-reliance on fertilizers. This intensive form of cultivation leads to removal of significant amounts of plant nutrients from the fields, owing to the high biomass yield produced within a brief span of two to four months. Consequently, regular application of both organic and inorganic fertilizers is essential to sustain the high levels of productivity, particularly when utilizing improved crop varieties. The ban on fertilizers and agrochemicals in Sri Lanka has necessitated a paradigm shift towards sustainable practices for nutrient management and pest and disease control in agriculture. Farmers are adopting organic alternatives such as composting, crop rotation, and green manure to enrich soil fertility and ensure proper nutrient balance. Accordingly, this section focuses on examining the supply and usage patterns of chemical and organic fertilizer and other pest and disease control substances supply and usage in the period leading up to and following the import ban on chemical fertilizer and other agrochemicals.

4.1 Chemical Fertilizer Usage

Literature related to fertilizer consumption in the Sri Lankan vegetable production sector consistently highlighted the point that farmers overuse fertilizers and other agrochemicals (Padmajani et al, 2014). Several studies have reported that the usage of fertilizers in upcountry vegetable cultivation was higher than the recommended rates (Wijewardhana and Amarasiri, 1993;1997, Wijewardhana et al., 2001, Wijewardhana., 2001a, b and c). Excessive use of chemical fertilizers not only increases the cost of production, but also contributes to the environmental quality (Ariyapala and Nissanka, 2006). However, indiscriminate use of fertilizers continues in these cropping systems throughout the year with least consideration on soil quality, partly due to the low cost of subsidized chemical fertilizer. Studies on fertilizer usage in intensively cultivated vegetable soils have been conducted during the period when the material subsidy on chemical fertilizers have been in place (Weerahewa et al., 2010). In addition to the references quoted above, Kendaragama (2006) studied the fertilizer usage in different cropping systems in Sri Lanka when the “Kethata Aruna” fertilizer material subsidy programs were in place and reported that chemical fertilizer usage for vegetables in upcountry vegetable cropping systems varied from 100 to 425% of the recommended level (Upekshani et al., 2018).

Subsequently, this section details how the recent fertilizer policy importation ban affected the above situation. Figure 4.1 illustrates the number of different chemical fertilizers applied to vegetables 2020/21 Maha season (before) and 2021/22 Maha season (after) soon after the policy change. Earlier, farmers who did not apply any chemical fertilizer were nearly one percent and soon after the policy change, 18

percent of the surveyed vegetable farmers have not applied any chemical fertilizer to their field.



Source: HARTI survey data, 2022

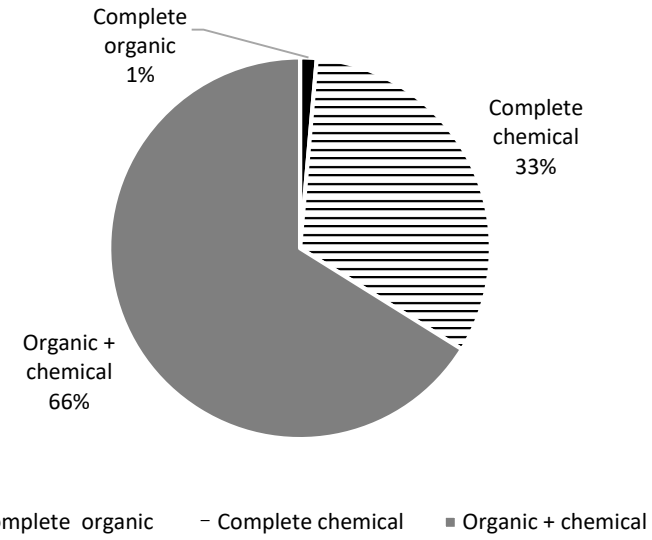
Figure 4.1: Number of Different Chemical Fertilizers Applied Before and After the Policy Change

Furthermore, when there was no restriction of fertilizers in the market, the majority of 59 percent had applied three or more types of chemical fertilizers to their vegetable cultivations. Once the fertilizer restriction came into effect the proportion of farmers who applied more than three types of fertilizers was reduced to a quarter.

4.2 Farmer Perception on Plant Nutrient Management and Willingness to Pay for Fertilizer

Sustainable nutrient management should be based on being capable and effective in presenting economic, social, and environmental benefits. The nutrient cost is increasing rapidly, and high nutrient amounts are utilized to give high crop yields, which remove nutrients and require high inputs. It is therefore necessary to provide more food at an affordable price, failing which leads to high production costs. Hence, both productivity and nutrient use efficiency must be enhanced (Panhwar et al., 2019). With the introduction of high yielding varieties that produced bumper harvest with high chemical inputs, the government of Sri Lanka introduced subsidy programmes for chemical fertilizers in a move to encourage farmers to utilize the fertilizer apply it on the field. Generally, food is grown as economically as possible, allowing farmers to make a living and making the crop affordable for everyone. The use of chemical fertilizers and pesticides, together with excessive water use and fossil fuels, and frequent planting of single crops are corner stores of conventional farming practices. Nevertheless, in the long term, conventional farming practices are not sustainable. The fertilized soil becomes toxic with chemicals and low in nutrients. Usable land becomes, scarce and the use of water and energy becomes high, with financial costs and it is not environmentally friendly (Cowling, 2013).

With this conventional setting in the field of vegetable production, the study gathered information on farmer perception on plant nutrient management and willingness to pay for the fertilizers. Majority of 66 percent of the respondents believed that the most effective and sustainable plant nutrient management method is a combination of both organic and inorganic fertilizers (Figure 4.2). Another 33 percent of the vegetable farmers believe that applying 100 percent chemical fertilizer is the most suitable way while nearly one percent believe that required nutrients to the plants can be provided by means of organic fertilizers.



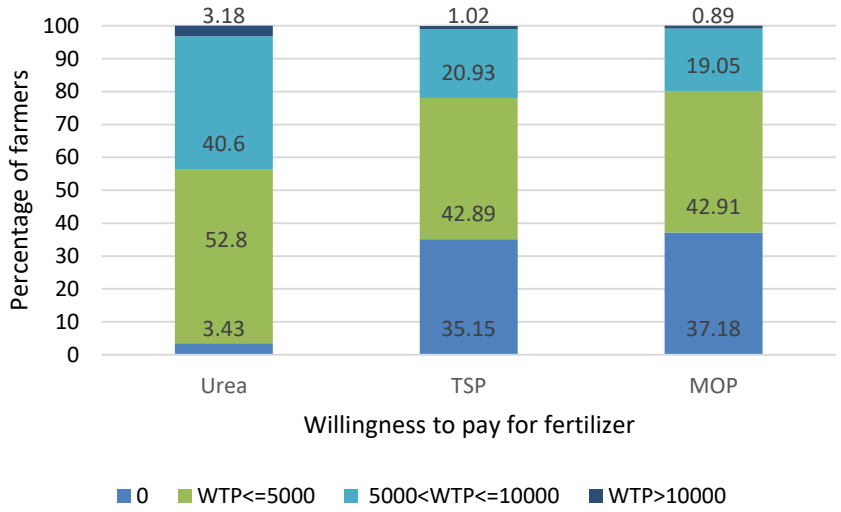
Source: HARTI survey data, 2022

Figure 4.2: Farmer Perception on Farm Nutrient Management

The general public, including farmers, is of the view that the government is responsible for providing agricultural inputs, particularly fertilizer, at a low cost to farmers. Interviews carried out with farmers reveal that the fertilizer subsidy is the only relief they have in terms of decreasing the rising production cost. They were unable to reap the benefits of the recent sharp increase in vegetable prices because of the exacerbating inputs, labor, and transport costs. A sudden withdrawal of the subsidy would push farmers into low-income brackets, further worsening the situation. However, under the current scenario of high cost and low availability of chemical fertilizer when inquired about their expectations in granting chemical fertilizer in the form of subsidy in the future, majority of the vegetable farmers (67%) responded in the negative and added that they prefer to buy quality fertilizer at a reasonable price from the open market. However, 30 percent of the farmers expect to receive fertilizer as an in-kind subsidy, while three percent prefer to have cash grants for fertilizer in the future.

According to the field survey, since crop farming is the primary source of a household's income, farmers are willing to purchase and apply required inputs at any cost. But at the time of the survey, at the outset of July – September 2022, fertilizer and

agrochemical prices in the market were high and unregulated and almost all the farmers were complaining about it. Hence, farmers were asked about their willingness to pay for three main fertilizers, Urea, Muriate of Potash and Triple Superphosphate. Figure 4.3 illustrates the categorized farmer willingness to pay for three main fertilizers. Most of the farmers are willing to pay an even higher price to apply Urea on their fields, followed by TSP and MOP.



Source: HARTI survey data, 2022

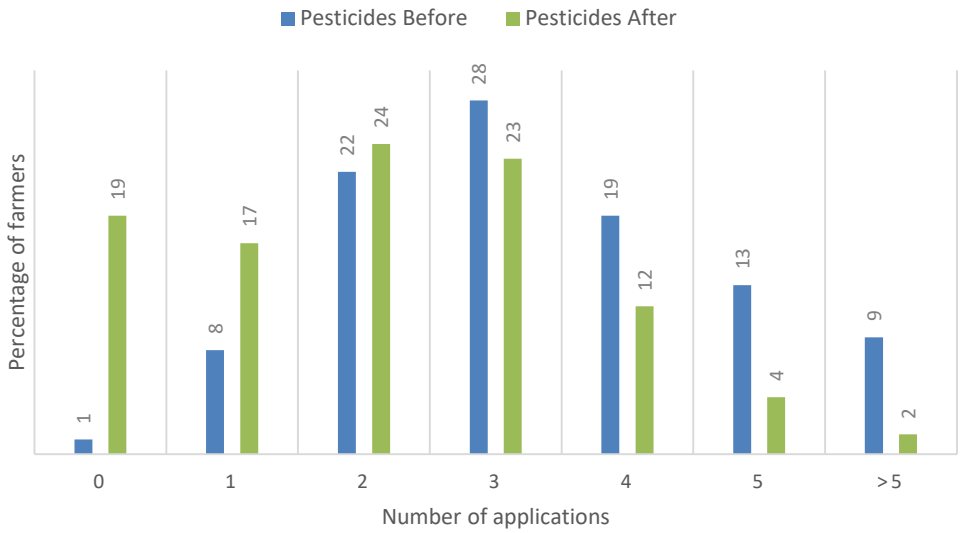
Figure 4.3: Farmer Willingness to Pay for Three Main Fertilizers

4.3 Pest and Disease Management

Vegetables are vastly different from most perennial crops as they have a short period of about 2-3 months in the field but produce high quantities of biomass. Therefore, most farmers in the upcountry tend to use high quantities of pesticides and fertilizers. Especially the cold and humid climatic conditions combined with high yielding varieties of crops and an increased use of chemical fertilizers provides a conducive environment for the development and multiplication of pests and diseases.

On the other hand, consumer demand and price for vegetables depend on healthy, succulent and fresh-looking vegetables with no visible rashes or damages caused by pests or diseases. In order to satisfy this demand, farmers have to tackle pest and disease problems. The use of agrochemicals including pesticides has been recognized to be an immediate and cheaper way to produce unblemished vegetables and increased farm productivity. This practice has unfortunately created numerous problems associated with pesticide abuse as mentioned earlier.

According to Figure 4.4 indicating the number of pesticide applications for different crops before and after the policy change, the number of pesticide applications has decreased considerably soon after the chemical importation ban.



Source: HARTI survey data, 2022

Figure 4.4: Number of Pesticide Applications Before and After the Policy Change

Under normal circumstances, the percentage of farmers who did not apply any pesticide is negligible, while with the restriction that number has increased to 19 percent. When agrochemicals are freely available at lower cost in the market more than 69 percent of the respondents sprayed three or more rounds of pesticides to the selected plot. Conversely, soon after the agrochemical restrictions, the same set of farmers who are cultivating the same crop in the same field have applied fewer rounds of pesticides. Crop wise analysis gives a more realistic picture because chemical application varies by crop.

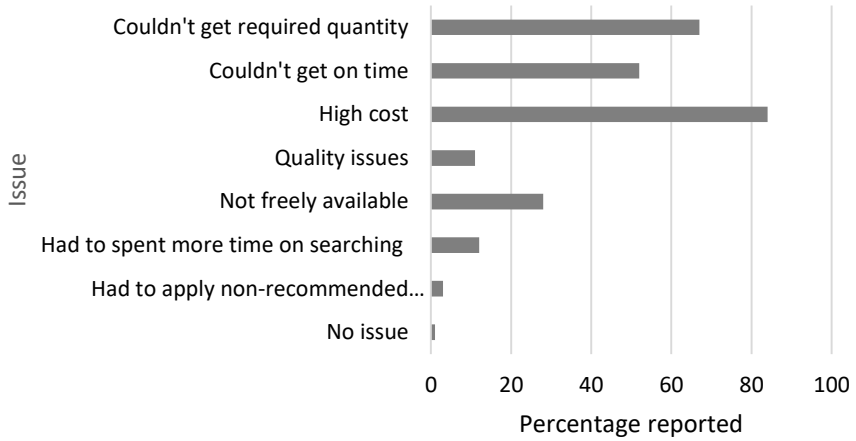
Concerning weed management using manual weeding methods, it has not changed with the policy change except the number of labour days and cost of labour. Wage rate changes over the two time periods are statistically significant while the number of man days deployed for the task was not statistically significant.

4.4 Agrochemical Acquisition and Availability

Key informant interviews and focus group discussions revealed that other adverse effects are likely such as rent-seeking behaviour, creation of monopoly power, importation of substitutes with sub-standard quality, and illegal trade of banned items has been reported soon after the sudden import ban. However most of the farmers have applied at least one type of chemical fertilizer to their vegetable crop.

Findings revealed that 70 percent of the farmers were able to purchase chemical fertilizers in the open market for the 2021*/22 Maha* season, while another 21 percent of the farmers have used the stocks they have purchased earlier. After the implementation on import restrictions on agrochemicals farmers had faced serious issues in acquiring required quantities of chemical fertilizers in the *2021/22 Maha*

season even though the restrictions were relaxed. Main issues pointed out by the farmers were high cost of fertilizers and inability to find required amount in required time (Figure 4.5).



Source: HARTI survey data, 2022

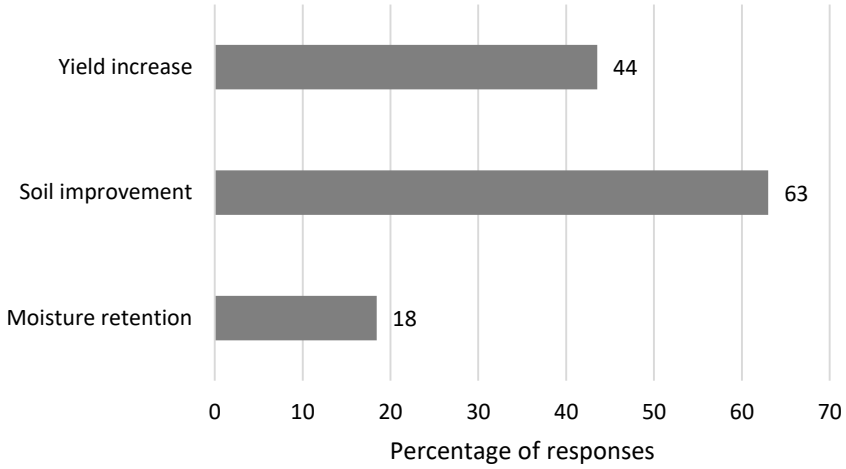
Figure 4.5: Difficulties Encountered in Obtaining Fertilizers

4.5 Organic Fertilizer Availability, Use and Issues

The aim behind the imposition of a ban on the importation of chemical fertilizers and other agrochemicals was to encourage a transition from conventional farming methods reliant on chemical inputs to more sustainable practices that utilize organic fertilizers. As a result of the limited availability of chemical fertilizers in the market, coupled with the discontinuation of chemical fertilizer subsidies, farmers are now compelled to rely on organic substances for the supply of plant nutrients, regardless of their prior inclination to do so. This segment of the report presents the on-site observations and outcomes pertaining to organic fertilizer usage, production, as well as encountered issues.

4.5.1 Application of Organic Fertilizers in Vegetable Production

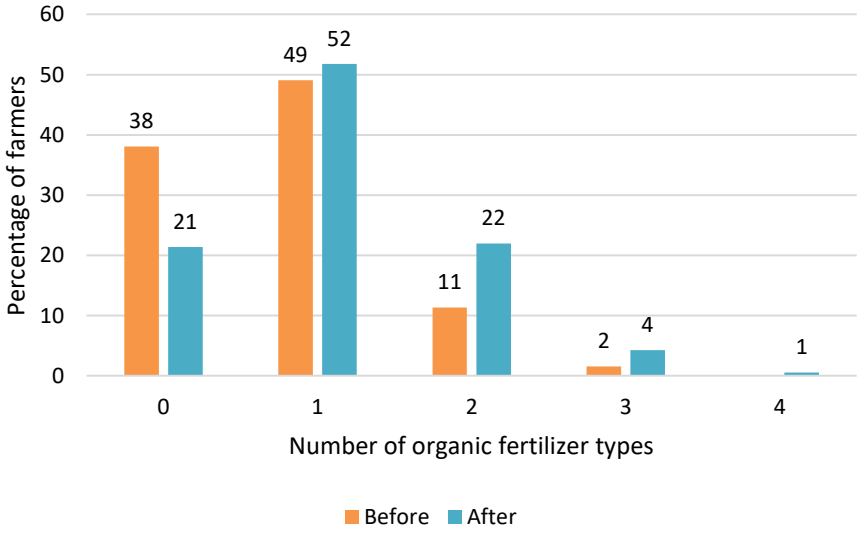
With the advent of the organic agriculture movement, farmers have been encouraged to adopt organic fertilizers as a replacement for chemical fertilizers. Prior to the government's declaration of the organic movement, a substantial proportion (64 percent) of vegetable farmers utilized organic fertilizers, recognizing their positive impact on soil quality, moisture retention, and crop yield (Figure 4.6).



Source: HARTI survey data, 2022

Figure 4.6: Purpose of Adding Organic Fertilizers

Figure 4.7 illustrates various types of organic substances employed by vegetable growers during two seasons under study. Prior to the ban on chemical fertilizer imports, 38 percent of surveyed vegetable farmers did not utilize any organic substances in their cultivation practices. However, following the implementation of the ban, this figure decreased to 21 percent. Consequently, a majority of farmers have integrated at least one type of organic substance into their fields, aligning with the principles of the organic agriculture movement.

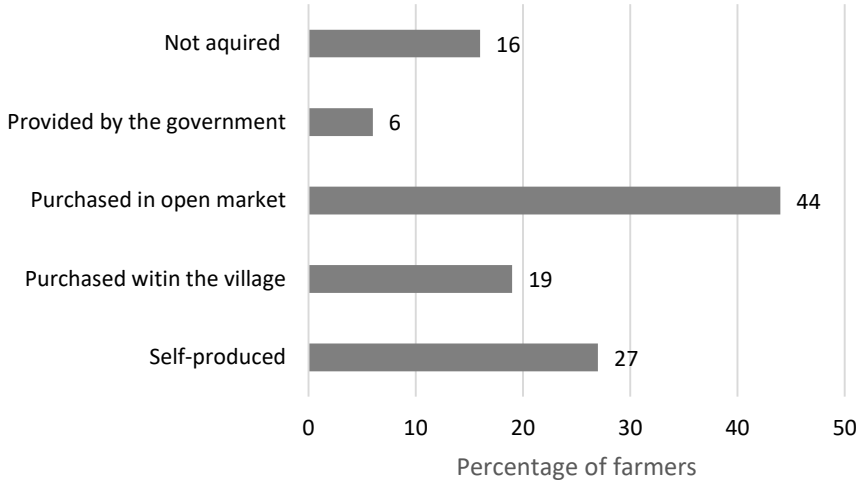


Source: HARTI survey data, 2022

Figure 4.7: Number of Different Organic Fertilizers Applied

4.5.2 Types and Source of Organic Fertilizers

Despite the diverse range of organic substitutes advocated by government and private sector agencies, the primary types of organic fertilizers employed by farmers consist of poultry manure (68%), compost (27%), and cow/goat dung (20%). Taking into account the accessibility of input substances within their surroundings, the government encourages farmers to produce their own organic fertilizers. However, as depicted in Figure 4.8, only 27 percent of vegetable farmers had engaged in the production of organic fertilizers independently. The majority (48 percent) relied on commercially available organic fertilizers in the open market while an additional 19 percent purchased organic fertilizers from local producers within their village.

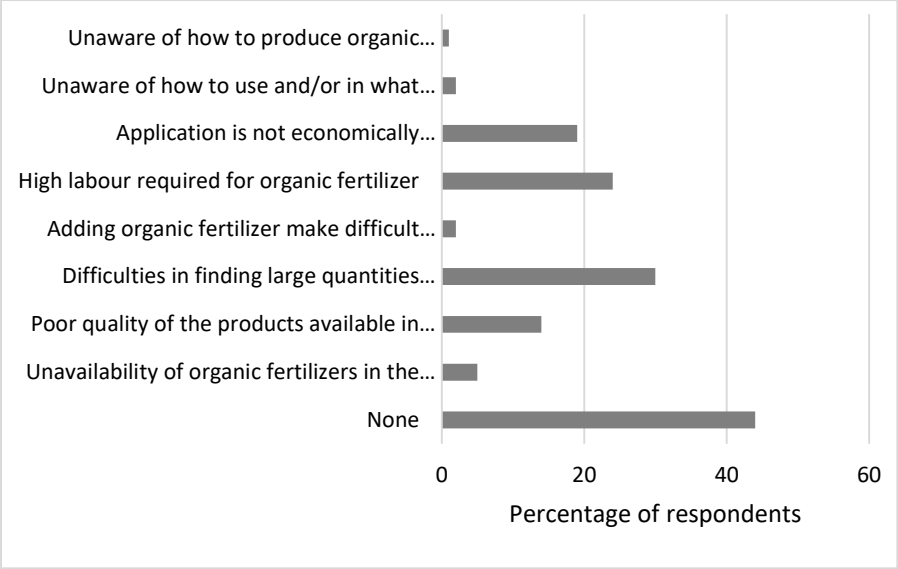


*Multiple responses
Source: HARTI survey data, 2022

Figure 4.8: Source of Organic Fertilizers

4.5.3 Issues of Using Organic Fertilizer

Farmers were asked about the issues they encountered while using organic fertilizers. The survey responses shed light on the reasons behind the usage patterns of organic fertilizers among vegetable farmers. The main difficulty faced by the majority of the users was sourcing large quantities of organic fertilizers required for their fields. The requirement for high labor inputs was cited by 24 percent of farmers as a hindrance to using organic fertilizers. Moreover, 19 percent of farmers considered the application of organic fertilizers as economically unsustainable. Additionally, 14 farmers expressed concerns regarding the poor quality of the products available, while five farmers reported the unavailability of organic fertilizers in the market. These factors collectively contribute to the varied adoption rates and utilization challenges of organic fertilizers among vegetable farmers as illustrated in Figure 4.9.



*Multiple responses

Source: HARTI survey data, 2022

Figure 4.9: Issues in Organic Fertilizer Use

CHAPTER FIVE

Household Food Security and Wellbeing of Farming Community

The aim of this chapter is to provide evidence and discuss the socioeconomic status and wellbeing of vegetable farmers after the ban of the importation of agrochemicals. Furthermore, this chapter discusses the status of food security of the vegetable farming community and measures/coping strategies taken to maintain their household food security.

5.1 Food Consumption

5.1.1 Categories of Food Consumption Score

In order to assess the food consumption status of the community the study collected data on the number of days on which different food groups were consumed by respective households in a week. This was carried out by using the standard questionnaire used by the WFP in their food security assessments.

According to the CARI method Food Consumption Score (FCS) is calculated using the following equation.

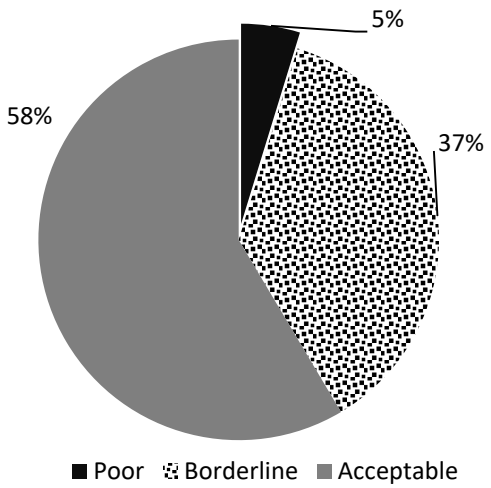
FCS = (FCSStap*2) + (FCSPulse*3) + (FCSDairy*4) + (FCSPr*4) + (FCSVeg*1) + (FCSFruit*1) + (FCSFat*0.5) + (FCSSugar*0.5)

Where;

FCS - food consumption score
FCSSta - number of days over the last 7 days, that members of the household eat cereals, rains, roots and tubers
FCSPulse - number of days over the last 7 days, that members of the household eat legumes/nuts
FCSDairy - number of days over the last 7 days, that members of the household drink/eat milk and other dairy products
FCSPr - number of days over the last 7 days, that members of the household eat meat, fish and eggs
FCSVeg - number of days over the last 7 days, that members of the household eat vegetables and leaves
FCSFruit - number of days over the last 7 days, that members of the household eat fruits
FCSFat - number of days over the last 7 days that members of the household consume oil
FCSSugar - number of days over the last 7 days, that members of the household eat sugar, or sweets

After obtaining the FCS for individual households by executing above, those individual FCS values were then categorized into food security score classes using suitable threshold levels according to the country's food consumption characteristics. Countries with low sugar and oil consumption use the threshold levels of lowest to 21, 21.5 to 35 and 35 to highest whereas, countries with high sugar and oil consumption levels advised to use the threshold levels of lowest to 28, 28.5 to 42 and 42.5 to highest. This study used the second set of threshold levels with the understanding of sugar and oil food consumption being at a higher end. This selection also complies with the WFP's practice in assessing the food security levels in the Sri Lankan context. Accordingly, the share of community in poor, borderline and acceptable categories were calculated as below.

FCS= < 28 □ "poor"
FCS between 28.5 and 42 □ "borderline"
FCS beyond 42.5 □ "acceptable"



Source: HARTI survey data, 2022

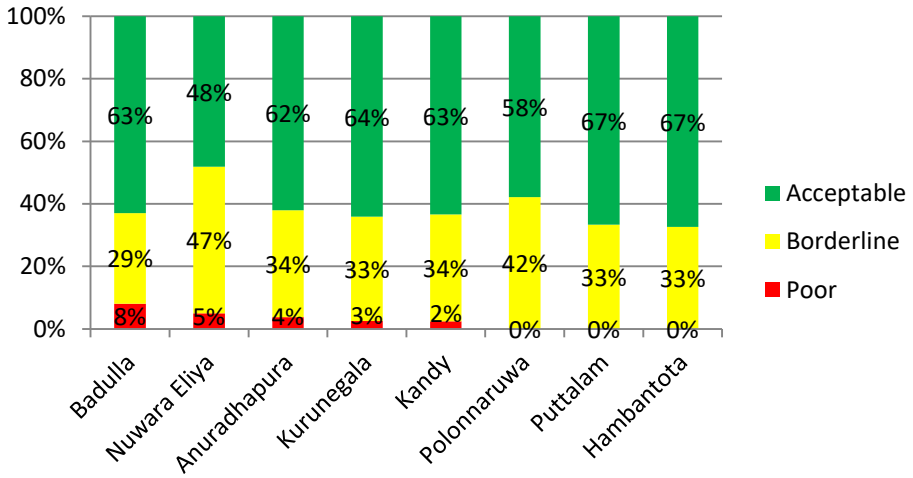
Figure 5.1: Distribution of Respondents According to FCS Categories

As shown in Figure 5.1, of the total respondents, 42 percent were not consuming adequate diets and out of that five percent were having poor food consumption scores. However, the majority (58%) of responded families had an acceptable level of food consumption score. The study sample largely consisted of rural sector agricultural communities, this figure complied with the rural sector food consumption score level of most recent assessments (June 2022) carried out by the WFP in Sri Lanka (WFP, 2022).

5.1.2 Variation of FCS Level across Districts

With respect to the district wise variation of the food consumption levels, Figure 5.2 shows the Frequency of households under each FCS class and variation across districts of the same. As it shows, in most of the districts more than 60 percent had an

acceptable level of food consumption except Nuwara Eliya district (42%) and Polonnaruwa district (58%). However, eight percent of the respondents in the Badulla district had a poor food consumption level which is more than the average level of the same category of the total sample. This result is also acceptable where the Badulla district has the highest poverty headcount in 2022 out of the districts considered for this study (Department of Census and Statistics, 2022).



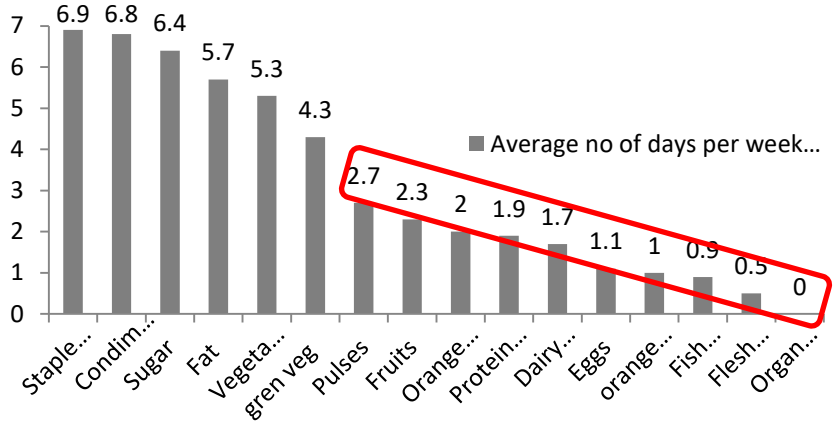
Source: HARTI survey data, 2022

Figure 5.2: Variation of FCS Level across Districts

5.2 Food Consumption Pattern

5.2.1 Consumption of Different Food Groups

As shown in Figure 5.3, the highest mean was recorded in the staple food (6.9 days per week) group followed by sugar (6.4 days per week), condiments (6.8) fat (5.7 days per week) and vegetables (5.4 days per week). In contrast, dairy products (only 1.7 days per week) and protein foods (1.9 days per week) remain the least consumed food groups during the week considered for the data collection. Despite the expected food consumption habit/pattern for a balanced diet, actual results show an imbalanced nature of the diet/foods consumed by the responded families, which is very much skewed towards high calorie intake from carbohydrates, sugar and fat with significantly low intake of protein, vitamins, and minerals.



Source: HARTI survey data, 2022

Figure 5.3: Summary of Consumption of Different Food Groups

These findings in relation to average intake of different food groups followed a similar trend with the recent empirical findings of similar assessment conducted by the WFP in Sri Lanka during the month of June 2022 (WFP, 2022). However, the average intake of food groups marked in red has further declined in comparison to results of the WFP study and this could be attributed to worsening of the economic status of the country as the data collection of this study was undertaken in the third quarter of 2022.

5.2.2 Nutrition Status of Food Consumption

In understanding the nutritional status of the food intake, average days of vitamin A rich foods, protein rich foods and Hem-iron rich food was calculated by summing up the number of days consumed by relevant food groups as in formulae below.

FGVitA = FCSDairy + FCSPrMeatO + FCSPrEgg + FCSVegOrg + FCSVegGre + FCSFruitOrg
FGProtein = FCSPulse + FCSDairy + FCSPrMeatF + FCSPrMeatO + FCSPrFish + FCSPrEgg
FGHIron = FCSPrMeatF + FCSPrMeatO + FCSPrFish

Where;
FGVitA - score of vitamin A rich food
FGProtein- score of protein rich food
FGHIron - score of protein rich food
FCSDairy - fCS of dairy foods
FCSPrMeatO - fCS of organ meat
FCSPrMeatF- fCS of flesh meat
FCSPrEgg- fCS of eggs
FCSVegOrg- fCS of orange vegetables
FCSVegGre- fCS of green and leafy vegetables
FCSFruitOrg- fCS of orange fruits
FCSPulse - fCS of pulses

After that, scores of FGVitA, FGProtein and FGHIron were categorized into three groups following the logic of 0 = 0 days; 1 through 6 = 1 to 6 days; 7 through 42 = 7 days. The obvious impact of food consumption pattern to the nutrition status of the consumers was clearly visible in the study findings as shown in Table 5.1.

Table 5.1: Variation of Food Intake in Terms of Different Nutrition Groups

	Vitamin A rich food		Protein rich food		Hem-iron rich foods	
Average No of Days consumed	No of families	%	No of families	%	No of families	%
0 days	2	0.26	22	2.85	251	32.26
1-6 days	162	21.09	399	51.68	515	66.2
7 days	604	78.65	351	45.47	12	1.54
Total	768	100	772	100	778	100

Source: HARTI survey data, 2022

According to the results, one third of responded families failed to ensure even a single day of intake of the Hem-iron which is a serious concern in terms of nutrition balance of the diets. This can lead to severe repercussions such as anemia in infants, young children and especially for pregnant and lactating mothers.

5.3 Food Based Coping Strategies Adopted in the Phase of Food Shortage

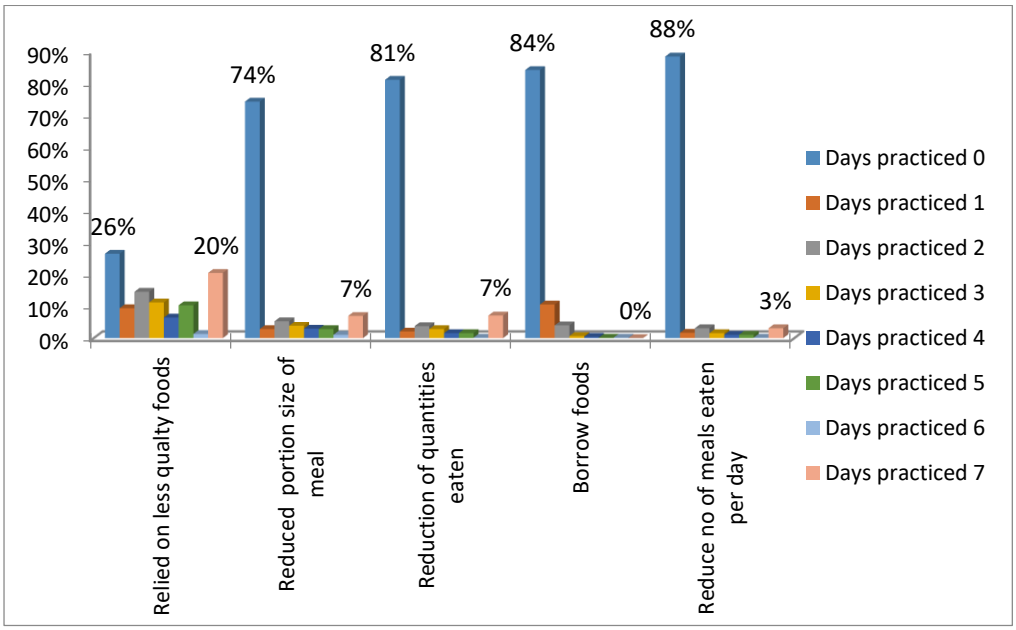
5.3.1 Variation of Adopting Food Based Coping Strategies

When disturbances occur, food availability and communities' access to food become affected . Under these situations people tend to adopt a range of coping actions as a means of changing their food consumption habits/patterns. Understanding of such actions is critical in designing both short term recovery actions and to build resilience against such incidence in the long run. Accordingly, the study made an attempt to collect data on food based coping actions carried out by the community using standard questions suggested in the CARI approach of food security assessment.

Accordingly, respondents were asked about whether they have practiced four food based coping actions relied on less preferred and less expensive foods; borrowed food or relied on friends or relatives to find food; reducing the number of meals eaten per day; reduce the portion size of the meal; and reduce the quantity eaten by adults/mothers for children. Where any of such actions were followed, they also asked about the frequency of practicing that action during the last month from the period of data collection.

Figure 5.4 shows the variation of the frequency of practicing selected food based coping actions by the respondents during the last 30 days. As shown in the graph, relying on less preferred food was the common practice of coping action (practiced by 74%) followed by reduction of the meal size (practiced by 26%). It is also worth

mentioning that except for borrowing foods, all other coping actions were practiced through the week by 20 percent (relied on less preferred foods) to three percent (reduce the number of meal eaten a day) of the community.



Source: HARTI survey data, 2022

Figure 5.4: Frequency of Adopting Food Based Coping Strategies

5.3.2 Food Based Coping Strategy Index Score (rCSI)

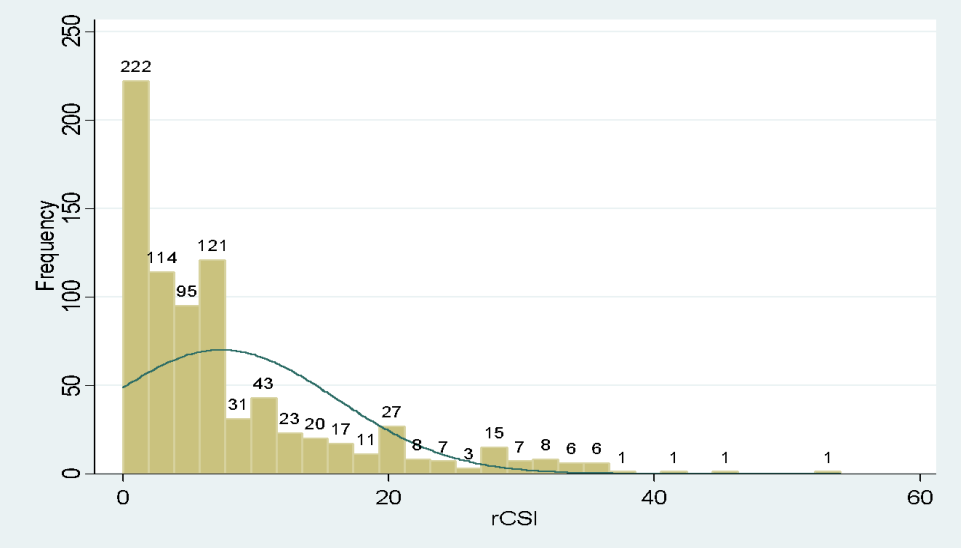
In addition to the qualitative analysis, the study also attempted to understand the variation of adopting coping strategies in qualitative terms through calculating the food based coping strategy score (i.e. reduce coping strategy index - rCSI) for each household. Accordingly, rCSI was calculated by using following index;

rCSI = (rCSILessQlty) + (rCSIBorrow x 2) + (rCSIMealNb) + (rCSIMealSize) + (rCSIMealAdult x 3)

Where,
rCSI – reduced coping strategy index of the household
rCSILessQlty - rely on less preferred and less expensive food in the past 7 days
rCSIBorrow - borrow food or rely on help from a relative or friend in the past 7 days
rCSIMealNb - reduce number of meals eaten in a day in the past 7 days
rCSIMealSize - limit portion size of meals at mealtimes in the past 7 days
rCSIMealAdult - restrict consumption by adults in order for small children to eat in the past 7 days

While the maximum possible value for rCSI is 56, the recorded values of the rCSI for the entire sample population lies 0 to 54 with a mean value of 7.4. Distribution of the rCSI values showed a left skewed pattern (as shown in Figure 5.5) which implies that

the majority of households have not adopted food based coping actions to a greater extent.



Source: HARTI survey data, 2022

Figure 5.5: Distribution of rCSI Score

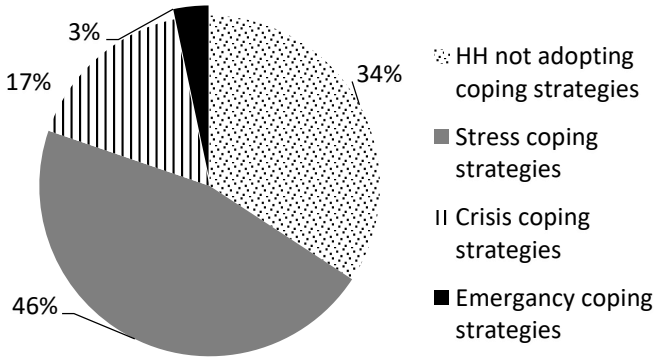
5.4 Livelihood Based Coping Strategies Adopted in the Phase of Food Shortage

5.4.1 Variation of Adopting Livelihood Based Coping Strategies

When the food shortage gets severe and when the access to food becomes significantly affected, people tend to adopt livelihood based coping strategies in addition to the food based coping strategies. Therefore, the study also tried to understand the situation of the sample community in terms of their tendency to adopt livelihood based coping actions. For that also studies used a standard set of questions identified in the CARI method of food security analysis, which are commonly practiced by WFP. These questions were designed in a way to understand the status of severity of the need for coping actions under three categories namely, stress, crisis and emergency situation. As the severity of the food shortage and its consequences on households increased, the nature of coping actions changed from stress to emergency. Subsequently, the impact or disturbances to their livelihood caused due to adopting respective coping actions progressed through stress to emergency coping actions. As a standard way of practice, the study set four questions to capture coping actions adopted under stress situations, and three each to capture coping actions adopted under crisis and emergency situations.

Respondents were asked whether they needed to practice each of ten selected coping actions (under three categories) at least once during the last 30-day period from the point of data collection. Their responses were represented in Figure 5.6, where one

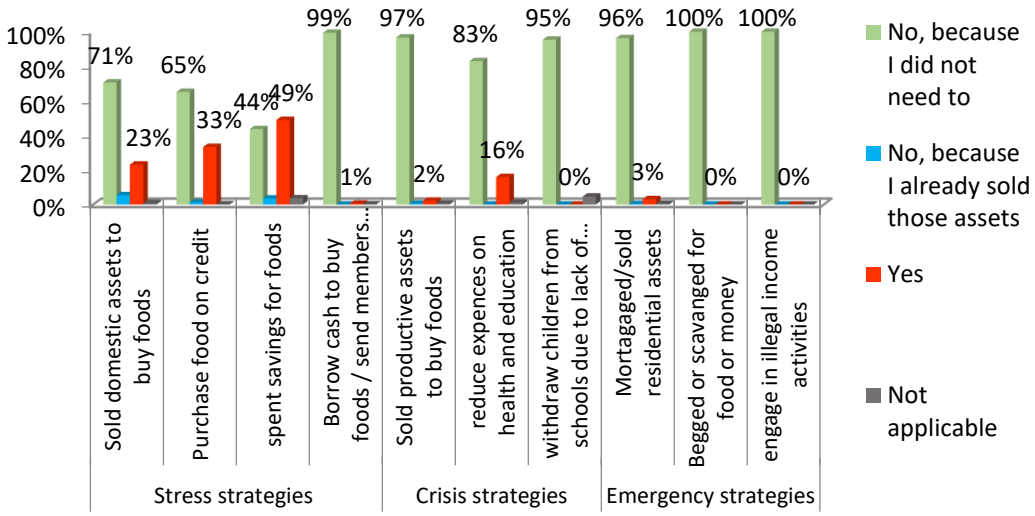
third of the sample has not adopted any livelihood based coping action while 46 percent had to adopt stress situation-livelihood based coping actions.



Source: HARTI survey data, 2022

Figure 5.6: Variation of Adopting Livelihood Based Coping Strategies

First three of stress-situation livelihood based coping actions i.e., sold domestic assets to buy foods, purchased food on credit and spent savings for foods were adopted by 30, 35 and 56 percent of the sample respectively. Except for 'reducing expenses on health and education' (practiced by 16%); and mortgaged or selling residential assets (practiced by only 3%), none of other coping actions were adopted by the sample households (Figure 5.7). This again confirmed that the sample population has not undergone serious consequences driven by the food shortage.

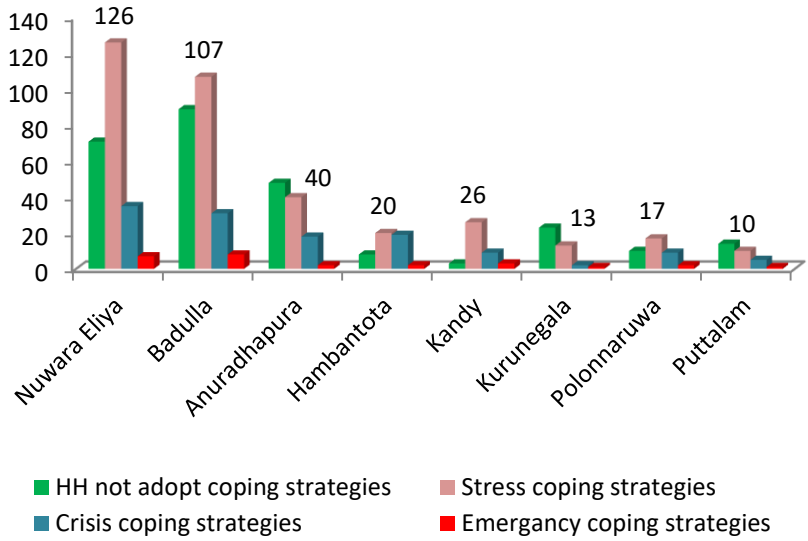


Source: HARTI survey data, 2022

Figure 5.7: Frequency of Adopting Livelihood Based Coping Strategies

In terms of district wise variation in adopting livelihood based coping strategies, Nuwara Eliya, Badulla and Anuradhapura districts recorded the first second and third highest number of households which have adopted livelihood based coping strategies (Figure 5.8). Compared to other districts, Badulla and Nuwara Eliya districts have a

higher poverty headcount which explains the high incidence of adoption of livelihood based coping strategies during food shortage.



Source: HARTI survey data, 2022

Figure 5.8: District Wise Variation in Adopting Livelihood Based Coping Strategies

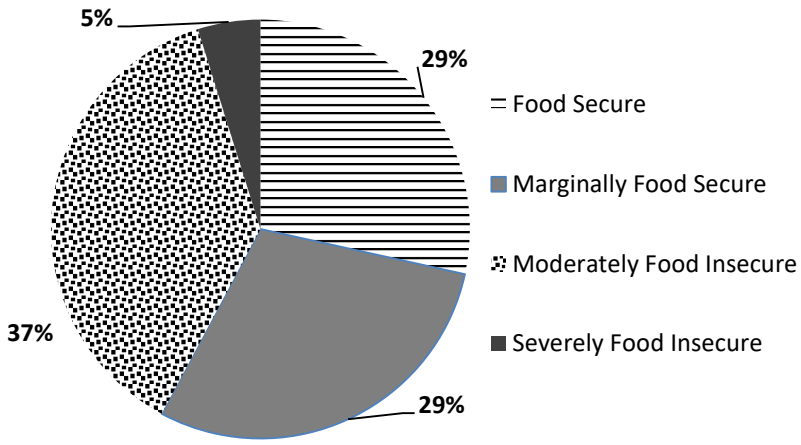
5.5 (Overall) Food Security Status

Following the CARI approach, the study attempted to understand the overall food security of the sample households. Accordingly, calculated values of FCS and rCSI values were aggregated as shown below to derive the overall food security levels of the sample.

Table 5.2: Food Security Status Indicator

Domain	Indicator	Food secure	Marginally food secure	Moderately food insecure	Severely food insecure
Current status – food consumption	Food consumption score and, Reduced coping strategy index	Acceptable consumption and reduced Coping Index below 4	Acceptable consumption and reduced Coping Index 4 or above	Borderline consumption	Poor consumption

As shown in Figure 5.9, nearly two thirds of the sample population (58%) were at a food secure stage while 5 percent were severely food insecure.



Source: HARTI survey data, 2022

Figure 5.9: Food Security Status

The number of households remaining at food insecure level according to this study is slightly higher than that of the recorded value of the same group from the recent WFP study (WFP, 2022). The reason for this could be the worsened economic status of the country at the time of data collection as compared to the time of WFP study.

CHAPTER SIX

Findings and Recommendations

6.1 Major Findings

The study produced several key findings that hold significant value for decision-makers:

- The abrupt shift in fertilizer policy has led to a reduction in the land area allocated for vegetable cultivation.
- Farmers experienced an average yield loss exceeding 57 percent per acre, despite using a mix of chemical and organic fertilizers.
- Over 80 percent of farmers applied at least one type of chemical fertilizer, though at rates lower than the recommended levels.
- Prior to the government's declaration of an organic farming movement, 64 percent of vegetable farmers were already applying organic fertilizers, recognizing their benefits in improving soil health and moisture retention.
- A majority (66 percent) of respondents believe that the most effective and sustainable method of plant nutrient management is a combination of organic and inorganic fertilizers.
- Most farmers (61 percent) were unable to produce organic fertilizers themselves and relied on purchasing them from the market. However, they faced challenges in finding the necessary quantities, managing the high labor requirements, and maintaining the economic viability of organic fertilizers alone for commercial vegetable production.
- The majority of vegetable farmers expressed that having access to high-quality fertilizers at reasonable prices in the open market was more important than receiving a subsidy.
- Farmers also faced challenges due to the unavailability of quality organic fertilizers when needed, insufficient information and knowledge on transitioning to organic farming, and the lack of regulation in fertilizer quality and pricing.
- Despite these challenges, the findings suggest that most of the surveyed vegetable farming households were not at an acute stage of food insecurity.

6.2 Conclusions

The study examined the effects of the Imports & Exports (Control) Regulation No. 07 of 2021, which banned the importation of chemical fertilizers and pesticides on May 6, 2021. The findings revealed a significant yield gap between the 2020/21 Maha season and the 2021/22 Maha season for most vegetable crops, despite Sri Lanka's

traditionally low dependence on agrochemical inputs. This decline in agricultural productivity led to a considerable contraction in output, severe welfare losses, and negative consequences for food security.

Overall, the changes in fertilizer import policies have drastically impacted the productivity of vegetable farmers. Limited availability of fertilizers, rising costs, and the introduction of alternative fertilizers, coupled with instability in the agricultural sector, have significantly reduced farmers' ability to achieve optimal yields. These developments underscore the importance of policymakers considering the effects on farmers' livelihoods. To mitigate the adverse outcomes, it is crucial to provide support mechanisms such as improved access to affordable, high-quality fertilizers, technical training, and consistent agricultural policies. These measures are essential to ensure sustainable farming practices in the country.

The abrupt ban on chemical fertilizers without a comprehensive, phased transition plan disrupted agricultural productivity, causing challenges for farmers and jeopardizing food security. Although the goal of promoting organic farming is commendable, the success of such policies depends on a gradual, balanced approach that takes into account the agricultural sector's needs and capacities. A well-structured transition plan is necessary to move towards more environmentally sustainable practices without compromising the immediate productivity and food security needs.

To effectively implement a shift towards organic agriculture, a phased approach should be adopted, beginning with selected areas after a thorough analysis of key factors. Decision-making must involve a careful evaluation of soil fertility and the specific nutrient needs of the crops grown in each region. Additionally, understanding the socio-economic dynamics of local farming communities is essential to ensure that the transition aligns with their capacities and needs. A phased implementation allows for the gradual adaptation of farming practices, giving stakeholders the time required to acquire the necessary knowledge and resources for organic farming. By addressing these considerations, policymakers can create strategies that facilitate the sustainable adoption of organic agriculture while minimizing disruptions and promoting the long-term ecological and socio-economic benefits.

Over-reliance on imported chemical fertilizers and their subsidized prices is unsustainable both economically and environmentally. Therefore, transition from conventional farming methods is necessary but must be approached through a long-term, stepwise process. To achieve this goal, further adaptations in cropping systems, such as improved fertilization management, integrated pest control, and the inclusion of livestock, are required. These changes will help close current yield gaps and contribute to the development of truly sustainable, green farming systems.

To enhance yields under organic farming systems, government investment in research and extension services is essential. In particular, technological advancements such as optimized fertilization strategies based on biological nitrogen fixation, development

of plant-based pesticides, improved crop rotation practices, and innovations for labor-intensive tasks (e.g., weeding in rice cultivation) are necessary. Additionally, breeding crop varieties better suited to organic systems and integrating livestock with crop farming can support higher productivity in traditional agricultural systems. These efforts will ultimately enhance yields and foster the intensification of organic farming practices, making them more viable and sustainable for the long term.

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