IMPORT BAN OF FERTILIZER AND OTHER AGROCHEMICALS (2021): ASSESSING SHORT-TERM EFFECTS ON THE PADDY SECTOR

M.A.C.S. Bandara
Rifana Buhary
M.H.K. Rambodagedara

HARTI

Import Ban of Fertilizer and Other Agrochemicals (2021): Assessing Short-Term Effects on the Paddy Sector

M.A.C.S. Bandara
Rifana Buhary
M.H.K.Rambodagedara

Research Report No: 255 November 2023

Hector Kobbekaduwa Agrarian Research and Training Institute
114, Wijerama Mawatha
Colombo 07
Sri Lanka

First Published: 2023
ISBN: 978-624-5973-34-7

Bandara, M.A.C.S.
Import ban of fertilizer and other agrochemicals(2021) : assessing short-term effects on the paddy sector/ M.A.C.S. Bandara, Rifana Buhary and M.H.K. Rambodagedara. – Colombo : Hector Kobbekaduwa Agrarian Research and Training Institute, 2023.
xii,102 p. : figures ; 29 cm. - (Research report ; No. 255)

ISBN: 978-624-5973-34-7

i. 631.86095493 DDC 23 ii. Author
iii. Buhary, Rifana (co. author) iv. M.H.K. Rambodagedara (co. author)
v. Title vi. Series

1. Organic fertilizer-Sri Lanka
2. Agriculture -Sri Lanka
3. Rice-Sri Lanka

Hector Kobbekaduwa Agrarian Research and Training Institute
114, Wijerama Mawatha, Colombo 07
Sri Lanka

Final typesetting and lay-out by : Niluka Priyadarshani De Silva

Cover page design by : Udeni Karunarathna

Tel. Phone : +94 11 2696981
+94 11 2696437

Fax : +94 11 2692423

Email : librarian@harti.gov.lk

Web page : www.harti.gov.lk

Suggested citation: Bandara, M.A.C.S. Buhary, R., and Rambodagedara M.H.K, (2023). Import Ban of Fertilizer and Other Agrochemicals (2021): Assessing Short-Term Effects on the Paddy Sector. HARTI Research Report No: 255, Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo, Sri Lanka.

FOREWORD

In the realm of agricultural policy and practice, in 2021 the controversial decision to ban the import of fertilizer and other agrochemicals brought in both positive and negative dimensions with lasting implications on the local agriculture and its practices that shed light on the country's economy at large.

This study, focusing on the Short-Term Effects on the Paddy Sector in Sri Lanka, is particularly timely for assessing the consequences of this noteworthy policy change. The ban, aimed at reducing the reliance on synthetic fertilizers and agrochemicals, was a bold step towards bringing in sustainable and ecologically conscious agricultural practices. However, it came under heavy criticism given to many lapses in its implementation process and haphazardness.

In this study, a thorough examination of policy and reality is done on the situation that prevailed in the immediate aftermath of the import ban, particularly how its impact on the paddy cultivation.

This study is not merely confined to a set of data but reveals the associated changes into agricultural practices and its community and the measures that they took to adapt. It unveils the resilience of communities as they seek new pathways and opportunities in the face of transformation. I believe the findings will provide new insights into policymaking with regard to formulating the national agricultural policy.

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

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Dr. G. G. Bandula, Director/Chief Executive Officer (CEO), and former Director Mr. Malinda Seneviratne of the Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI). Their invaluable guidance and support were vital in publishing this report. Our heartfelt appreciation goes to Prof. Buddhi Marambe, Senior Professor of the University of Peradeniya and Dr. Fredrick Abeyratne, Member of the Research and Training Committee (RTC) at HARTI for the encouragement and insightful recommendations. Their constructive comments significantly contributed the report’s refinement.

Special mention should be made of Ms. Thilani Munaweera, Head of the Environment Division at HARTI, for her exceptional guidance and involvement throughout the study. The research team greatly values her contribution.

This research study was made possible through partial funding from the Australian Government Department of Foreign Affairs and Trade (DFAT), with the United Nations World Food Programme (WFP) who provided invaluable technical assistance. Their unstinting support is deeply appreciated.

We are much thankful 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 fundamental to the project's success. Sincere thanks are extended 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 who worked on this study deserve commendation for tirelessly gathering essential field data. We acknowledge the exceptional assistance provided by Management Assistants Ms. Uthpala Jinadari Ranasinghe and Ms. Gayathri Rathwaththe of HARTI. Their involvement in tasks such as typesetting, page layout, and manuscript preparation is appreciated. We also express our appreciation to Ms. Suharshi Perera, Editor, for editing of the final report and, to Mr. S.A.C.U. Senanayake for proofreading.

Our heartfelt thanks are extended to Mr. W.H.A. Shantha, Head of the Information and Communication Division at HARTI, and his dedicated team. I express my gratitude to Ms. Niluka Priyadarshani De Silva for the final typesetting and layout work.

M.A.C.S. Bandara
Rifana Buhary
M.H.K. Rambodagedara

EXECUTIVE SUMMARY

The Government of Sri Lanka imposed the Import and Export Regulations No. 7 of 2021, banning the import of synthetic fertilizers and pesticides (agrochemicals), aiming at promoting organic agriculture considering issues related to human health, finances, and environmental sustainability. However, the sudden implementation of the import restrictions not only caused uncertainty among farmers, but also lead to a sharp decrease in crop yields while posing a threat to food security. The Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) conducted a survey comparing two paddy cultivating seasons (2020/21 and 2021/22) to assess the effects of the fertilizer policy changes on rice production, household economy, and food security.

The survey findings revealed that there was an overall 5% reduction in the extent of paddy cultivation, primarily due to temporary suspension or reduced extents of cultivation by 8% of the paddy farmers. Further, there was an average paddy yield loss by 53%, with 62% of the farmers experiencing more than 50% yield loss. The main reasons cited for the yield loss were: (a) absence of chemical fertilizers and (b) failure to carry out timely application of fertilizer. A significant increase in the use of new organic fertilizers and emergence of organic fertilizer producers within the farming community were also witnessed. Nevertheless, the production of organic fertilizer encountered hurdles stemming from inadequate raw materials and quality measures.

The study also highlighted how the livelihood of paddy farmers was impacted by the policy changes. Most paddy farming families failed to adopt coping strategies, thus relied on savings to mitigate food shortages. During the reference period, most paddy farmers (82 percent) were food secure or marginally food secure, indicating lower vulnerability and stronger coping mechanisms. However, a small proportion (5 percent) experienced severe food insecurity. Although they faced challenges, the overall need for adopting food coping strategies was not significant. Despite maintaining an acceptable food intake, during food scarcity, farmers tended to choose less attractive and cheaper food options. The survey findings revealed that implementing a ban on agrochemicals resulted in significant short-term impacts on the paddy sector, including decreased yield, increased demand and shortages of supply of organic fertilizers, emergence of informal markets, and price hikes. While environmentally and economically sustainable fertilizer policies are necessary, extreme solutions such as complete ban or limited licensing for import of agricultural inputs are not successful at least in the short term.

The study recommends the government to adopt a more gradual and a phased approach in the move towards organic farming. Easy access and use of fertilizers as well as consistent supply of other chemical inputs should be ensured. Issues faced by the organic fertilizer producers such as raw material availability should be addressed. Future research needs to aim at identifying and promoting sustainable fertilizer policies that focus on socio-economic and environmental factors.

LIST OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ARPA	-	Agriculture Research and Production Assistant
ASC	-	Agrarian Services Center
CES	-	Constant Elasticity of Substitution
COP	-	Cost of Production
DAD	-	Department of Agrarian Development
DFAT	-	Department of Foreign Affairs and Trade
DO	-	Divisional Officer
DOA	-	Department of Agriculture
ERP	-	Eppawala Rock Phosphate
EU	-	European Union
FAO	-	Food and Agriculture Organization
FCS	-	Food Consumption Score
FCS-N	-	Food Consumption Score - Nutritional Quality Analysis
FGD	-	Focus Group Discussion
FO	-	Farmer Organization
GCE A/L	-	General Certificate of Education, Advanced Level
HARTI	-	Hector Kobbekaduwa Agrarian Research and Training Institute
HHs	-	Households
HYV	-	High Yielding Varieties
LCS	-	Livelihood-based Coping Strategies
LCWZ	-	Low Country Wet Zone
MLE	-	Maximum Livelihood Estimation
rCSI	-	reduced Coping Strategies Index
SFA	-	Stochastic Frontier Analysis
UNWFP	-	United Nations World Food Programme
WFP	-	World Food Programme
WTP	-	Willingness to Pay

CHAPTER ONE

Introduction

1.1 Background

Rice is the staple food of the majority of Sri Lankans, and as such, paddy cultivation is a socio-economically important sector for the country. It not only helps in achieving food security but also offers livelihood opportunities for a considerable number of the population. Dubbed as the "Granary of the East," Sri Lanka has a remarkable production capacity. The ancient irrigation system, consisting of many magnificent tanks constructed by the old rulers, is a testimony to a well-developed crop production system in Sri Lanka since ancient times. Furthermore, the importance assigned to each phase; production, consumption, land use, and the labour force; in the rice value chain is indicative of the prime position of the crop in the socio-economic milieu of the country.

The total area planted with paddy was 730,000 ha in the *Maha* season and 400,000 ha in the *Yala* season in 2020 (Department of Census and Statistics, 2021). This represents the highest extent (47%) of agricultural land use (Land Use Policy Planning Department, 2020). Data from the Central Bank of Sri Lanka (2020) reveals that farmers cultivated over one million hectares of paddy lands and produced 4.6 million metric tons of paddy in 2019 in a both seasons. This meets the rising domestic rice requirement at the highest level by using high-yielding varieties. According to DCS (2019), estimated number of farm families in the country is 2.1 million and estimated population of these households is 8.1 million[1]. Kadupitiya et al. (2022) also indicate that more than 1.8 million farm families are still engaged in paddy farming as a primary or secondary source of livelihood. It is imperative to note that even though paddy is produced by many small-scale farmers who hold less than 0.4 hectares of land their contribution accounts for approximately 70 percent of the total paddy production in the country (Shantha, 2017). Hence, paddy cultivation can be distinguished as the way of life for many rural dwellers as it is integrated with every component of their day-to-day life.

Since Independence, successive governments have implemented several strategies to develop the agriculture sector and achieve food security. These strategies include large-scale irrigation development projects with land development and human settlement schemes, provision of free irrigation water and extension services, improving access to farm credit, guaranteed output price schemes, and input subsidies

[1] Farm families include 3.8 persons per family on average (DCS, 2019).

(Weerahewa et al., 2010). As a result, rice production in Sri Lanka has been increasing over time, and the introduction of High Yielding Varieties (HYV) with the Green Revolution in the early 1960s was a major turning point. Traditional varieties produce lower yields with a lower level of inputs, but high-yielding varieties are more sensitive to inputs, especially water and fertilizer. To achieve maximum results, farmers have to use more of these inputs. In this context, the government introduced the first fertilizer subsidy policy in 1962 with the objective of providing fertilizer at a lower price to encourage farmers to use it extensively and maximize the benefits from HYVs (Ekanayake, 2006). Sri Lankan farmers rapidly adopted these high-input agricultural practices (Sandika & Dushani, 2011).

According to Weerahewa et al. (2010), the fertilizer subsidy programme initiated in 1962 is one of the long-lasting, most expensive, and most politically-sensitive policies implemented to promote paddy cultivation in Sri Lanka. The recent policy change on the import ban of fertilizer and other agrochemicals has received significant political and social attention. Although fertilizer and other agrochemicals boost agricultural productivity, the government's decision was grounded on the environmental and health consequences of using chemicals, foreign exchange drain, and the introduction of eco-friendly substitutes. The environmental and health hazards associated with the increased and indiscriminate use of agrochemicals, particularly synthetic fertilizers and pesticides in Sri Lanka are well-documented in a number of publications (Balasooriya et al., 2017; Herath et al., 2017; Lakshani et al., 2017; Padmajani et al., 2014; Chaminda et al., 2012; Marasinghe et al., 2011; Watawala et al., 2010; Aponso et al., 2003). Considering these hazards caused partly due to the excessive use of synthetic fertilizers and pesticides, exploring alternatives is timely. Moreover, the fertilizer subsidy exerts huge pressure on the limited fiscal space of the government, and in 2020, approximately USD 188.51 million (LKR 34,966 million) was spent on fertilizer subsidies for food crops, which constituted 53.6% of the government expenditure on the agriculture sector (Department of Sensors and statistics. (2021)). Therefore, dependence on chemical fertilizers and pesticides for future agricultural growth results in an unsustainable burden on the government coffers.

In light of this the government of Sri Lanka imposed the Import and Export (control) Regulation No 7 of 2021 by banning the import of synthetic fertilizers and pesticides with effect from May 6, 2021, and declared a green agricultural movement with the objective of making agricultural systems more financially and environmentally sustainable. Since these policy actions were not fully data-driven or well-informed, it created a sense of uncertainty and unrest among the farming communities who had accustomed to input-intensive agriculture to obtain higher productivity and farm profits. Subsequently, the government eased the restriction and allowed private sector to import chemical fertilizers by issuing licenses. Despite lifting of the total ban on November 30, 2021, fertilizer importation did not resume in full force probably due to the restrictions in foreign exchange outflow and the soaring global market prices of fertilizer. However, this swift change in the policy into organic farming and banning agrochemicals may negatively affect the paddy sector. Therefore, a two-pronged approach to understand both supply and demand-side weaknesses of this fertilizer policy is crucial in general, and paddy in particular, for adoption of a well-informed fertilizer policy in the future.

1.2 Rationale of the Study

Implementation of the green agriculture policy in Sri Lanka in 2021 and prohibition of importing agrochemicals differ significantly from policy measures addressing organic farming elsewhere, such as those within the Common Agricultural Policy of the European Union (EU). In the EU, transition to certified organic agriculture is supported by incentives such as subsidies that compensate for yield reductions and increased labour costs, while rewarding the environmental and societal benefits of organic farming (Feuerbacher et al., 2018). Furthermore, under the Farm to Fork strategy of the 'Green Deal', the European Commission (EC) has set a target of at least 25% of the EU's agricultural land under organic farming by 2030[2]. In EU, the decision to convert to organic farming is typically a conscious choice made by farmers, driven by economic viability and ethical values, often embedded in grassroots movements (Dabbert et al., 2004; Fairweather, 1999). The current import ban on agrochemicals in Sri Lanka is primarily focused on immediate removal of inputs, which naturally lacks proper integration of measures that promote the adoption of improved organic farming practices as defined by the principles of the International Federation of Organic Agriculture Movements (IFOAM, 2014). Consequently, farmers in Sri Lanka would move into organic farming by default rather than based on principles of organic farming, such as those described by IFOAM. This significant difference in approach is not adequately discussed and considered by relevant stakeholders.

Due to the absence of agrochemical inputs in organic farming, nutrient access for plant growth is limited, and managing pests and diseases becomes more challenging, resulting in lower yields compared to conventional agriculture. While this is well-documented in developed countries (Ponisio, 2015), there is currently no specific scientific research on the impact of the recent fertilizer policy change on the relative productivity and socio-economic conditions of the farming community in Sri Lanka.

No comprehensive study has been conducted to examine the implications of the policy on the import ban on agrochemicals on various stakeholders in the paddy sector which has a significant role in meeting food security needs of the country. Therefore, considering the challenges, issues, and potential strategies to overcome them, the policy-making process needs to be carefully planned and continually reviewed and

[2]https://eur-lex.europa.eu/resource.html?uri=cellar:13dc912c-a1a5-11eb-b85c-01aa75ed71a1.0003.02/DOC_1&format=PDF

adjusted to align with the current green economic policies of Sri Lanka[3]. Conducting an island-wide survey is necessary to comprehensively investigate the situation. In this regard, this research aims to explore the effects of the recent fertilizer policy change on paddy production, household economy, and food security, both directly and indirectly impacting farming communities. The findings can contribute to the adaptation and refinement of the fertilizer policy to support sustainable agricultural practices.

1.3 Research Questions

1. What are the effects of the ban on fertilizer and other agrochemical imports on input supply and use in paddy farming?
2. What are the alternatives to fertilizer and other agrochemicals after the import ban, their availability, and accessibility?
3. What was paddy production/productivity before and after the import ban?
4. What was the cost spent on fertilizer and other agrochemicals before and after the import ban?
5. What are the farmers' levels of awareness of substitutes for fertilizer and other agrochemicals and their use?
6. What is the farmers' perception of fertilizer and other agrochemical import ban?
7. How have farmers responded to the limited availability of fertilizer and other agrochemicals?
8. How was the household food security affected and the coping strategies they adopted?

1.4 Objectives

The general objective of the study was to identify short-term effects of changes in the agrochemical import policy on paddy production and livelihood of farming households and related farming communities.

The specific objectives were (1) to assess the short-term effects of the recent change in the policy of import of fertilizer and other agrochemicals on, (a) Supply and use of paddy production inputs, (b) Paddy production, productivity, and utilization of produce, and (c) Household food security and coping strategies of the paddy farming community. (2) Evaluate Policy implications and suggest remedial measures

[3]https://www.presidentsoffice.gov.lk/index.php/2023/02/06/sl-has-initiated-an-action-plan-to-ensure-a-green-economy-by-2050-president/

1.5 Organization of the Report

The report is structured in five chapters. Chapter One is the introductory chapter which provides an overview of the study background, rationale, research problems, and objectives. Chapter Two presents a comprehensive explanation of the methodology employed in the study. Chapter Three presents the demographic characteristics of the participants, as well as an analysis of the supply and use of paddy inputs. Chapter Four presents a comparative analysis conducted to assess the situation before and after the agrochemical import ban in terms of input utilization, production, and produce utilization. Chapter Five presents a household food security and wellbeing of paddy farming community. Finally, Chapter Six concludes the report by summarizing the findings and presenting policy implications based on the study's outcomes.

CHAPTER TWO

Methodology

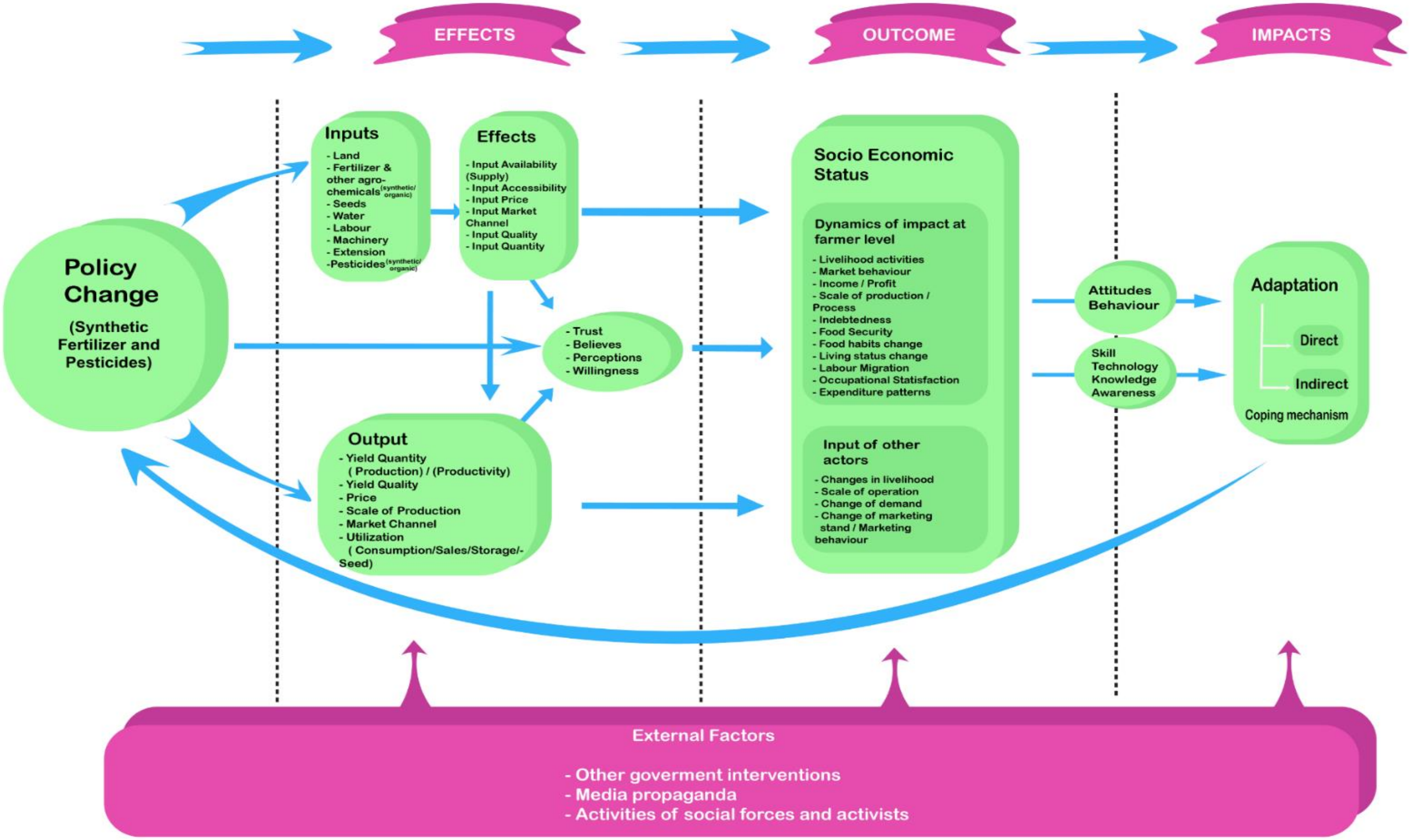
2.1 Conceptual Framework

The theoretical framework used in this study was set to find direct answers to the research questions? what were the rewards and penalties of recently implemented green agriculture policy of 2021? What are the attitudes and perceptions of farmers 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.

2.2 Sample Selection

In Sri Lanka, paddy cultivation is practiced under three water management systems: major irrigation, minor irrigation, and rainfed system. Moreover, in these water management systems there is significant heterogeneity in terms of the socio-economic conditions of farmers. Therefore, in this study water management system was used as primary factor in demarcating the sample populations and major, minor and rainfed systems considered as separate sample populations. Paddy cultivation in the *Maha* season (the main cultivating season) was considered for this study.

Cochran formula was used to calculate sample size given a desired level of precision, desired confidence level, and the estimated proportion of the attribute present in the population (Piran-Qeydari et al., 2022). It is considered appropriate especially in situations with large populations. For the present study, it was decided to keep the margin of error and confidence level as 5% and 95%, respectively. According to the Cochran multistage stratified sampling technique the sample size for major and minor systems is 392 and 233 for rainfed systems by totaling the sample to 625. Even though Mahaweli systems is also a major irrigation system, it was considered as a separate system under major irrigation schemes because of its different management aspects and objectives.



Source: Authors' illustration

Figure 2.1: Conceptual Framework for the Study

Subsequently, the allocation of farmers to each group was determined proportionately based on the total land area cultivated under each irrigation type in the selected 11 paddy-cultivating districts across the country. A selection of districts representing 60% of the total paddy-cultivated land area was made to ensure coverage of the majority of paddy extent. At the field level, the sample was distributed proportionately among the farmer organizations to be representative. Farmer selection for the survey was done randomly within each category. Selected districts and number of farmers under each district is given in Table 2.1.

Table 2.1: Sample Distribution

District	Water Management System				Total
	Major	Mahaweli	Minor	Rainfed	
Anuradhapura	59	34	65	28	186
Ampara	65				65
Polonnaruwa	59				59
Kurunegala			47	36	83
Vavuniya			29		29
Badulla		34			34
Batticaloa				51	51
Moneragala				32	32
Kilinochchi				31	31
Kalutara				28	28
Galle				27	27
Total	**183**	**68**	**141**	**233**	**625**

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

2.3 Data and Methods of Data Collection

Data

To investigate relevant issues, the study combined secondary data with primary data collected through in-depth interviews. Secondary data includes documentary evidence that has direct and indirect relevance for an analysis related to the objectives. Primary data was collected focusing on the 2020/21 *Maha* season as the reference data before the policy change and 2021/22 *Maha* season as the post-policy data.

Data Collection Methods

Questionnaire Survey: Primary data for the study was obtained from Computer-Assisted Personal Interviewing (CAPI) techniques, conducted by means of a structured questionnaire.

Focus Group Discussions (FGDs): FGDs allow participants to come to a common agreement that provides deep insights and the true situation of ground-level conditions along with direct and indirect impacts occurring due to 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): These interviews involve interviewing a small group of people who are likely to provide important information, ideas, and insights on a specific topic. In this study representatives of farmer organizations, key-value chain actors/representatives, and ground-level officers involved with the production process were mainly considered as key informants.

2.4 Operationalization of Variables

Tables 2.2, 2.3 and 2.4 provides information on the operationalization of the variables during the study.

Table 2.2: Variable Operationalization for the Specific Objective 1 - To assess the effects of recent change in policy on import of fertilizer and agrochemicals on supply and use of paddy production inputs

Dimensions	Elements /Indicators	Measures	Source of Data
Socio-economic	Demographic Factors	Gender, age, education level of the principal farmer, Household size, Main and other income source, Engagement in agriculture, Agriculture income share	Farmer survey
Input supply and use before and after the 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, Quantity used, Unit price, Source of supply, Availability Sufficiency	Farmer survey
	Organic fertilizer availability, use and quality	Quantitative and qualitative data on; Type of fertilizer used, Quantity used, Unit price, Source of supply, Availability	Farmer survey
	Organic fertilizer production and marketing	Quantitative and qualitative data on; Types of raw materials used, Availability of raw materials, Quantity produced, Quantity sold, Unit price, Constraints for production	Farmer Survey, KII with ground level officers
	Other agrochemical (Pesticide, Weedicide)	Quantitative and qualitative data on; Type of other agrochemical used, Quantity used, Unit price, Availability	Farmer survey
	Labour	Quantitative data on; Type of labour, Gender, Wage rate, Labour duration	Farmer survey

Table 2.3: Variable Operationalization for the Specific Objective 2 - To assess the effects of recent change in policy on import of fertilizer and agrochemicals on paddy productivity, production, and utilization of produce.

Dimensions	Elements /Indicators	Measures	Source of Data
Productivity/production before and after import ban	Output	1. Yield per unit of land	Farmer survey
	Issues in production	1. Reasons for yield difference	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	Farmer survey

Table 2.4: Variable Operationalization for the Specific Objective 3 - To assess the effects of recent change in policy on import of fertilizer and agrochemicals on household food security of farming community

Dimension	Indicator	Variables/measures	Sources of data
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 - Level of farmer self-sufficiency in household food production (Rice and other essentials) (Likert scale) **Food access:** ***Having sufficient resources to obtain appropriate foods for a nutritious diet*** - Level of food acquisition (Likert scale/qualitative data from FGD) Having sufficient resources to obtain appropriate foods for a nutritious diet (Likert scale/qualitative data from FGD)	**Questionnaire Survey,** FGDs, KIIs and Case studies Sample Farmers (Count and recall)

		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) - Access to clean water (drinking and fulfill sanitation conditions (Rheingans *et al*, 2014) (Likert scale / qualitative date from FGD)	

2.5 Data Analysis

The effects of import ban on fertilizer and other agrochemicals on agriculture sector in Sri Lanka was specifically analyzed referring to two areas of interest, i.e. economic and social perspectives. Three main types of approaches were followed for the analysis:

(a) Descriptive Analysis: consultation and review of existing literature, and of studies and existing documents; evaluation and description of information collected through questionnaires.
(b) Quantitative Analysis: elaboration of statistical data and of data collected through questionnaires and quantification of the phenomena of fertilizer responsiveness.
(c) Qualitative Analysis: expert assessments for the integration or substitution of quantitative evaluations.

Additionally, standard food security indicators recommended by the World Food Programme (WFP 2008: WFP 2016: WFP, 2019; WFP 2021b) were employed to assess the food security status of farming households, as outlined below.

2.5.1 Assessment of the Household Level Food Security

The number of farm households confronting food insecurity situations may be on the rise because of the possible uncertainties and risks associated with crop productivity and farm income as a result of switching from conventional to organic agricultural practices. Therefore, this study also attempted to assess the food security status, in short run, of the sample households particularly in rural and estate communities by using Consolidated Approach for Reporting Indicators (CARI) (WFP, 2021a) tool used for rapid measurement of household food security and the impact of food aid programmes in humanitarian emergencies by the WFP.

2.5.2 FCS - Food Consumption Score

The food security status of the paddy farmers was assessed using the food consumption score (FCS). It is a composite score based on the dietary diversity of households (HHs), food frequency, and relative nutritional importance of diverse food groups (WFP, 2008).

> *"The frequency-weighted diet diversity score or "Food consumption score" is a score calculated using the frequency of consumption of different food groups consumed by a household during the 7 days before the survey" (WFP, 2008; p8)*

As shown in Table 2.5, standard weights are assigned for each food group. The FCS was calculated by multiplying each food group frequency by the food group weight. This is based on a seven-day recall period.

Table 2.5: Standard Food Groups and Current Standard Weights for Food Consumption Score

	FOOD ITEMS	Food groups (definitive)	Weight (definitive)
1.	Maize, maize porridge, rice, sorghum, millet pasta, bread and other cereals Cassava, potatoes and sweet potatoes, other tubers, plantains	Main Staples	2
2.	Beans. Peas, groundnuts and cashew nuts	Pulses	3
3.	Vegetables, leaves	Vegetables	1
4.	Fruits	Fruits	1
5.	Beef, goat, poultry, pork, eggs and fish	Meat and fish	4
6.	Milk yoghurt and other diary	Milk	4
7.	Sugar and sugar products, honey	Sugar	0.5
8.	Oils, fats and butter	Oil	0.5
9.	Spices, tea, coffee, salt, fish powder[4], small amounts of milk for tea.	Condiments	0

Source: WFP,2008

FCS = (main staples*2) + (pulses*3) + (vegetables*1) + (fruit*1) + (meat*4) + (dairy*4) + (fats*0.5) + (sugar*0.5) + (condiments*0)

---

4 https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf

Following the calculation of the food consumption score, the FCS thresholds should be created based on the frequency of the scores and knowledge of the local consumption patterns[5] (WFP, 2008). If FCS is higher, it means dietary diversity and frequency are higher in the HHs. High food consumption score indicates a higher possibility that a HH achieves nutrient adequacy (WFP, 2008).

2.5.3 Reduced Coping Strategies Index (rCSI)

This index assesses the frequency and degree of severity of food consumption behaviors that households had to undergo due to food scarcity considering the seven-day recall period prior to the survey. It is used as an indicator to assess the difficulties experienced by households owing to food scarcity across different contexts (WFP, 2019). The rCSI employs a standard set of five unique coping strategies that any household can employ. In this study, it was calculated considering these behaviors using a universal set of severity weighting for each behavior (Maxwell and Caldwell, 2008). The five standard coping strategies and relevant severity weightings are as follows:

(a) Eating less-preferred foods (1.0)
(b) Borrowing food/money from friends and relatives (2.0)
(c) Limiting portions at mealtime (1.0),
(d) Reducing the number of meals per day (1.0).
(e) Limiting adult intake (3.0), and

The following steps were used to calculate rCSI (as guided by FAO)

The frequency of relevant coping strategies adopted by each paddy farming HH during the last 7 days was recorded during the HH survey. The frequency varies from 0 to 7 (0 means HH did not use the coping strategy any day, 7 means they used it all 7 days of the week).

During the data analysis, the frequency score of each coping strategy was multiplied by the given severity weigh

These weighted frequency scores were summed up for calculating the rCSI for each household. The possible values can range from 0-56.

A high score indicates the negative coping strategies adopted by a particular Household. This means increased food insecurity (Maxwell and Caldwell, 2008).

[5] https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf

2.5.4 Food Security Status

The Consolidated Approach for Reporting Indicators (CARI) console looks at diverse dimensions of food security. It measures the adequacy of HHs current food consumption with the consideration of the current status domain. It shows the access and availability of food consumption at the HH level. It is calculated with the consideration of the FCS and the rCSI. The following steps were used (WFP, 2021b) to calculate the food security status of the paddy farmers.

1. Use Food Consumption Groups (calculated using FCS) to create a new variable in the dataset. This is to convert each household's food consumption into the corresponding 4-point scale[6]
2. To convert each household's food consumption into a 4-point scale following steps were used
   - Convert 'Acceptable' households to 'Food Secure'. Then assign a score of 1 (Food Secure).
   - Convert 'Borderline' households to 'Moderately Food Insecure'. Then assign a score of 3 (Moderately Food Insecure).
   - Convert 'Poor' households to 'Severely Food Insecure'. Then assign a score of 4 (Severely Food Insecure).
   - Convert 'Food Secure' households to 'Marginally Food Secure' households using the rCSI score. If the HHs has rCSI of 4 or higher, then those HHs were assigned a score of 2 (Marginally Food Secure) before the relevant analysis was done.

2.5.5 Food Consumption Score - Nutritional Quality Analysis (FCS-N)

Food Consumption Score - Nutritional Quality Analysis (FCS-N) is a measure of the HHs adequacy of key macro and micronutrient-rich food groups. In order to determine nutrient deficiency, FCS-N examines how frequently meals high in protein, iron, and vitamin A were consumed throughout seven days before the interview (WFP, 2016). In the present study, it was assessed in the seven-day recall period.

The following food items were considered for nutrient-rich food groups

1. Vitamin A-rich foods: Dairy, Organ[7] meat, Eggs, Orange veg, Green vegetables, and Orange fruits
2. Protein-rich foods: Pulses, Dairy, Flesh meat, Organ meat, Fish and Eggs
3. Hem iron-rich foods: Flesh meat, Organ meat, and Fish (WFP, 2015: p12)

---

[6] The Food Consumption Score was calculated and categorized three food consumption groups Poor, Borderline, or Acceptable

[7] https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp277333.pdf?_ga=2.147894128.678095800.1691992971-1153779513.1677418717

CHAPTER THREE

Supply and Use of Agricultural Production Inputs in Paddy Cultivation

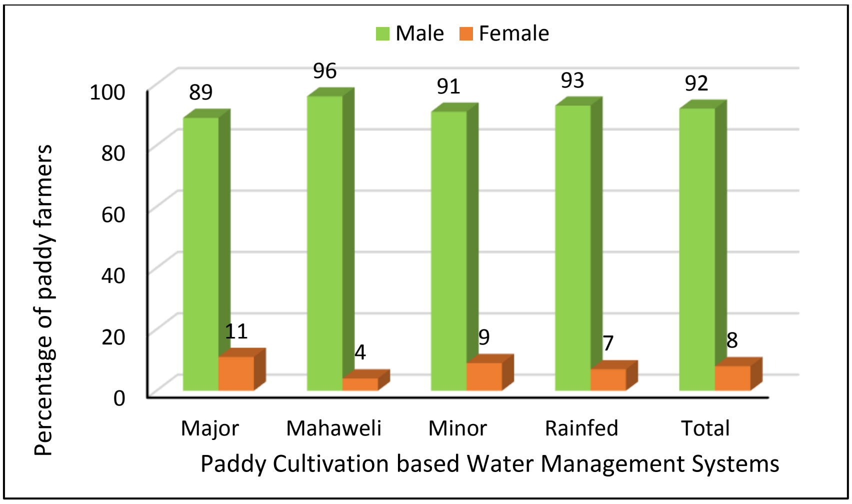
Paddy farming encompasses several preparatory and cultivation stages and resources, including key factors such as land, water, seeds, fertilizer, pesticides, and labour that impact production. This chapter is organized into several sections that provide a comprehensive analysis and explore different aspects of farmers' demographics and agricultural input and practices particularly land, chemical fertilizer, pesticide and organic fertilizer.

3.1 Demographic Characteristics of Sample Farmers

The analysis of demographic characteristics of a sample of 625 farmers can provide valuable insights into societal trends and changes that occur as a result of changes in fertilizer import policies. The study focuses on key attributes such as age, gender, highest level of formal education received, and primary source of income for the principal farmer who is directly involved in agricultural activities and makes crucial decisions within the household. Furthermore, the study also examines the size of the household, other sources of income for the household, family members involved in agricultural activities, and the proportion of agricultural income in relation to the total household income during the reference period.

3.1.1 Gender Distribution of Principal Farmers

The gender divide in agricultural activities is evident in the sample of 625 households. Of the principal farmers in these households, 92% were male (Figure 3.1). Female representation was the lowest in Mahaweli areas, especially in Badulla. District-wise analysis also revealed that there were no female principal farmers in Vavuniya and Kilinochchi districts. However, 11% of farmers in major irrigated areas, especially in Polonnaruwa and Anuradhapura districts, were female farmers who played a significant role in agricultural activities and decision-making for their families.



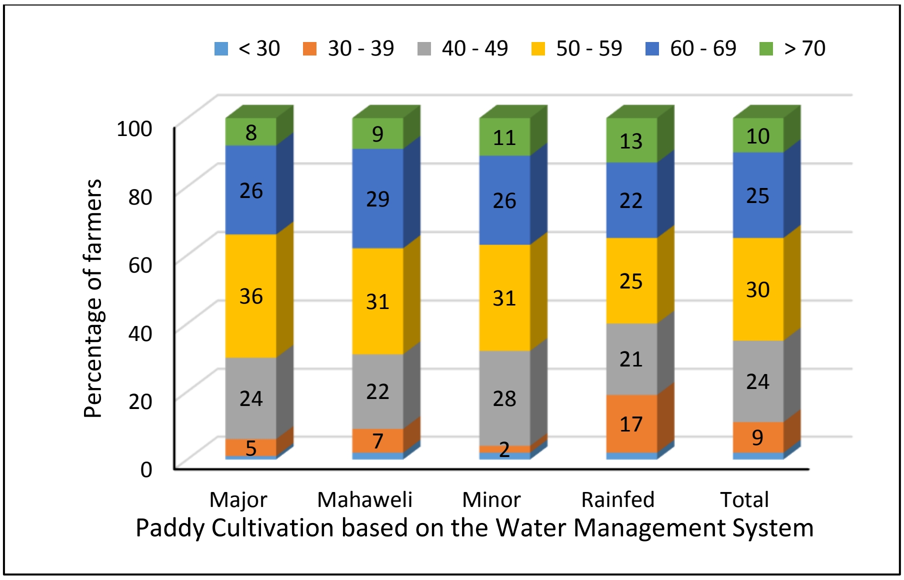
Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.1: Distribution of Principal Farmers by Gender in Paddy Cultivation based on the Water Management System

3.1.2 Age Distribution of Principal Farmers

According to Figure 3.2, the majority of principal farmers engaged in paddy cultivation (66%) were over 50 years old, while only a small percentage (11%) were below 40 years of age. This suggests extremely low representation from young farmers in paddy cultivation, with more engagement by the elderly farmers. The observed trend of low family size (Figure 3.4) and a lack of belief among the younger generation that agriculture is a profitable business might be attributed to the changing economic and societal dynamics (Bogodage, 2021). However, an analysis of irrigation system reveals that in rainfed areas where paddy farming is mostly subsistence-oriented shows a considerable involvement of youth in paddy farming, with 19% percent of principal farmers being below 40 years. It is noteworthy that particularly in Batticaloa, Moneragala, and Kalutara districts the percentage of principal farmers below 40 years old is 31%, 28% and 24%, respectively.



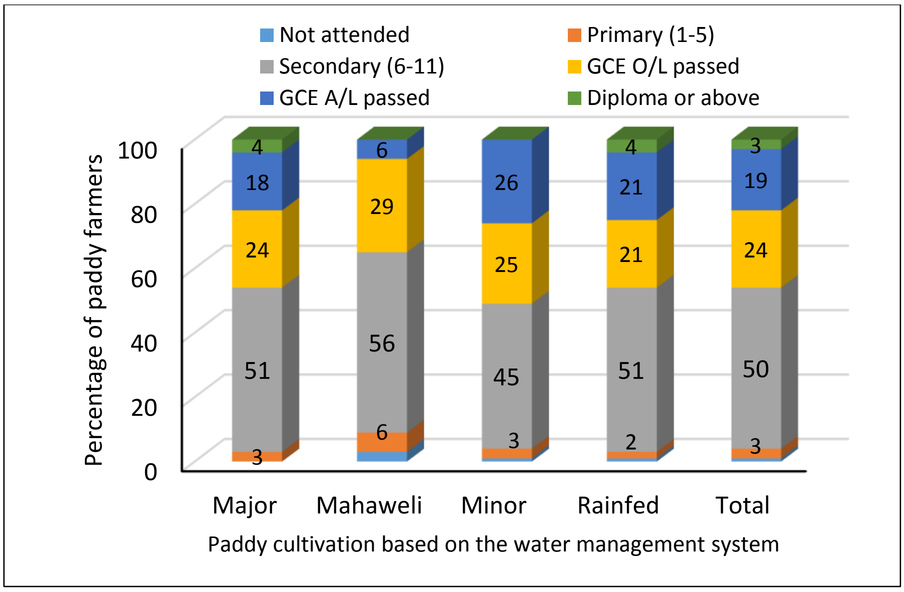
Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems)

Source: HARTI survey data, 2022

Figure 3.2: Distribution of Principal Farmers by Age in Paddy Cultivation based on the Water Management System

3.1.3 Educational Level of Principal Farmers

Figure 3.3 illustrates that a significant proportion of principal farmers in the sample (>50%) have obtained educational qualifications below Grade 11. The findings further highlight a concerning trend that in the Mahaweli areas, the majority (65%) of principal farmers have lower educational attainment. High prevalence of educational disadvantage among principal farmers in these areas could have important consequences, including reduced access to information, limited understanding of modern farming practices, and decreased capacity to adopt new technologies.



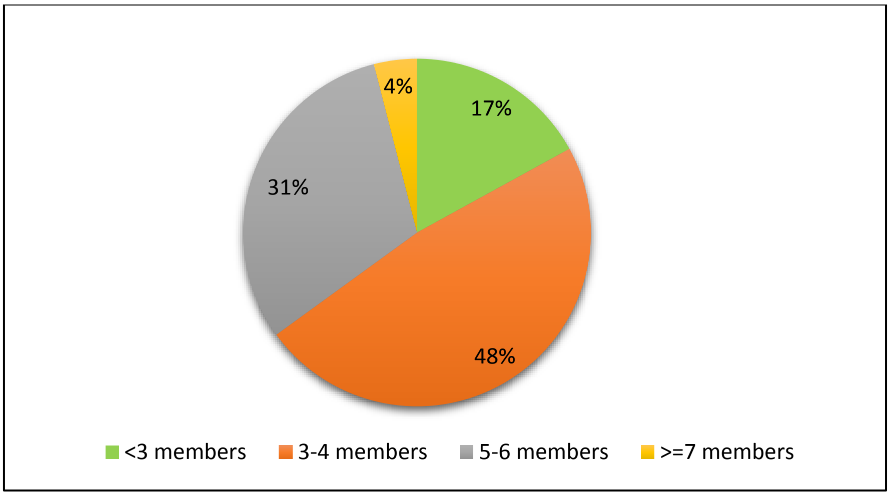
Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems)

Source: HARTI survey data, 2022

Figure 3.3: Distribution of Principal Farmers by Educational Level in Paddy Cultivation based on the Water Management System

3.1.4 Household Size

A significant proportion of the households (65%) have a family size below five members (Figure 3.4). Moreover, only 4% of the families surveyed have a family size of seven or more members.



Source: HARTI survey data, 2022

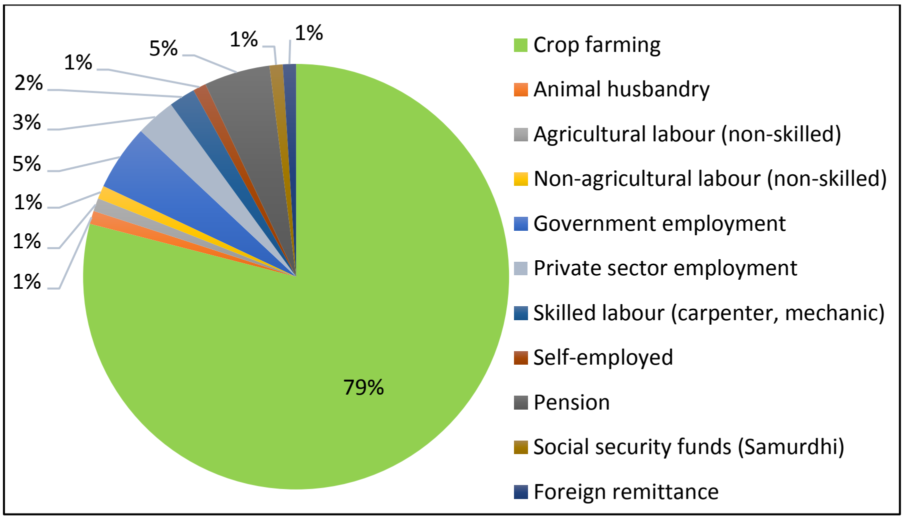
Figure 3.4: Distribution of Households by Household Size

These results suggest a growing trend towards smaller family units within the farming community, which can be attributed to various factors such as urbanization, modernization, and changing social norms. The shift towards smaller family units may have significant effects for the agricultural sector, particularly in terms of labour availability, farm management practices, and resource allocation.

3.1.5 Income Sources of Farm Households

a. Primary Employment

According to Figure 3.5, crop farming was the primary employment of more than 75% of the principal farmers in survey sample, regardless of the irrigation system. This suggests that crop farming is a crucial source of income for farm households in the study areas, while animal husbandry only represented 1% of the sample.



Source: HARTI survey data, 2022

Figure 3.5: Distribution of Principal Farmers by Primary Employment

About 10% of farmers were also in the government sector employment or have already retired. This implies that households may have expanded their income streams beyond their primary career, possibly as a way to mitigate risks or explore other opportunities, while also producing food for their own consumption.

b. Other Income Sources

Table 3.1 provides information on the other income sources of farming households in addition to primary employment of principal farmers. The data reveals that a significant proportion of farming households (24%) solely rely on crop farming as their only source of income. Notably, the percentage of households with no other income source is higher in Mahaweli (43%) and other major (33%) irrigation areas, where households were mainly dependent on agriculture. In contrast, the percentage of households with no other income source is lower in minor (18%) and rainfed (16%) areas where households received income from other sources.

Table 3.1: Distribution of Households by Other Income Sources r based on the Water Management System Used

Other Income Source	Water Management System				
	Major (%)	Mahaweli (%)	Minor (%)	Rainfed (%)	Total (%)
None	33	43	18	16	24
Crop farming	19	15	17	25	20
Animal husbandry	10	9	14	12	11
Agricultural labour (non-skilled)	2	7	3	6	4
Non-agricultural labour (non-skilled)	4	7	6	5	5
Government employment	6	4	6	4	5
Private sector employment	8	1	8	5	6
Skilled labour	8	1	8	8	7
Self-employed	7	12	9	14	11
Pension	6	3	9	4	5
Social security funds (*Samurdhi*)[8]	10	7	19	21	16
Foreign remittance	2	0	1	4	3

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

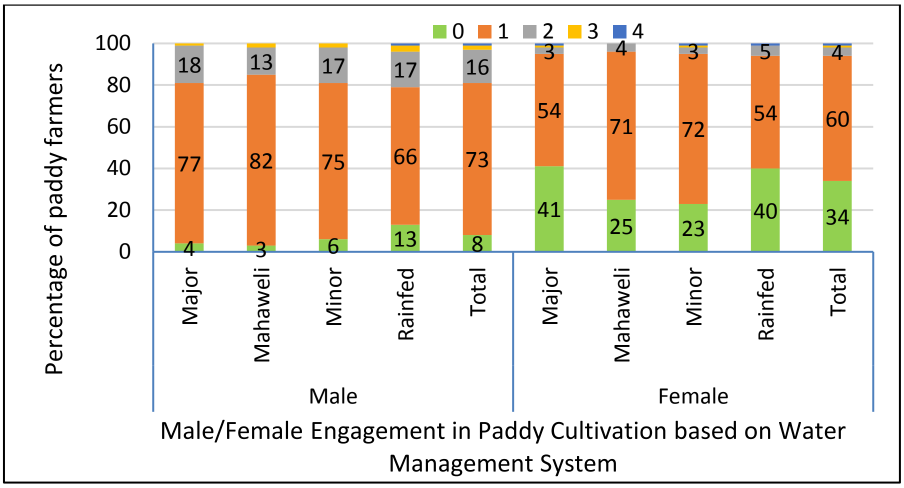
The data also indicates that crop farming serves as an additional income source for a quarter of households in the rainfed areas. Other income sources for sample farming households include social security funds, self-employment (other than crop farming), and animal husbandry, each of which serves as an income source for more than 10% of households overall. Furthermore, it is notable that foreign remittance is not a significant income source for farming households, with only around 3% of households receiving financial support from overseas. This finding suggests that households are primarily dependent on domestic income sources, with agriculture playing a crucial role in many cases.

3.1.6 Engagement in Agriculture

Insights from Figure 3.6 shed light on the participation of household members in agriculture. The data reveals that a noteworthy proportion of households have no male (8%) or female (34%) family members engaged in farming. Even when there was

[8] Introduced in 1995 through Act no. 30 of 1995, the *Samurdhi* (Prosperity) Programme aims to provide financial aid and social welfare benefits to low-income families, empowering disadvantaged communities through economic support and vocational training.

engagement, it was mostly limited to a single male (73%) or female (60%) per household, and this pattern was consistent across the country.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

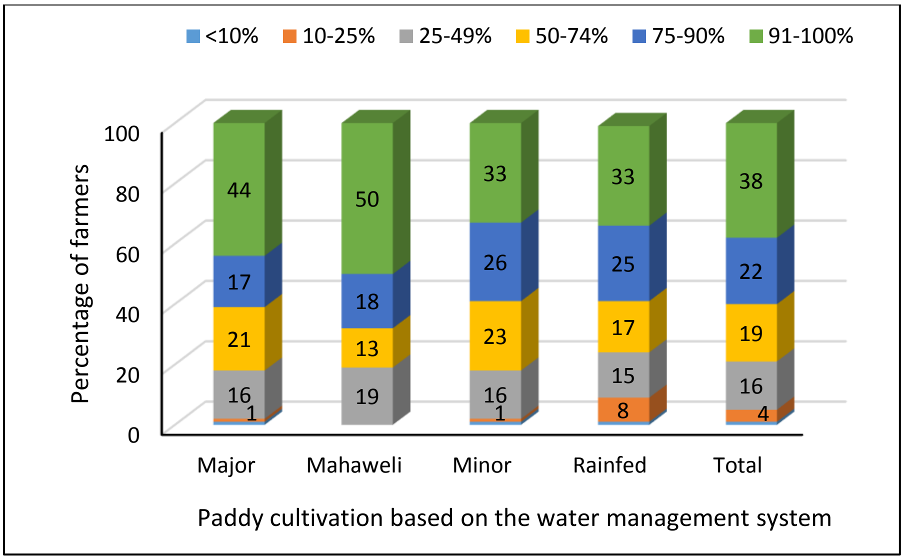
Figure 3.6: Distribution of Household Members Engaged in Agriculture

The data also highlights variations based on irrigation systems, with a higher proportion of male members being not taking part in farming in rainfed areas, where hired labour is commonly used for cultivation. Additionally, the data shows that females in around 40% of households in rainfed and major irrigated areas do not participate in farming, indicating limited participation of women in agriculture in these regions.

It is noteworthy that overall family engagement in agriculture is limited in the study sample, with only a few members of a household being involved. These findings underscore the need to increase the involvement of family members, particularly women, in agriculture, as this could have important implications for the well-being of farming households. There may be opportunities to enhance the participation of family members in agriculture, which could contribute to the resilience and productivity of farming systems. Encouraging women's participation in agriculture can enhance productivity and diversify farming practices. Promoting advanced agricultural technologies can also attract younger family members to engage in farming, making it more appealing and sustainable.

3.1.7 Agriculture Income Share of Households

The data presented in Figure 3.7 highlights the significant contribution of agriculture to the income of sample households, with agriculture contributing to more than three-fourths of income among 60% of households. These findings re-validate those in Figure 3.5 —that agriculture is the primary livelihood source for paddy farming households.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

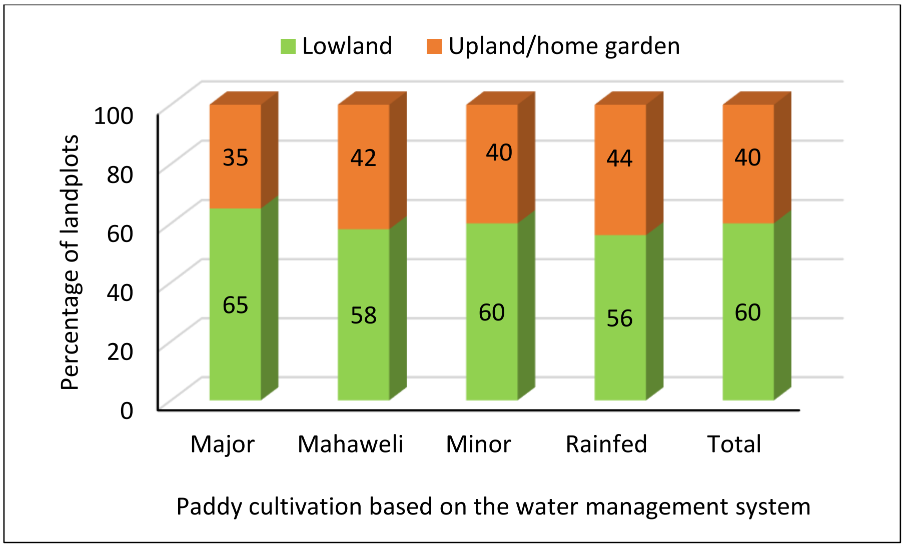
Figure 3.7: Distribution of Households by Income Share in Paddy Cultivation based on the Water Management System

Furthermore, the data indicates that a substantial proportion of farm households (38%) rely almost entirely (>90%) on agriculture for their livelihoods. The trend is noticeable, particularly in minor irrigation systems and rainfed regimes, where the share of agriculture is more clearly defined in Mahaweli and other major irrigation systems. This is due to the availability and reliability of irrigation water resources. However, households in these areas heavily rely on agriculture for their livelihoods, revealing inadequate diversification in income sources. As a result, these households are highly susceptible to external shocks, such as agricultural policies, climate change, and market fluctuations.

3.2 Land

3.2.1 Land Type

Paddy farmers typically possess diverse types of land plots, such as lowlands and uplands, which they may either own, cultivate, or manage for landowners, or other pieces of lands such as home gardens. The distribution of land plots among households concerning irrigation systems during the 2020/2021 *Maha* season to 2021/2022 *Maha* season is depicted in Figure 3.8.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems)

Source: HARTI survey data, 2022.

Figure 3.8: Distribution of Land Plots by Land Type in Paddy Cultivation based on the Water Management System

The primary types of land plots owned by paddy farmers were lowland and upland, which were typically in a 3:2 ratio. Around 65% of major irrigated areas consisted of lowlands, the preferred option for paddy cultivation due to their water retention ability. Conversely, uplands are frequently utilized for other crop cultivation.

3.2.2 Land Extent

Table 3.2 provides information on the mean extent of land plots owned or cultivated by paddy farmers categorized by irrigation system and the type of land including lowland, upland, and home garden. Data shows that lowland areas have the largest mean extent across all irrigation systems, with an average of 2.81 acres (1.137ha) as lowland areas are the most suitable for paddy cultivation due to their water-retaining capacity. The Minor irrigation system has the lowest mean extent of lowland areas, which could be attributed to the region's located -- dry zone with limited water resources for irrigation.

Table 3.2: Mean Extent of Land Plot by Land Type in Paddy Cultivation based on the Source of Irrigation Water

Paddy cultivation based on the water management system	Average Extent (Acre)			Average Extent (ha)		
	Lowland	Upland	Home garden	Lowland	Upland	Home garden
Major	2.95	1.73	0.85	1.19	0.70	0.34
Mahaweli	2.62	1.11	1.07	1.06	0.45	0.43
Minor	1.89	1.95	0.58	0.76	0.79	0.23
Rainfed	3.38	1.82	1.03	1.37	0.74	0.42
Total	2.81	1.76	1.03	1.14	0.71	0.42

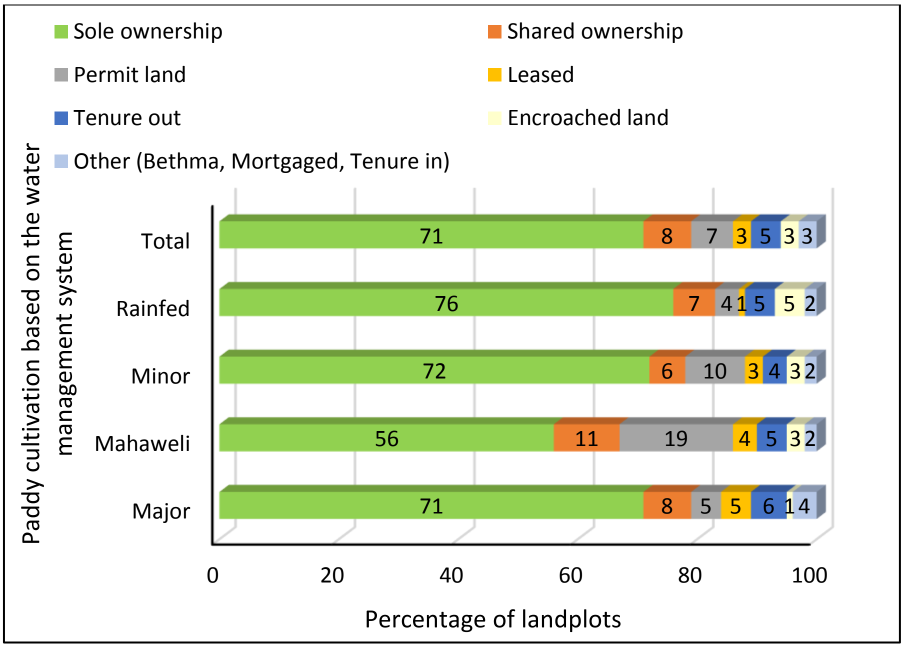
Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems)

Source: HARTI survey data, 2022

Upland areas in the study locations had a mean extent of 1.76 acres (0.71ha), which is significantly smaller than lowland areas. Upland areas are often used for other crops or as pasture lands for livestock. Home gardens have the smallest mean extent across all irrigation systems, with an average of 1.03 acres (0.42ha). Home gardens are typically small plots of land used adjacent to dwelling for growing fruits, vegetables, and other crops for household consumption.

3.2.3 Land Ownership

Ownership and usage rights of lands vary among farmers, with different legal restrictions in place. These range from sole ownership, shared ownership, leased land, tenure in, tenure out, permit land, encroached land, and mortgaged land. Sole ownership was the most prevalent type of land ownership across all irrigation systems, accounting for about 70% of land plots. Shared ownership was the second most common type, with approximately 8% of land plots falling under this category. This could be due to a weak of legal framework on shared land ownership or simply a preference among landowners for sole ownership. Permit lands were relatively high in Mahaweli areas (19%), which were granted for agricultural activities. Out of the total land plots, 3% were leased lands for cultivation, while 5% were tenured out by farmers. Additionally, approximately 3% were encroached lands that were occupied by farmers without legal ownership.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.9: Distribution of Land Plots by Land Ownership in Paddy Cultivation based on the Water Management System

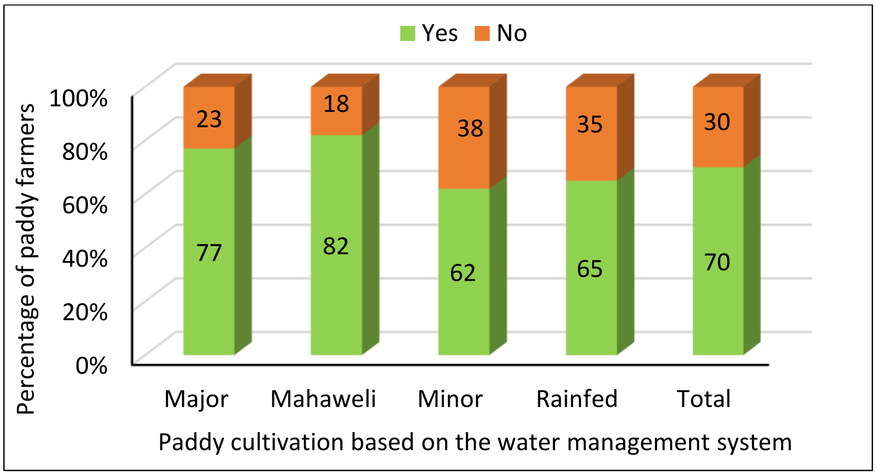
3.3 Utilization of Chemical Fertilizers during Post-Import Ban

Farmers use different types of chemical fertilizers, such as Urea, TSP, and MOP, to increase their agricultural productivity. While these inputs can enhance the health and yield of crops, they must be used with caution to prevent negative impacts on the environment. Following recommended guidelines, applying the fertilizers at the right time and in appropriate quantities is crucial to avoid over-fertilization, which can be detrimental to humans, plants, and the ecosystem.

Excessive use of chemical fertilizers is a significant challenge in promoting sustainable agriculture, and it has a lasting effect on the environment, particularly on water sources (Weerahewa & Dayananda 2023). Governments have implemented various strategies to tackle this problem, including import bans on pesticides and synthetic fertilizers. This study regarding the use and supply of chemical fertilizers has yielded noteworthy insights into whether these policies have been effective in achieving their intended goals.

3.3.1 Application of Chemical Fertilizers

Even though there was an import ban and limited stock available in the market, 70% of the total sample of farmers in this study have applied different types of chemical (synthetic) fertilizer, however, required fertilizer quantity to the paddy crop has not been applied in the *Maha* season 2021/22, which was the cultivating season after the import ban was imposed. The results indicate that farmers in the study area had access to chemical fertilizer even at levels lower that the required quantity. Farmers also had problems in accessing the limited amounts of chemical fertilizer available on time (Figure 3.10).



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems)

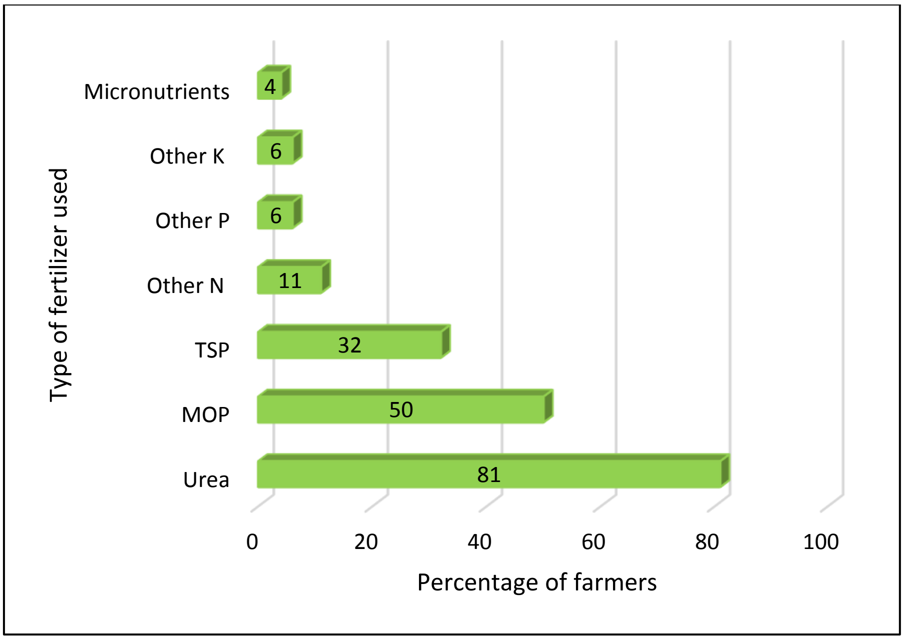
Source: HARTI survey data, 2022

Figure 3.10: Distribution of the Sample by Chemical Fertilizer Application in Paddy Cultivation based on the Water Management System

Accessing chemical fertilizers, however, was difficult with limited availability. The number of farmers who applied one or more types of chemical fertilizer in the Mahaweli (82%) and in other major (77%) irrigation schemes was higher than those in the minor and rainfed production systems. A Chi-square test revealed a significant relationship among different irrigation systems ($\chi 2 = 16.0402$, $p<0.05$) to show that farmers who cultivated in the Mahaweli and other major irrigation schemes were more likely to use chemical fertilizers than those cultivate minor irrigation schemes and under rainfed condition. The higher water security in the major irrigation schemes might be a main contributing factor to the greater tendency of farmers in the major irrigation schemes to use chemical fertilizers compared to those in the minor irrigation schemes. Further, the strong institutional foundation within the Mahaweli irrigation scheme would be a factor for the farming community to apply chemical fertilizer for better yields.

3.3.2 Types of Chemical Fertilizer Used

Chemical fertilizers come in various types and are categorized based on the nutrients they provide. Among the commonly used fertilizers providing Nitrogen, Phosphorus, and Potassium fertilizers are Urea, TSP, and MOP, respectively, to improve productivity. Figure 3.11 illustrates that during the *Maha* season 2021/22, the majority of paddy farmers (81%) used Urea fertilizer, followed by MOP (50%) and TSP (32%). Additionally, around 11% of farmers used Ammonium sulphate and other Nitrogen-based fertilizers in paddy cultivation.



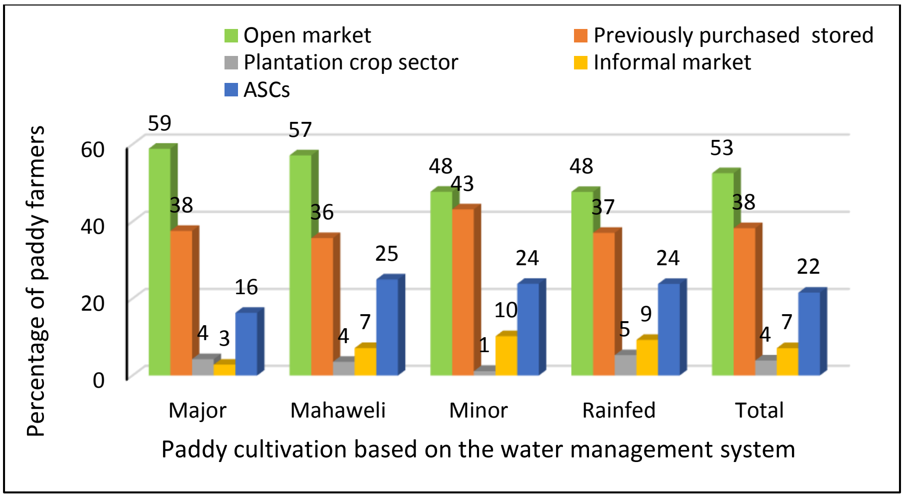
Note: N = nitrogen, K = potassium, P = phosphorous, TSP = Triple Super Phosphate, MOP = Muriate of Potash)
Source: HARTI survey data, 2022

Figure 3.11: Distribution of Farmers by Type of Fertilizer Applied

3.3.3 Source of Chemical Fertilizer

Figure 3.12 presents data on the distribution of sources from which farmers obtained fertilizers after the import ban, among different types of irrigation considered in this study. Accordingly, 53 percent of farmers acquired chemical fertilizers from the open market, 38 percent of farmers used their previously purchased and stored fertilizer stocks, and 22 percent of farmers purchased them from the Agrarian Service Centers (ASCs).

The analysis also revealed that the open-market sources were the most common for acquiring fertilizers, followed by previously-stored stocks, irrespective of the type of irrigation. Consequently, it can be inferred that the yield obtained during the *Maha* season 2021/22 was a result of limited application of chemical fertilizers, emanating out of the ban imposed on these agricultural inputs, but not attributed to farmers moving into a total system of organic agriculture.



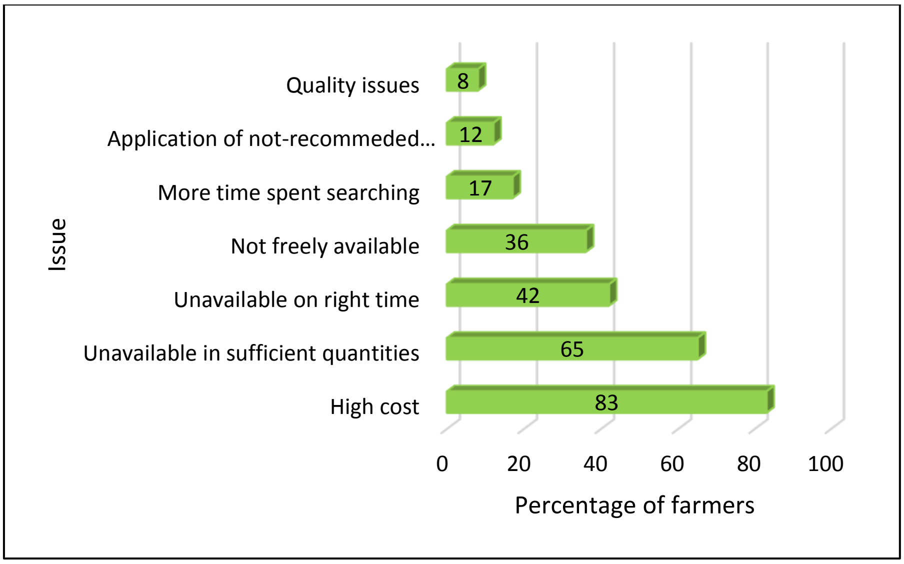
Source: HARTI survey data, 2022 (Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems)

Figure 3.12: Source of Fertilizer in Paddy Cultivation Based on the Water Management System

3.3.4 Difficulties in Accessing Fertilizer

Arbitrary imposition of an import ban on agrochemicals by the government caused farmers to search for locally available alternatives, particularly fertilizers. However, almost all farmers encountered difficulties in acquiring chemical fertilizers and other agrochemicals after the policy change. The issues that arose are listed in Figure 3.13.

According to the survey, the absence of imported fertilizers resulted in an increase in the cost of locally available stock, which was considered a burden by 83% of the farmers. Furthermore, 65% of farmers faced challenges in obtaining sufficient quantities of fertilizers and other agrochemicals, while 42% faced difficulties in obtaining them at the correct time. Fertilizer shortage in commercial markets due to excessive hoarding by private retailers following the ban was widely reported across the country at the time of the survey.



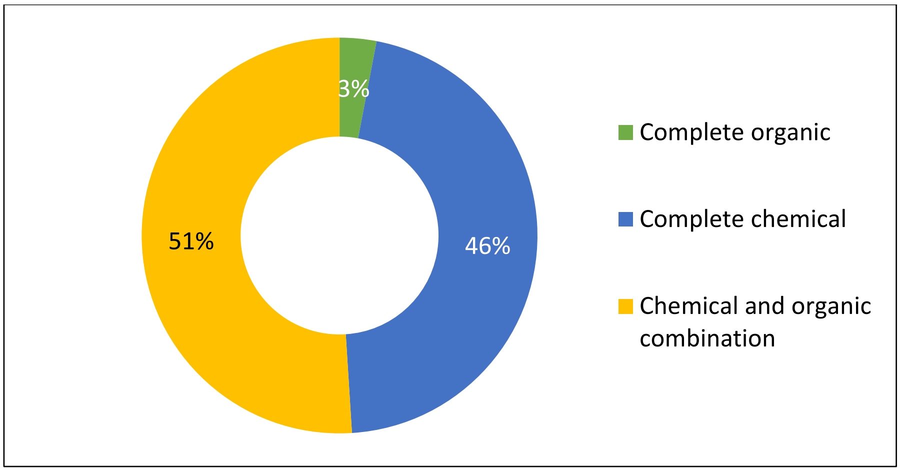
Source: HARTI survey data, 2022

Figure 3.13: Issues Related to Acquisition of Synthetic Fertilizer and Other Agrochemicals

3.3.5 Perception on Supply of Plant Nutrients

In an effort to understand the most optimal approach for supplying nutrients to plants, farmers were surveyed to obtain their perspectives on using organic, chemical, or a combination of both methods. Reinforcement of the government take for a complete transition to organic farming – highlighting the aspects such as environmental sustainability, human health and frugality-- was hailed by only 3% of farmers surveyed, who expressed their support for this option. On the contrary, the majority favoured a mixed-approach consisting both organic and chemical methods, while a substantial proportion (46%) opposed organic farming altogether, as illustrated in Figure 3.14.

For over six decades (since 1962) paddy farmers have reaped the benefits of fertilizer subsidies in various forms. These subsidies took the form of both cash grants and in-kind provisions (material subsidy). Farmers were surveyed to gauge their preferences and expectations for future government subsidies, specifically whether they would prefer chemical fertilizers provided as a subsidy (Figure 3.15).

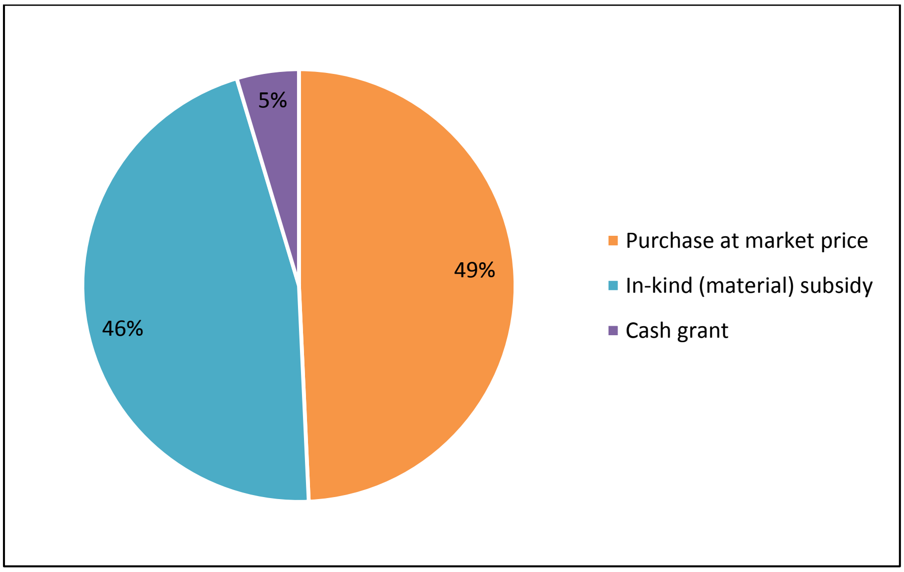


Source: HARTI survey data, 2022

Figure 3.14: Perception of Supply of Plant Nutrients

3.3.6 Preference for Chemical Fertilizer Subsidy

Nearly half of the farmers showed interest in receiving subsidies, while the others preferred purchasing fertilizer at market prices. This preference was due to the difficulties they faced in obtaining free or subsidized fertilizer, such as dealing with multiple signatures, filling out forms, bureaucratic procedures, time-consuming processes, and unnecessary delays. Based on their past experiences with different forms of subsidies, farmers have shown a higher preference for in-kind provisions (material subsidy) rather than cash grants, as demonstrated in Figure 3.15.

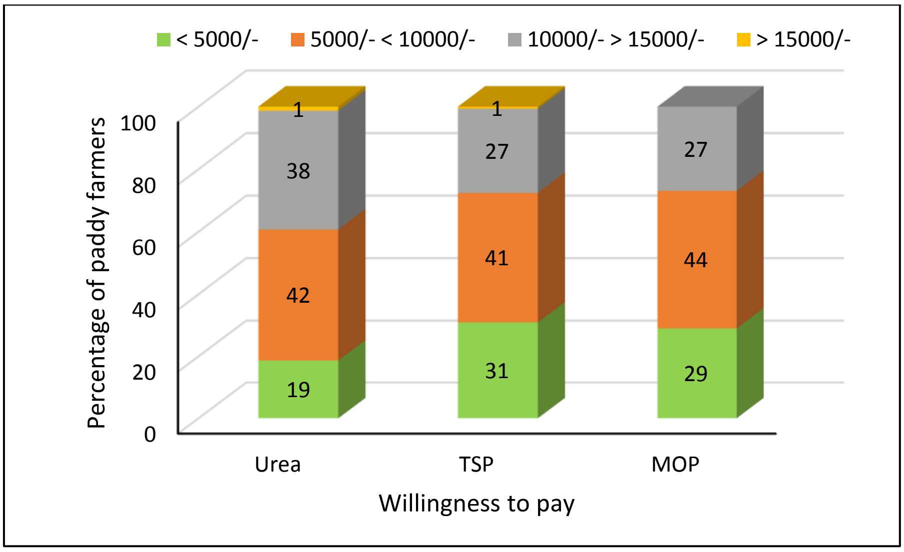


Source: HARTI survey data, 2022

Figure 3.15: Farmers by Preference for Chemical Fertilizer Subsidy

3.3.7 Willingness to Pay for Chemical Fertilizers

In the context of the fertilizer import ban, the government has historically provided subsidies on fertilizer, leading to farmers not fully understanding the actual cost of these inputs. However, following the ban, the survey also conducted to assess their Willingness to Pay (WTP) for different types of fertilizer, including Urea, MOP, and TSP. The findings revealed that the majority of farmers expressed their willingness to pay amounts ranging from Rs. 5,000 to Rs. 15,000 per 50 kg bag, for any type of fertilizer (Figure 3.16). However, it is worth noting that a considerable proportion of farmers still indicated a willingness to pay less than Rs. 5,000 for fertilizer.



Source: HARTI survey data, 2022

Figure 3.16: Farmers' Willingness to Pay for 50 kg Bag of Fertilizer

The standard deviations of WTP values for different fertilizers, exceeding Rs. 3,000, indicate that there is a considerable variation in the amount farmers on their WTP (Table 3.3). These findings highlight the need for a better understanding of farmers' WTP for fertilizer in the context of subsidy removal and import bans. These findings also suggest that farmers are willing to pay a considerable amount for fertilizers, indicating the importance of their availability and affordability.

Table 3.3: Descriptive Statistics of Willingness to Pay (WTP) for Fertilizer

Statistic	Urea (Rs./50 kg)	MOP (Rs./50 kg)	TSP (Rs./50 kg)
Mean	6,898	5,985	5,961
Minimum	350	350	0
Maximum	20,000	15,000	30,000
Standard Deviation	3,165	3,073	3,285

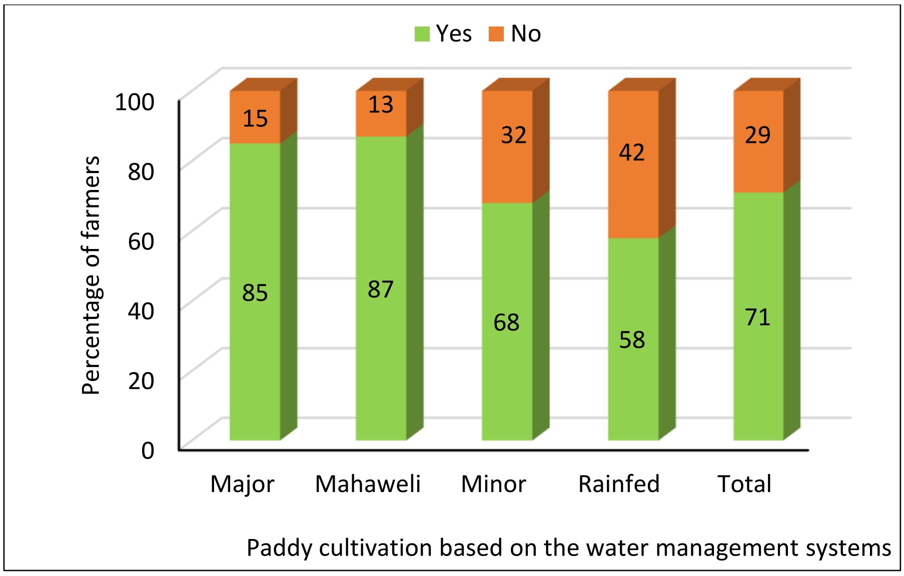
Source: HARTI survey data, 2022

3.4 Pesticide Use after the Import Ban

Pesticides play a crucial role in the management of pests, which include insects, weeds, and fungi, in paddy cultivation. These chemicals are applied to protect paddy crops from pests and diseases that can result in yield loss and negative impact on the quality of the grains. Pesticide usage in paddy cultivation is often necessary for farmers to prevent pest infestations and ensure optimal crop growth. While playing a crucial role in paddy cultivation, excessive use can harm the environment and human health. An import ban on pesticides was also implemented due to their potential harmful effects.

3.4.1 Application of Pesticide

In the *Maha* season 2021/22, a significant portion of farmers (71%) applied pesticides to their paddy crop during the survey period, indicating that there was considerable availability of pesticides, similar to fertilizers, even after the ban on imports. Irrigation type-wise analysis also showed similar pattern as of chemical fertilizer application (Figure 3.17). Number of farmers who applied one or more pesticides in Mahaweli (87%) and other major (85%) irrigated areas was higher than that in farming location in minor irrigation schemes and under rainfed. The Chi-square test showed a significant relationship (χ^2 = 44.667, df=3, p<0.05), where Mahaweli farmers were more likely to use pesticides than those cultivate in areas with other types of irrigation or under rainfed condition.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

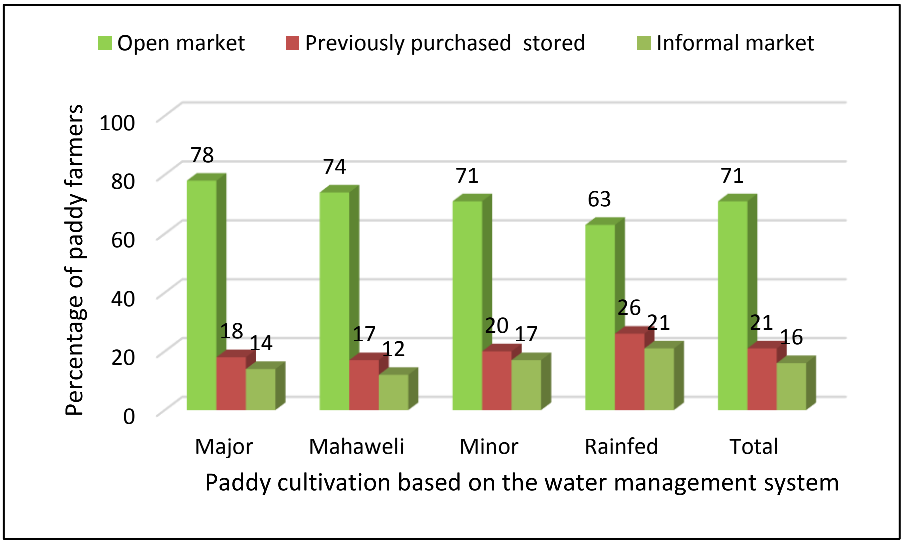
Source: HARTI survey data, 2022

Figure 3.17: Pesticide Application in Paddy Cultivation after the Import Ban based on the Water Management System

3.4.2 Source of Pesticide Acquirement after Import Ban

Figure 3.18 presents the sources of pesticides acquired by farmers in this study sample after the import ban was imposed. The majority of farmers (71%) obtained their pesticides from the open market, while 21% used what they had in their possession. Interestingly, 16% of farmers purchased pesticides from the informal market, indicating a higher tendency for the use of informal markets for procuring pesticides compared to fertilizers, which was 7%.

Further, the open market was the most common source of pesticide acquisition for farmers across all types irrigation used. This was followed by using previous stocks and purchases from the informal market. These findings suggest that farmers were willing to pay a significant amount to save their crops from pests and diseases, and that they turned to the open and informal markets to obtain the required pesticides after the import ban was imposed.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.18: Source of Pesticide Acquisition by Paddy Farmers based on the Water Management System

3.4.3 Challenges Encountered Following Import Ban on Pesticides

Farmers largely depend on chemical methods to control pest, disease and weeds and majority apply pesticides followed by the first observation of symptoms (Buhary et al., 2021). In the present study, 92% of farmers strongly believed that it is essential to have chemical pesticides to control pest and diseases in the paddy cultivation. In addition, a significant proportion of farmers (67%) reported facing difficulties due to unavailability of these chemicals.

Table 3.4: Difficulties Faced without Pesticide after Import Ban

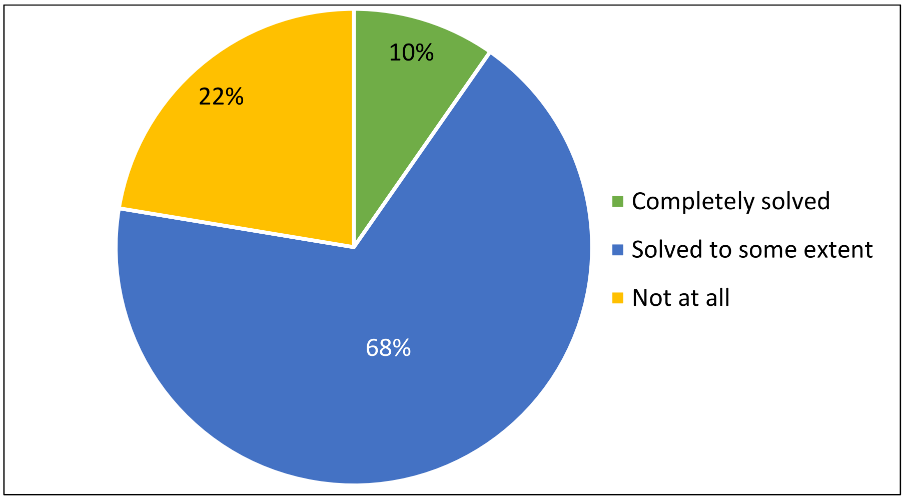
Issue	Percentage of farmers
Could not control weed	64
High cost of Pests & Diseases control	47
High incidence of pest attacks	46
High incidence of other diseases	10

Source: HARTI survey data, 2022

The prevalent challenge among plant protection aspects that the farmers faced was with weed control, which was a significant concern for 64% of them (Table 3.4). The exorbitant cost of controlling weeds, stemming from the surge in pesticide prices, coupled with the alarming frequency of pest attacks due to lack of preventive measures, were obstacles encountered by nearly half of the farmers in the sample.

3.4.4 Strategies Adopted to Overcome Chemical Pesticide Unavailability

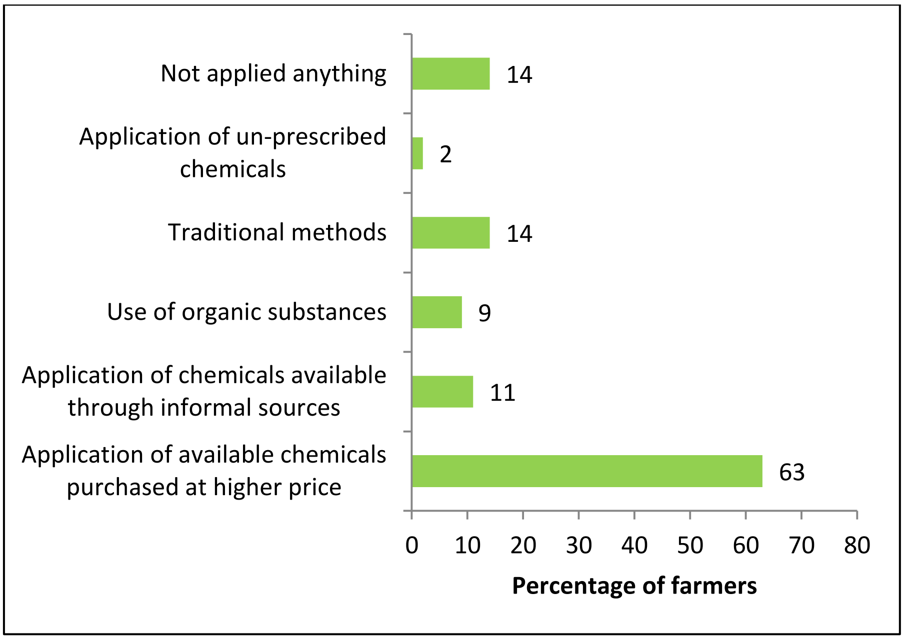
When questioned about the challenges and strategies adopted, the responses of farmers broadly fell into three categories (see Figure 3.19). It illustrates that only 78 percent of the farmers were able to successfully address the issue to some extent or completely, using the strategies they adopted following the import ban.



Source: HARTI survey data, 2022

Figure 3.19: Degree of Overcoming Pesticide Unavailability Issue

Figure 3.20 demonstrates a diverse array of strategies implemented by farmers to overcome the issue of pesticide, unavailability following the import ban. Notably, the data reveals that a significant proportion of farmers (63%) resorted to have purchased available chemicals at inflated prices to control pests and diseases in paddy. About (11%) turned to chemicals sourced from informal channels, while 9% opted for organic substances. Traditional methods were employed by 14% of farmers in the study sample, and 2% of them opted to apply un-prescribed chemicals. It is also noteworthy that 14% of farmers did not resort to any strategy to address the matter. Figure 3.20 illustrates the farmers' reaction to pesticide unavailability.



Source: HARTI survey data, 2022

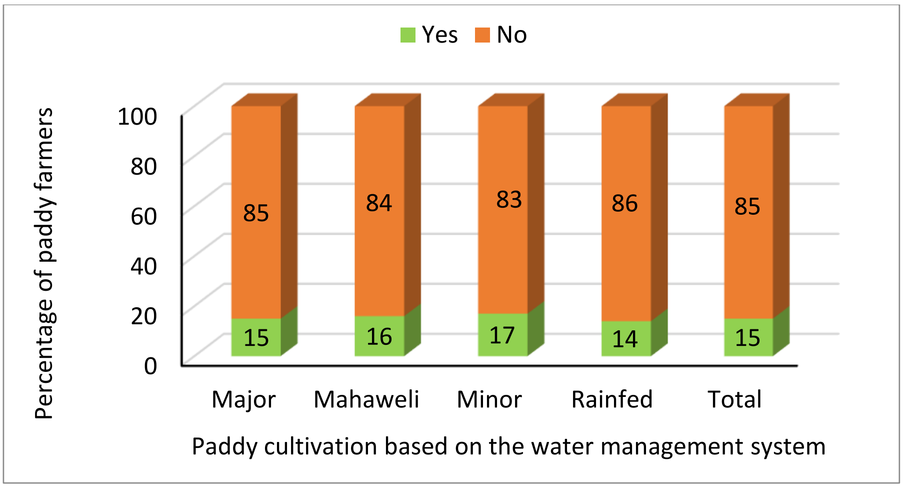
Figure 3.20: Strategies Adopted to Overcome Pesticide Unavailability

3.5 Organic Fertilizer Use after Import Ban

Organic fertilizers are an important source of plant nutrients in paddy cultivation. Unlike synthetic fertilizers, they are made of natural materials such as animal manure and plant waste. Compost, which are soil conditioners, made by humans are also used by farmers as fertilizers. Organic fertilizers improve the soil structure, enhance the water retention capacity, and provide a steady release of nutrients to the crops (Haque et al., 2021). This improves the overall health of the paddy crops, which results in a better yield, increased resistance to pests and diseases, and improved grain quality. The use of organic fertilizers is also beneficial for the environment as it reduces the amount of chemical fertilizers and pesticides that are required, thereby minimizing soil and water pollution. One of the reasons for the ban on agrochemical import was to promote the use of organic fertilizers.

3.5.1 Application of Organic Fertilizers

Around 15% of paddy farmers opted for the use of organic fertilizers in their cultivation, even prior to the implementation of the chemical fertilizer import ban, as depicted in Figure 3.21. Interestingly, the irrigation type seemed to have no significant impact on the usage of organic fertilizers in the past, as evidenced by the statistical analysis ($\chi 2$ df=3, N=625) = 0.765, $p>0.05$), highlighting the consistent trend across different irrigation systems.



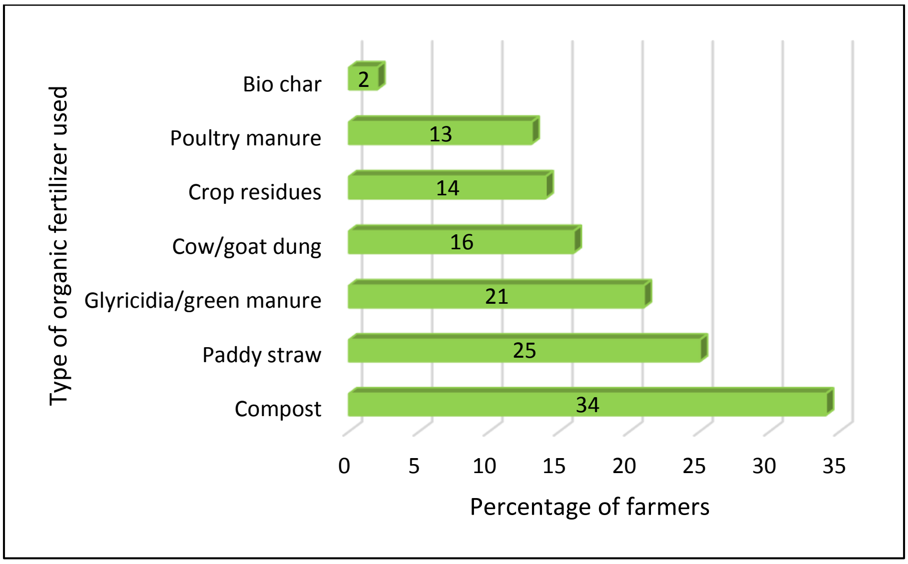
Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.21: Organic Fertilizer Application by Farmers in Paddy Cultivation based on the Source of Irrigation Water

3.5.2 Type of Organic Fertilizers Used

Figure 3.22 illustrates that the distribution of farmers based on the type of organic fertilizer they used in paddy cultivation. The most commonly used organic fertilizer was compost, which is actually a soil conditioner but not a fertilizer, and was used by 34% of the farmers. Paddy straw and glyricidia/green manure were the second and third most popular organic fertilizers, used by 26% and 21% of the farmers, respectively. Cow/goat dung, crop residues, and poultry manure were also used by some farmers, with ranged from 13% to 16%.

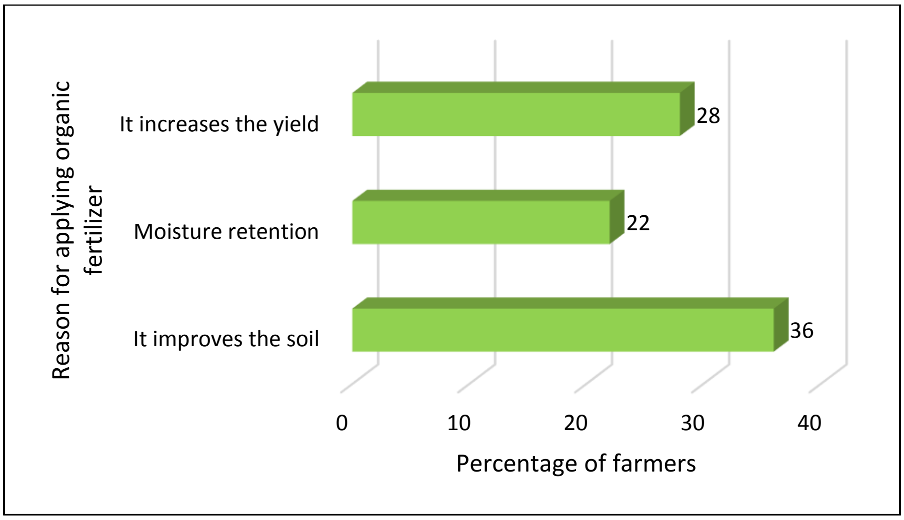


Source: HARTI survey data, 2022

Figure 3.22: Type of Organic Fertilizer Used

3.5.3 Purpose of Using Organic Fertilizers

Farmers used organic fertilizer to provide their crops with necessary nutrients for growth and yield improvement, as they perceived. The reasons for applying organic fertilizer varied, with the most common being improving soil health through nutrient-rich content such as Nitrogen, Phosphorus, and Potassium, leading to a more fertile soil structure as preferred by 36% of farmers (Figure 3.23). Additionally, 22% of farmers used organic fertilizer due to its ability to improve soil moisture retention, which reduces water loss to evaporation and increases water-holding capacity. Further, organic fertilizers that are essential source of nutrients would help increase crop yield, which is why 28% of farmers choose to apply it.



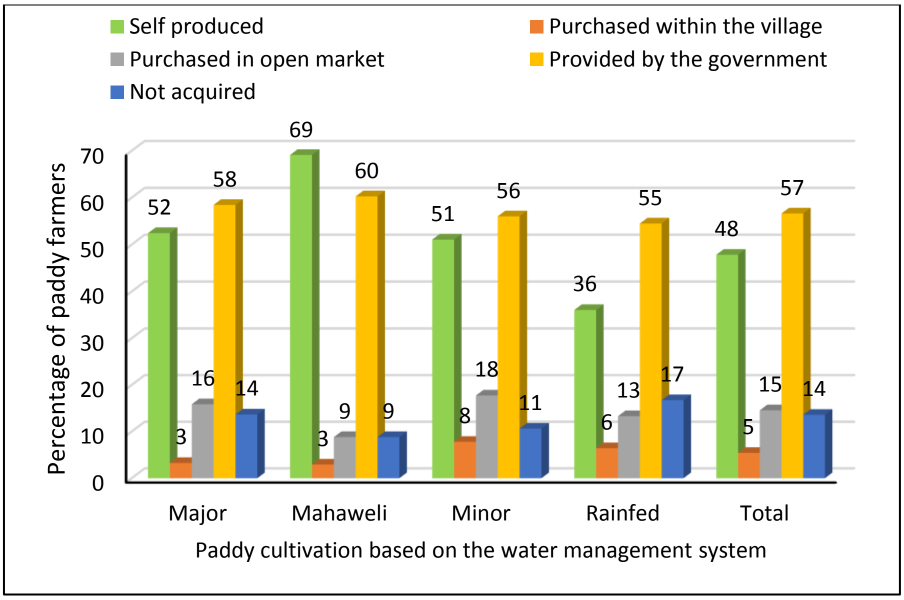
Source: HARTI survey data, 2022

Figure 3.23: Reasons for Applying Organic Fertilizers

3.5.4 Access to Organic Fertilizers

After the import ban was imposed, the majority of farmers surveyed have relied on organic fertilizers provided by the government. This was the prevailing trend across all irrigation systems, except for the Mahaweli irrigation scheme. In the Mahaweli areas, 69% of farmers produced their own organic fertilizers (Figure 3.24). High self-production rate of organic fertilizers in Mahaweli areas was partly attributed to an accelerated programme launched by the government to encourage the production of organic fertilizers as an alternative to chemical fertilizers in the area.

It should be highlighted that the purchase of organic fertilizers from the open market was also low (15%). This observation suggests that farmers may not rely on open market options for their organic fertilizer needs, possibly due to the lack of trust in the quality of the available products. Further, low demand may have resulted in a limited supply of organic fertilizers to the market, hence making it difficult for farmers to access them.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.24: Source of Organic Fertilizer Acquisition by Farmers in Paddy Cultivation based on the Water Management System

3.5.5 Issues Encountered in Using Organic Fertilizers

The transition from agrochemicals to organic fertilizers has posed various challenges for farmers. One significant challenge (48%) was the labour-intensive process of using organic fertilizers, which requires more labour to spread and incorporate into the soil. This can increase production costs and would impact profitability.

Additionally, farmers (35%) faced difficulties in obtaining large quantities of organic fertilizers required for their fields, as production and distribution infrastructure is not as developed as it is for the chemical fertilizers (Table 3.5). Poor quality of organic fertilizers available in the market was another significant issue faced by farmers (32%), as low-quality fertilizers can lead to reduced crop yields and soil degradation.

Moreover, some farmers found it economically unsustainable (24%) to use organic fertilizers due to higher cost of production and distribution. Other challenges include, lack of knowledge (7%) about the use organic fertilizers (methods, quantities, etc.), as well as unavailability of organic fertilizers in the market (7%) due to the shortage of production and weak distribution infrastructure. Some farmers (3%) also faced difficulty in carrying out some field operations, such as land preparation when using organic fertilizers, particularly paddy straw. This is because organic fertilizers tend to be bulky and require additional effort to spread and incorporate into the soil. Other issues (2%) encountered by farmers include the wash away of fertilizers with heavy rain, odor, and unknown nutrient composition.

Table 3.5: Issues associated with Organic Fertilizer Use

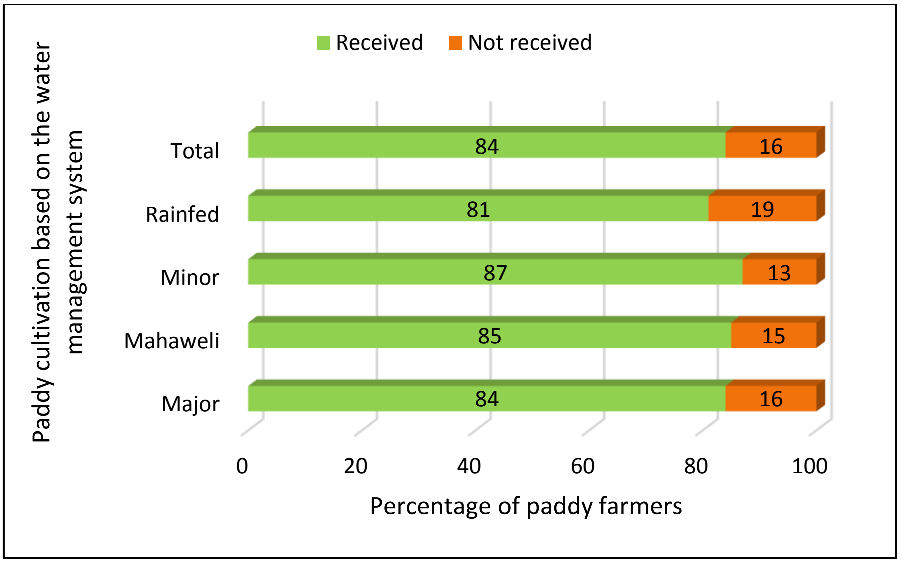
Issues	Percentage of farmers
High labour requirement	48
Difficulties in finding required quantities	35
Poor quality of the products available in the market	32
Application is not economically sustainable	24
Unavailability of organic fertilizers in the market	7
Unaware of how to use and/or in what quantities	7
Lack of information received through extension	7
Interfere with some field operations	3
None	19
Other	2

Source: HARTI survey data, 2022

3.5.6 Government Cash Subsidy on Organic Fertilizer Production

In the midst of a ban on chemical fertilizers, the government has pledged to offer a subsidy of Sri Lanka Rs. 12,500 per hectare, for up to two hectares, equating to a maximum of Rs. 25,000, for a total of five acres (2 hecatres). This subsidy was intended to be provided to paddy farmers who produced their own organic fertilizer during the 2021/22 *Maha* cultivation season.

Figure 3.25 illustrates the percentage of farmers who received the subsidy across irrigation systems, revealing a significant variation in subsidy allocation at a ($\chi^2_{(3, N=625)} = 56.410, p<0.05$). Around 65% of farmers in the Mahaweli areas obtained the subsidy, but only 21% of farmers in the rainfed areas received it. This could potentially be due to the Mahaweli 'F' zone being declared a sustainable development area for organic agriculture by the government, probably owing to increased awareness and adoption of organic farming practices in the area.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.25: Receipt of Cash Subsidy by Farmers for Producing Organic Fertilizer in Paddy Cultivation based on the Water Management System

Table 3.6 shows that the mean cash subsidy amount for producing organic fertilizers varied among the irrigation systems. The highest mean subsidy recorded in the study (Rs. 8,797 per farmer) received by farmers in rainfed areas, and the lowest of Rs. 7,657 per farmer received by farmers in the minor irrigation systems. Notably, the farmers in the Mahaweli irrigation system had the second-highest mean subsidy of Rs. 8,557 per farmer, despite a smaller sample size of 44 farmers.

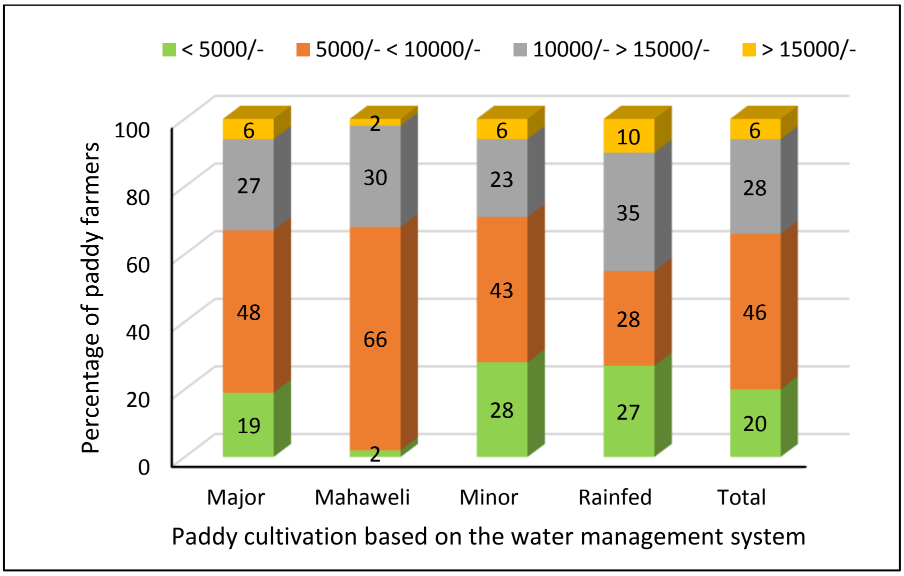
Table 3.6: Descriptive Statistics of Organic Fertilizer Cash Subsidy

Paddy cultivation based on the water management system	Count	Mean (Rs.)	Standard Deviation (Rs.)	Minimum (Rs.)	Maximum (Rs.)
Major	79	8,384	4,445	3,000	25,000
Mahaweli	44	8,557	2,483	3,000	15,000
Minor	67	7,657	4,801	1,500	25,000
Rainfed	49	8,797	5,496	1,500	25,000
Total	**239**	**8,297**	**4,500**	**1,500**	**25,000**

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.26 illustrates that a significant percentage of Mahaweli farmers (66%) received cash subsidies for producing organic fertilizers ranging from 5,000/- to 10,000/-. In rainfed areas, the largest percentage of farmers obtained subsidies between 10,000/- and 15,000/-, and it is noteworthy that 10% of farmers received subsidies exceeding 15,000/-. These statistics shed light on the government's efforts to promote organic farming practices and provide support to farmers as they transit to alternate agricultural methods. Additionally, the relatively high standard deviation of subsidy amounts across all irrigation systems indicates that the subsidy programme reached a diverse range of farmers with varying levels of production.



(Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems)

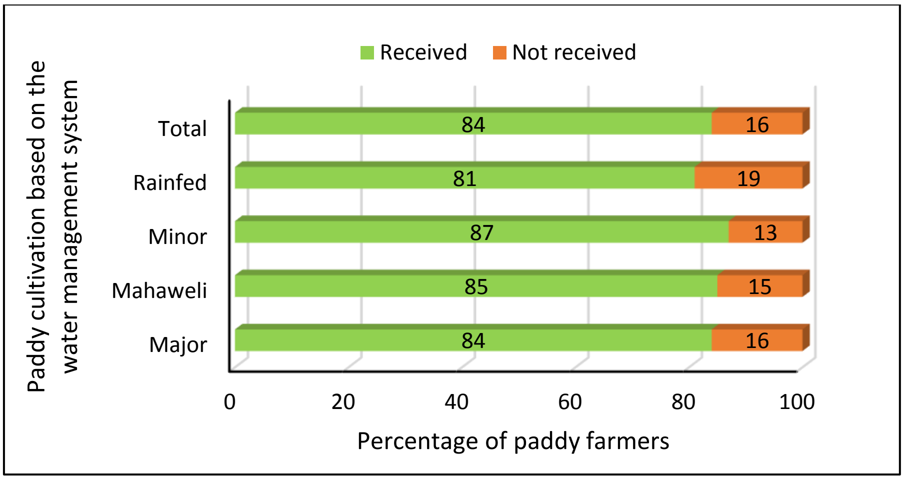
Source: HARTI survey data, 2022

Figure 3.26: Amount of Cash Subsidy for Producing Organic Fertilizer

3.5.7 Provision of In-kind Alternative Fertilizer Subsidy by the Government

a. Receipt of Subsidy

The government of Sri Lanka also took the responsibility and absorbed the cost in distributing organic fertilizer to the farmers (in-kind subsidy), to fulfil the requirement, through the agrarian service centers in the regions. Figure 3.27 illustrates the proportion of farmers who received or did not receive government-provided organic or nano-fertilizers in various irrigation systems. More than 80% of the farmers in the study sample were provided with the alternative fertilizers, which has the potential to enhance their crop production. Nonetheless, a significant number of farmers did not receive them, suggesting that the government should undertake additional outreach efforts to guarantee fair distribution of agricultural inputs.



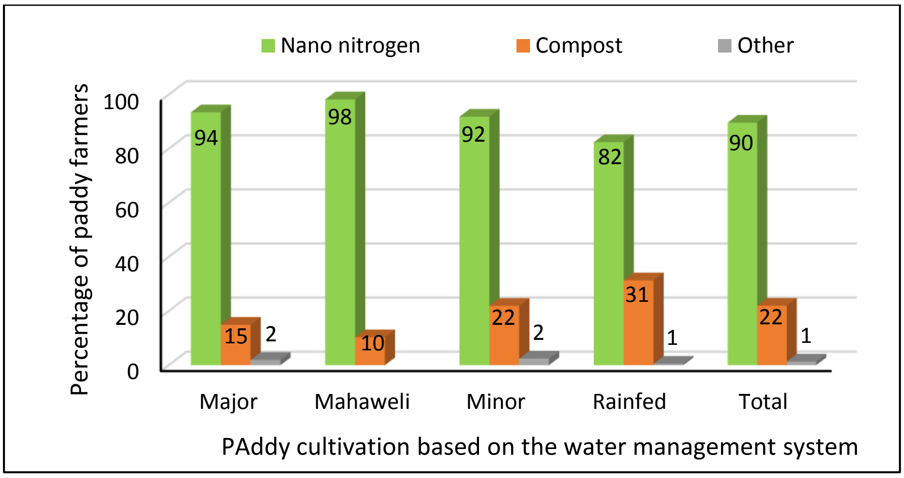
Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.27: Government In-kind Fertilizer Subsidy provided for paddy cultivation, based on the Water Management System

b. Type of Fertilizers as Subsidy

Figure 3.28 illustrates the various types of fertilizers offered by the government as alternatives to agrochemicals following the import ban. Impressively, Nano liquid Nitrogen emerged as the primary alternative, being supplied to 90% of farmers in the study sample. Furthermore, the data highlighted that in the Mahaweli region, 98% of the farmers received the Nano-nitrogen, whereas 10% of the same region were given compost. In contrast, the government provided compost to 31% of farmers in the rainfed area. Farmers also revealed that the government also provided them with fish tonic, paddy straw, and eco-nitrogen as alternative fertilizers in addition to Nano liquid nitrogen and compost.



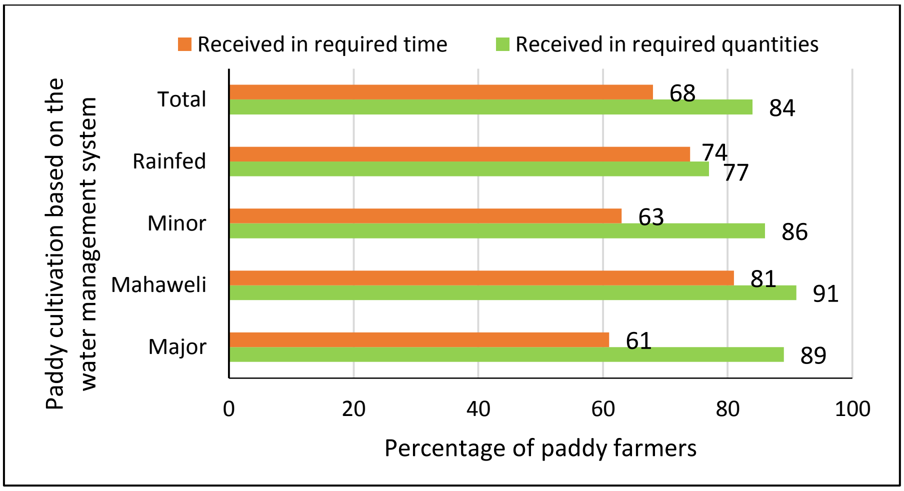
Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.28: Type Fertilizer Provided by the Government as In-kind Subsidy for Paddy Cultivation based on the Water Management System

c. Provision of Adequate Quantities of Alternate Fertilizers in a Timely Manner as in-kind Fertilizer Subsidy by the Government

Figure 3.29 illustrates that a majority of farmers surveyed have received the required quantities of alternative fertilizer, but the expected timeframe for receipt was not satisfactory. Additionally, it is noteworthy that the distribution of alternative fertilizers varied significantly across different irrigation systems, indicating an uneven distribution throughout the entire island during the import ban period ($\chi^2_{(3, N=522)} = 13.202, p<0.05$).



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.29: Status of In-kind Fertilizer Subsidy Received by Farmers in Paddy Cultivation based on the Water Management System

d. Use of Subsidized Alternate Fertilizer Provided by the Government

Table 3.7 presents data related to the use of government-subsidized alternative fertilizer by farmers. Overall, 81% of farmers applied the fertilizer to their fields, despite some challenges related to its distribution and quality. Of those who received the fertilizer in time with required quantities, 52% applied it to their fields. About 68% of farmers opted to apply the fertilizer when there were adequate quantities, while 59% applied it when they received it on time, irrespective of the quantity required. However, some farmers did not apply the fertilizer due to concerns about its quality, bad smell, or negative perception about the alternatives. These factors likely influenced farmers' decision-making on whether to apply the fertilizer on their fields. The findings suggest that the subsidy programme was partially effective in promoting the use of alternative fertilizers, but the programme faced challenges related to timely and equitable distribution, as well as farmer perceptions of the quality of the alternatives.

Table 3.7: Criteria Used by Farmers in Applying Fertilizer Received through the In-kind Alternative Fertilizer Subsidy Provided by the Government

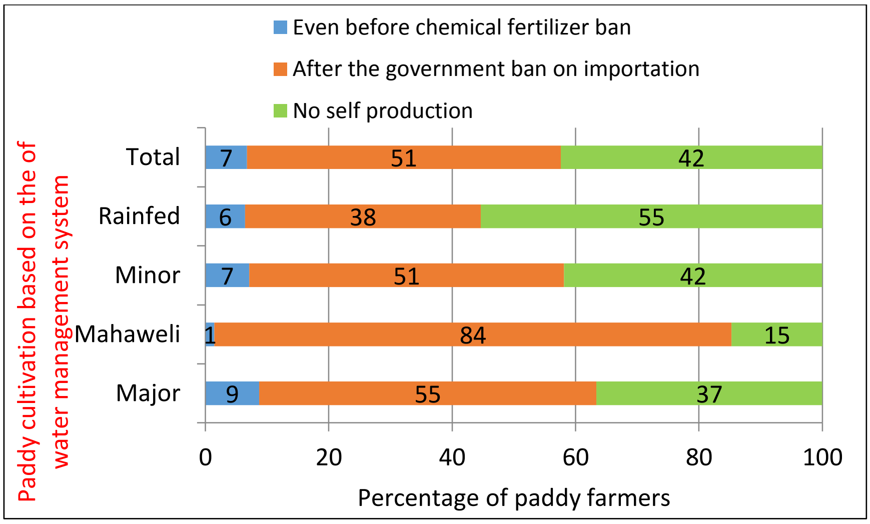
Application Criteria of Farmers	Percentage of farmers
Applied when either received required quantity or on time	81
Applied when received required quantity and on time	52
Applied when only received required quantity	68
Applied when only received on time	59

Source: HARTI survey data, 2022

3.5.8 Organic Fertilizer Production

a. Production

Except the farmers in the rainfed areas, more than half of the farmer sample surveyed in this study were producing organic fertilizer. Overall, 51% have started producing organic fertilizer only after the import ban (Figure 3.30). Furthermore, there is a significant difference in the self-production of organic fertilizer across different irrigation schemes, with 84% in the Mahaweli region starting to produce their own organic fertilizer after the import ban ($\chi^2_{(6,\ N=625)} = 49.334$, $p<0.05$). The higher production of organic fertilizer in the Mahaweli region compared to the rest is related to intense promotion campaign by the government in this area to encourage farmers to produce their own organic fertilizer. Therefore, it is evident that the import ban and subsequent organic promotion have led to an increase in the self-production of organic fertilizer by paddy farmers, particularly in the Mahaweli region where the government's engagement in the promotional campaign for the said process was intense.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.30: Level of Self-production of Organic Fertilizer by Paddy Farmers based on the Source of Irrigation Water

b. Use of Raw Materials

Table 3.8 presents valuable insights into the main raw materials chosen by the farmers for organic fertilizer production, revealing the reasons behind their choices. Glyricidia emerged as the most commonly used plant-based material, preferred by a significant percentage of farmers. This choice is supported by 96% of farmers who used it for major crops, 98% for crops cultivated in the Mahaweli scheme, 94% for crops in the minor irrigation schemes, and 87% for rainfed crops. Other green cuttings, including banana stems and leaves, gliricidia, water hyacinth (*Japan Jabara*), Salvinia, neem, grasses, and wild sunflower plants were also utilized by 79% of the farmers. Paddy straw, crop residues, and paddy husk were also used as raw materials in organic fertilizer production, with significant percentages of farmers incorporating them into their practices.

Table 3.8: Main Raw Materials Used by Sample Farmers for the Production of Organic Fertilizer

	Percentage of Farmers in Different Water Management Systems				
	Major	**Mahaweli**	**Minor**	**Rainfed**	**Total**
Crop-based material					
Glyricidia	96	98	94	87	93
Other green cuttings	73	83	79	84	79
Paddy straw	88	76	84	63	78
Paddy husk	33	43	18	24	29
Crop residue	60	62	45	65	59
Animal-based material					
Cow dung	93	86	96	81	89
Poultry manure	23	40	39	42	35
Goat manure	2	3	1	5	3
Bat dropping	1	0	2	0	1
Other					
Eppawala Rock Pospate	10	5	7	12	9
Kitchen waste	1	0	0	2	1

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

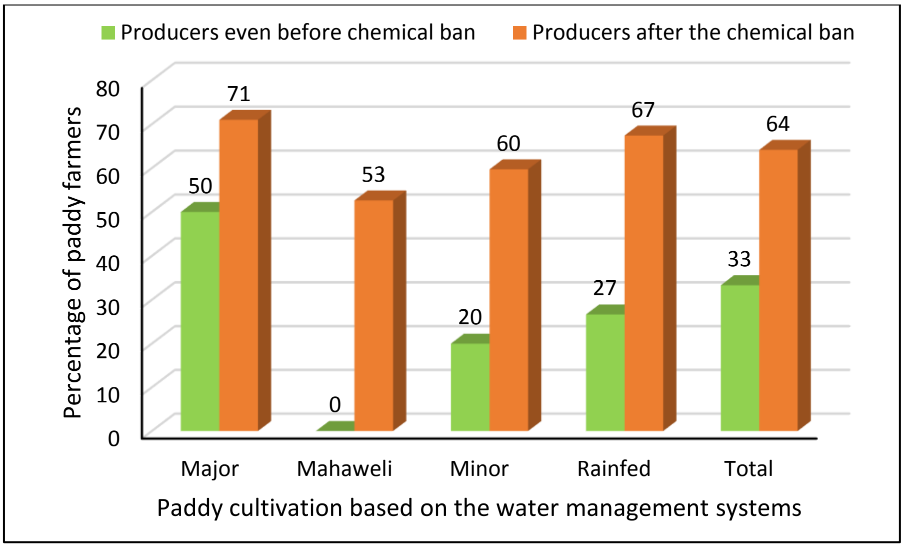
Paddy straw, utilized by 79% of farmers, is probably chosen due to its abundance as a byproduct of paddy cultivation, and its high carbon content, which contributes to organic matter and improves soil structure. Crop residues, used by 59% of farmers, are likely selected for their nutrient content and potential to recycle agricultural waste back into the system, reducing the need for external inputs. Paddy husk, used by 29% of farmers, may be preferred for its availability as a byproduct of rice processing, and its potential to improve soil aeration and water-holding capacity. These choices reflect the resourcefulness of farmers in utilizing locally-available materials to produce organic fertilizers, taking advantage of agricultural byproducts and waste materials to enhance soil fertility and crop productivity in a sustainable manner.

Furthermore, cow dung is a primary animal-based raw material, with 89% of farmers incorporating it into their organic fertilizer production process for paddy. This is likely due to the accessibility and affordability of cow dung as a readily available source of organic matter and nutrients. Additionally, one third of farmers also used poultry manure, indicating that animal-based materials are commonly used in organic fertilizer production.

Interestingly, a small percentage (9%) of farmers also mixed Eppawala Rock Phosphate (ERP) into their organic fertilizers. This suggests that some farmers may be utilizing ERP as a source of phosphorus, an essential nutrient for plant growth, in their organic fertilizer production. Further, kitchen waste was used by only 1% of farmers, indicating a relatively low utilization rate of this material in organic fertilizer production for paddy cultivation. This could be due to challenges associated with collection, handling, and processing of kitchen waste, as well as concerns about potential contamination and variability in nutrient content.

c. Difficulties in Organic Fertilizer Production

Figure 3.31 illustrates the percentage of farmers who reported facing difficulties in self-producing organic fertilizers, categorized by whether they were producers before or after the ban imposed on chemical imports. Notably, a higher percentage of new producers reported facing difficulties compared to the existing producers. Statistical analysis further revealed that there was a significant difference in difficulties faced by existing producers in different irrigation system ($\chi 2$ (3, N=318) = 6.355, $p<0.10$), indicating that new producers encountered more challenges in organic fertilizer production. Furthermore, the data showed that a larger number of farmers in major and rainfed irrigation areas reported facing difficulties compared to farmers in other regions. Interestingly, only new producers among Mahaweli farmers reported facing difficulties in organic fertilizer production.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.31: Difficulties in Organic Fertilizer Production Farmers in Paddy Cultivation based on the Water Management System

Table 3.9 presents the major challenges faced by farmers in producing organic fertilizer. Limited availability of raw materials was reported by 73% of farmers. Wijesooriya and Senarath (2021) also identified a gap in the availability of potential biomass residues for the production of organic fertilizers. This indicates that farmers struggle with obtaining sufficient raw materials to produce organic fertilizer, which may hinder their production capacity. Time constraints was faced by 66% of farmers. This suggests that farmers may not have adequate time to dedicate in producing organic fertilizer, which could be due to other farming activities or personal commitments. Time management and labour availability may be the key factors affecting organic fertilizer production. Another 13% of farmers reported of the lack of technical know-how as a challenge. This indicates that farmers may not have the necessary knowledge or skills to produce organic fertilizer, which could include understanding the process, equipment operation, and quality control. This also highlights the need for training and education programmes to improve farmers' technical knowledge in organic fertilizer production. Limited space for production was reported by varying percentages of farmers across different irrigation systems, ranging from 2% to 13%. This suggests that some farmers may face issues related to space availability for organic fertilizer production, which could impact their production capacity or ability to expand production.

Table 3.9: Major Challenges Faced in Production of Organic Fertilizer

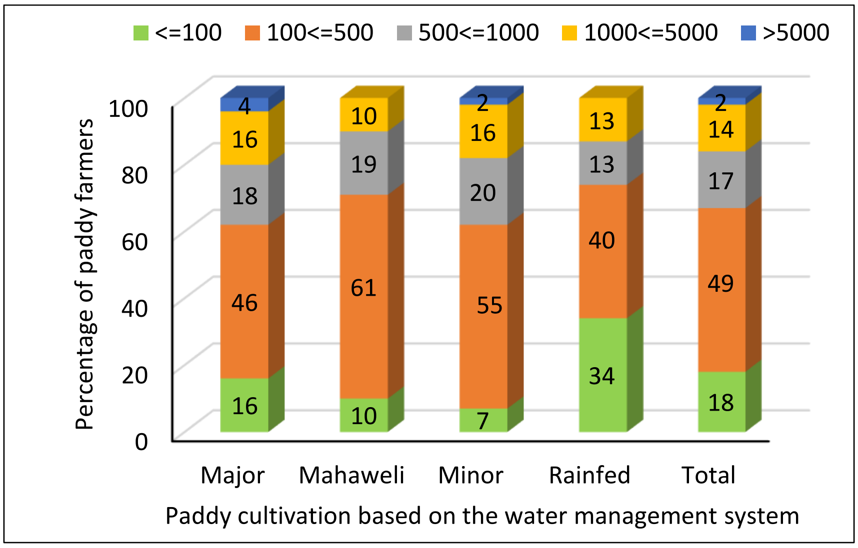
Challenge	Percentage of Paddy Farmers in Different Water Management Systems				
	Major	Mahaweli	Minor	Rainfed	Total
Limited raw material availability	77	73	76	70	73
Lack of technical know how	11	7	22	11	13
Limited space for production	9	13	2	9	8
Time constraint	68	60	58	70	66

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

d. Quantity of Organic Fertilizer Produced

Data presented in Figure 3.32 depicts the distribution of farmers based on their production of organic fertilizer. The largest group of farmers (49%) falls into the category of producing organic fertilizer in the range of more than 100 to 500 kg. Further analysis revealed that in rainfed areas are predominantly characterized by small-scale organic farmers (74%), producing less than 500 kg of organic fertilizer. This suggests that rainfed areas are predominantly characterized by small-scale farmers who cultivate paddy for self-consumption (Buhary et al., 2021), resulting in lower levels of organic fertilizer production. Conversely, in major and minor irrigation schemes, a relatively higher percentage (38%) of farmers are classified as large organic producers, producing more than 500 kg of organic fertilizer, cultivating larger extents of land and producing larger quantities of organic fertilizer compared to rainfed areas.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

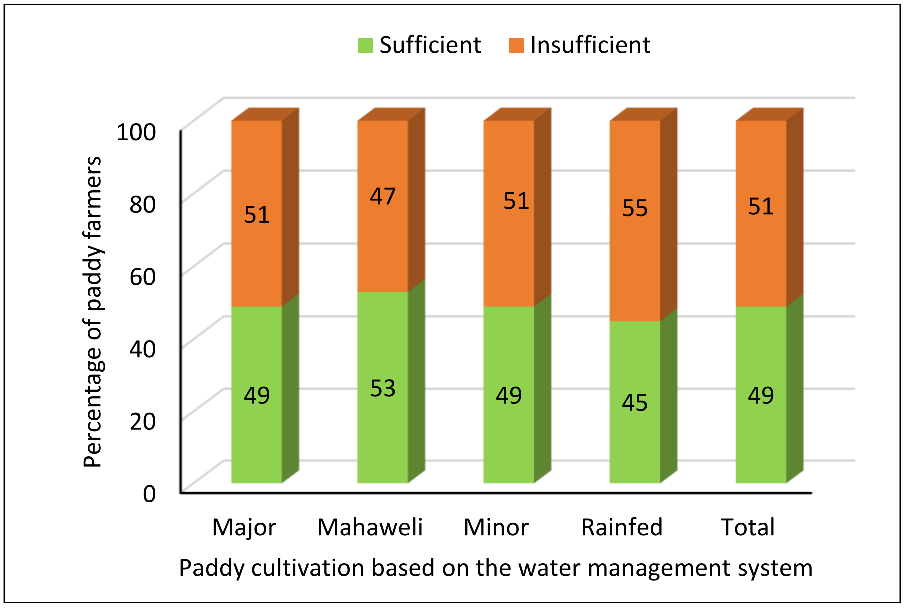
Source: HARTI survey data, 2022

Figure 3.32: Quantity of Organic Fertilizer Produced by Paddy Farmers based on the Water Management System

e. Adequacy of the Organic Fertilizers Produced

As illustrated by Figure 3.33, there seems to be no significant variation in the sufficiency of quantity produced of organic fertilizer for their own paddy cultivation among different types of irrigation areas ($\chi^2_{(3, N=360)} = 1.044$, $p>0.05$). This suggests that the source of irrigation water has not impact on the adequacy of organic fertilizer production by farmers for their own paddy cultivation.

Approximately 50% of farmers who were involved in organic fertilizer production perceived that their production was adequate for their cultivation needs, while the remaining 50% did not find it sufficient, regardless of the source of irrigation water used. This implies that there is a notable divide among farmers in terms of their perception of the sufficiency of their organic fertilizer production.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 3.33: Sufficiency of Organic Fertilizer Production in Paddy Cultivation based on the Water Management System

f. Quantity Sold and Price

Only a small percentage of farmers (<2%) of the total of 360 self-organic fertilizer producers, sold their organic fertilizers (Table 3.9). The majority of these farmers were from rainfed areas. Interestingly, none of the farmers from minor irrigation schemes or Mahaweli irrigation areas reported selling their organic fertilizer. The prices at which the organic fertilizer was sold varied among the farmers, i.e. Rs. 15 to 45 per kilogram.

Table 3.10: Profile of Farmers on Organic Fertilizer Production

Farmer	Water Management System	Quantity Produced (kg)	% Share of Quantity sold	Unit Price Sold (Rs./kg)
Farmer A	Major	6000	33	20
Farmer B	Rainfed	2000	50	45
Farmer C	Rainfed	2000	20	15
Farmer D	Rainfed	1500	67	40
Farmer E	Rainfed	1000	60	40

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

CHAPTER FOUR

Comparison of Paddy Input Use, Production, and Productivity Before and After Agrochemical Import Ban

The imposition of import bans on agrochemicals (Fertilizer and other agrochemicals) can significantly impact the dynamics of farming practices and production outcomes. In Sri Lanka, where paddy cultivation as being the major staple, changes in the utilization of agricultural inputs and production patterns after an import ban could have far-reaching negative effects. Factors such as the extent of input utilization; including land, organic and chemical fertilizers, weed control, insect pest and disease management, yield per unit of land, crop sales, and storage, are crucial in assessing the post-import ban scenario. Overall, this chapter examines the shifts in agricultural input usage and production patterns in paddy cultivation prior to import ban (2020/21 *Maha* season) and after the import ban (2021/22 *Maha* season) to assess the impact of the ban imposed, and to explore the implications and outcomes of such drastic policy changes.

4.1 Land Use Before and After the Import Ban

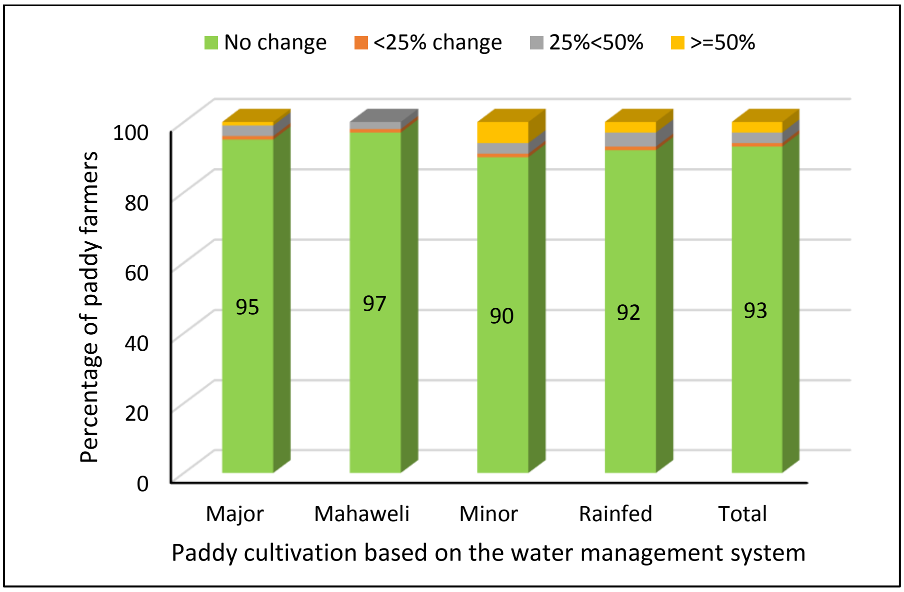
The restrictions on imported agrochemicals would lead to farmers adopting alternate farming practices, which could impact the extent of paddy land use. Factors such as the availability of local inputs, changes in yield levels, and farmers' ability to cope with the ban may influence the extent of paddy land use in the post-import ban scenario. Understanding how paddy land use patterns evolve after an import ban is important to assess the implications and outcomes of such changes on the agricultural sector and food security in Sri Lanka.

4.1.1 Whole Extent Change

The analysis of paddy cultivation data from the sample farmers during the period of 2020 to 2022 revealed a 5% decrease in the total paddy cultivated extent in the 2021/22 *Maha* season, which is main cultivation season after import ban, compared to that of 2020/21 *Maha* season. This reduction was reported by 8% of farmers, who either did cultivate a lower extent or temporarily suspended paddy cultivation in certain land plots. This decrease in cultivation was observed amidst the challenges posed by the COVID-19 pandemic and the ban on fertilizers, impacting household food security. This finding highlights the notable changes in paddy farming practices and land utilization among farmers due to import ban on agrochemicals.

4.1.2 Plot Extent Change

The analysis performed to assess the changes in a selected single plot revealed that the average extent of paddy cultivated in 2021/22 *Maha* did not change in 93% of farmers surveyed, compared to that in 2020/21 *Maha* season (Figure 4.1). Only 7% of farmers did cultivate lower extents in selected plots than the previous *Maha* season due to many reasons such as policy issues, climate change, economic crisis and other reasons. Among them, the main reason to lower extent cultivated in the 2021/22 *Maha* season was the lack of fertilizer and other agrochemicals, as stated by 11% of farmers.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 4.1: Change in the Extent of Paddy Cultivated After the Import Ban of Agrochemicals

Overall, the average size of paddy cultivated of the selected plots was 3.12 acres (1.26 hectares) in 2020/21 *Maha* season, but it was declined to 3 acres (1.21 hectares) in the following 2021/22 *Maha* season (Table 4.1). Table 4.2 also demonstrates that, from among the districts considered in the study, Batticaloa, Kilinochchi and Vavuniya had a higher average paddy land plot extent of 6.87 acres (2.78 hectares), 6.18 acres (2.50 hectares) and 4.86 acres (1.97 hectares) respectively. Consultation with farmers from those areas revealed that many of the farmers cultivate farmland not only they own but also the adjacent encroached lands they occupied after the terrorist war that ended in 2009. Kurunegala, Kalutara and Galle had a lower average paddy land extent among the rest mainly due to urbanization and economic development activities in those districts.

Table 4.1: Average Extent of Land Plot Cultivated Using Different Sources of Irrigation Water Before and After the Import Ban of Agrochemicals

Water Management System	Average Extent of Chosen Plot in Acres (Hectares)	
	2020/21 *Maha* season	**2021/22 *Maha* season**
Major	2.99 (1.21)	2.91 (1.18)
Mahaweli	2.61 (1.06)	2.60 (1.05)
Minor	2.59 (1.05)	2.43 (0.98)
Rainfed	3.68 (1.49)	3.56 (1.44)
Total	3.12 (1.26)	3.00 (1.21)

(Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems)

Source: HARTI survey data, 2022

Table 4.2: Average Extent of Land Plot by District Before and After Import Ban of Agrochemicals

District	Average extent of chosen plot in Acres (Hectares)	
	2020/21 *Maha* season	**2021/22 Maha season**
Anuradhapura	2.71 (1.10)	2.57 (1.04)
Ampara	3.67 (1.49)	3.67 (1.49)
Kurunegala	1.28 (0.52)	1.24 (0.50)
Vavuniya	4.86 (1.97)	4.66 (1.89)
Kilinochchi	6.18 (2.50)	6.18 (2.50)
Batticaloa	6.87 (2.78)	6.79 (2.75)
Badulla	2.48 (1.00)	2.48 (1.00)
Polonnaruwa	2.33 (0.94)	2.21 (0.89)
Kalutara	1.68 (0.68)	1.53 (0.62)
Galle	1.80 (0.73)	1.74 (0.70)
Moneragala	3.09 (1.25)	2.65 (1.07)

Source: HARTI survey data, 2022

A paired t-test was performed to determine whether there was a statistically significant difference in means between the paddy land extent cultivated using different sources of irrigation water before and after the import ban of fertilizer and other agrochemicals (Table 4.3). Results revealed that the extent cultivated by farmers was lower after the import ban (3.01 ± 3.39 acres or 1.22 ± 1.37 hectares) as opposed to the previous cultivated extent (3.12 ± 3.44 acres or 1.26 ± 1.39 hectares); a statistically significant decrease of 0.108 (95% CI: 0.1475 to 0.0685 acres, $t_{(624)}$ = -5.3664, p <0.001). However, the change in the cultivated extent was marginal especially in the Mahaweli and other major irrigation schemes, due to assured irrigation water for cultivation, where the fertilizer issue did not have a drastic influence on the extent cultivated. In contrast, paddy cultivation in minor irrigation schemes and rainfed areas, where people had major challenges with water availability, tend to reduce their cultivated extent after the fertilizer policy change.

Table 4.3: Results of Paired t-Test on the Average Change in Paddy land Extent Cultivated with Different Sources of Irrigation Water

Water Management Systems	t value	Degrees of Freedom	P value (2-tailed)
Major	-2.2694	182	0.0244
Mahaweli	-1.3964	67	0.1672
Minor	-3.2265	140	0.0016
Rainfed	-3.5620	232	0.0004
Overall	-5.3664	624	0.0000

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

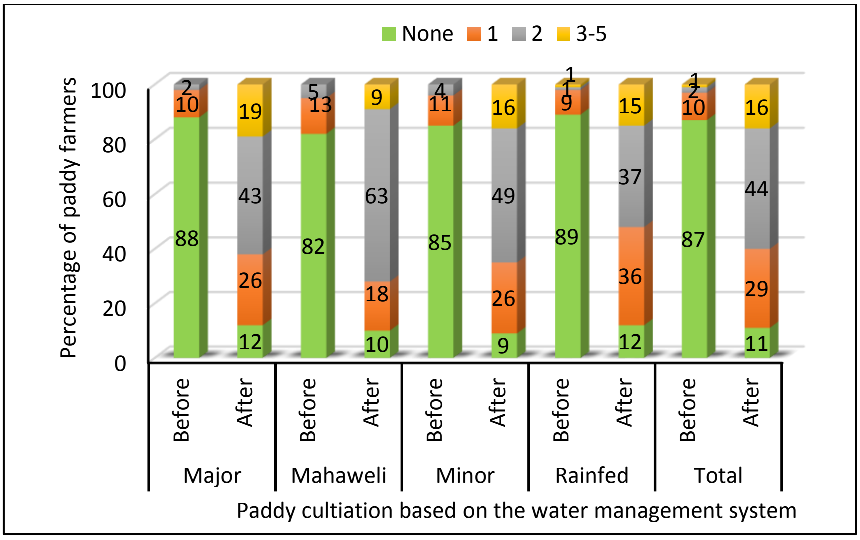
Source: HARTI survey data, 2022

4.2 Organic Fertilizer Use - Before and After the Import Ban

The sudden implementation of an import ban on agrochemicals was done with a proposed agenda by the government of Sri Lanka to facilitate promotion of organic fertilizers. This section aims to explain the changes in the types of organic fertilizers utilized before and after the ban, as well as the corresponding variations in compost quantity applied and their prices.

4.2.1 Type of Organic Fertilizer Used

Figure 4.2 illustrates the percentage of farmers who have used organic fertilizers before and after the implementation of the import ban of chemical fertilizers. Notably, prior to the ban, only 13% of farmers in the sample were utilizing organic fertilizers. However, following the ban on import of chemical fertilizers, this percentage increased significantly to 89%. Another intriguing observation is that before the policy change, farmers were limited to using a single type of organic fertilizer. However, after the import restriction, the majority of farmers, regardless of their location, began using multiple types of organic fertilizers in order to fulfill the nutritional requirements of their rice crops. This shift in practices might have been driven by the absence of other options due to the complete ban on chemicals, and the increased cost of the limited available chemicals before the ban.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 4.2: Different Types of Organic Fertilizer used by Paddy Farmers Before and After the Import Ban of Fertilizers

Table 4.4 presents the different types of organic fertilizers used by paddy farmers in the selected plots before and after the import ban. The primary and the most prevalent choice of organic fertilizer utilized by the paddy farmers was compost, which showed a 72% increase in usage in the 2021/22 *Maha* season, after the import ban of chemical fertilizers. Further, a small proportion of farmers (approx. 5%) opted for animal-based organic fertilizer and have increased the use of animal manure, including cow dung, goat dung, and poultry manure. Moreover, a limited number of farmers incorporated commercially available organic granular fertilizers and liquid fertilizers into their farming operations. Although the usage of these fertilizers was relatively low, it signifies a minor but tendency to adopt such products by some farmers in the chosen plot.

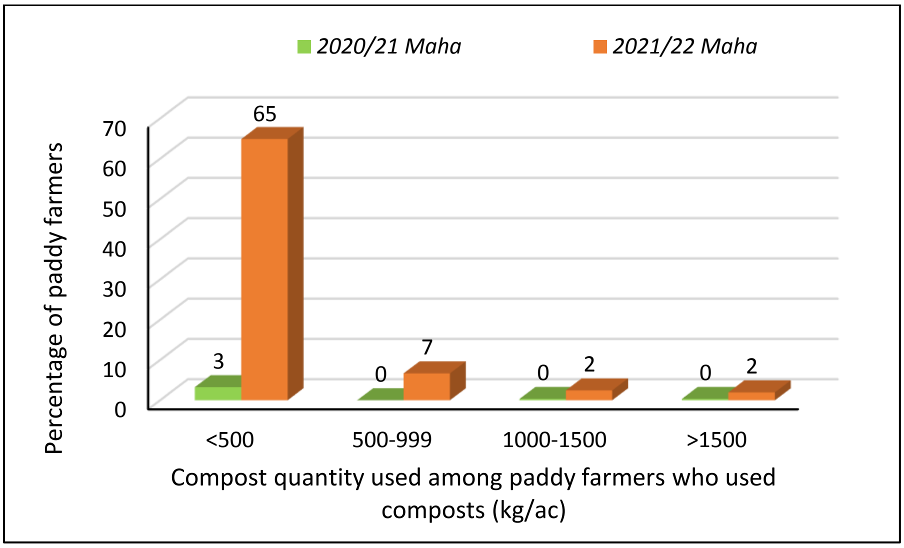
Table 4.4: Organic Fertilizer Applied Before and After Import Ban of Agrochemicals

Organic fertilizer	2020/21 *Maha* season		2021/22 *Maha* season	
	Count	%	Count	%
Compost	24	4	468	76
Paddy straw	17	3	14	2
Glyricidia/green manure	16	3	14	2
Poultry manure	11	2	30	5
Cow/goat dung	10	2	28	5
Bio char	6	1	10	2
Crop residues	8	1	4	1
Commercial organic granular fertilizer	3	0	23	4
Commercial organic liquid fertilizer	2	0	19	3

Source: HARTI survey data, 2022

4.2.2 Quantity of Compost Used by Paddy Farmers

Before the import ban, 97% of the paddy farmers in the study have not used composts in their cultivation. Among the 3% of the farmers who applied composts in paddy cultivation, have used it at quantities less than 500 kg/ac (Figure 4.3). However, the government recommendation is to apply 5 tons/ha (equivalent to 1250 kg/ac or 5000 kg/ha) for paddy fields[9]. After the import ban, among the 76% of farmers who used compost, 95% of them (72 from the total sample) were still using less than 1000 kg/ac (4000 kg/ha). This indicates that there were challenges in meeting the required quantity of compost for paddy cultivation. Only 2% of farmers in the sample managed to apply the recommended quantity after the ban, suggesting that a majority of farmers still applied composts at much lower quantities than the recommended amount. Results of this study also revealed that while there were issues in meeting the required quantity, some farmers applied excessive amounts of compost.



[10]Source: HARTI survey data, 2022

Figure 4.3: Quantity of Compost Used by Paddy Farmers Before and After the Import Ban of Fertilizer

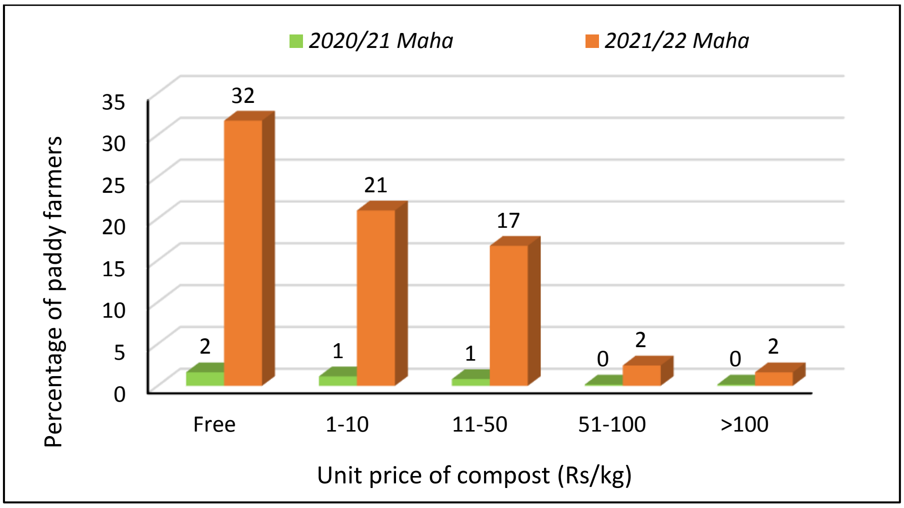
---

[9] https://www.sundaytimes.lk/210509/sunday-times-2/organic-fertiliser-only-policy-will-plunge-lanka-into-a-food-crisis-442857.html

[10] In Figure 4.3, x-axis values are as follows <500kg/ac or 2000kg/ha; 500-999kg/ac or 2000-3996kg/ac; 1000-1500kg/ac or 4000-6000kg/ha; >1500kg/ac or 6000kg/ha

4.2.3 Price of Compost

Figure 4.4 depicts the unit prices of compost purchased by the farmers in the sample before and after the import ban. Prior to the import ban, only 3% of farmers in the study sample were using compost. Among this group, half of the farmers were able to obtain compost for free, while the rest spent less than Rs. 50 per kg to acquire the compost. Interestingly, after the import ban, 32% of farmers from the total sample (42% of all compost users) managed to obtain the compost for free. This is due to the several campaigns initiated by the government to provide free or fully-subsidized supply of composts to farmers, especially during the 2021/22 *Maha* season cultivation. Moreover, half of the compost users were able to purchase it at a cost of less than Rs. 50 per kg, indicating that there were affordable options available for farmers to acquire compost even after the import ban.



Source: HARTI survey data, 2022

Figure 4.4: Unit Price of Compost Before and After the Import Ban of Fertilizers

4.2.4 Labour Use for Compost Application

The data shows that the average labour required for compost application marginally increased from 1.24-man days per acre (4.96 man days per hectare) in the 2020/21 *Maha* season to 1.31 man days per acre (5.24 man days per hectare) in the 2021/22 *Maha* season (Table 4.5). This increase suggests that farmers had to invest more time and effort in applying compost fertilizer during the 2021/22 *Maha* season compared to the previous *Maha* season.

Table 4.5: Average Labour Usage for Compost Application Before and After the Import Ban of Fertilizer

	Season	Mean
Labour usage for compost application in man days/acre (man days per hectare)	Before	1.24 (4.96)
	After	1.31 (5.24)

Source: HARTI survey data, 2022

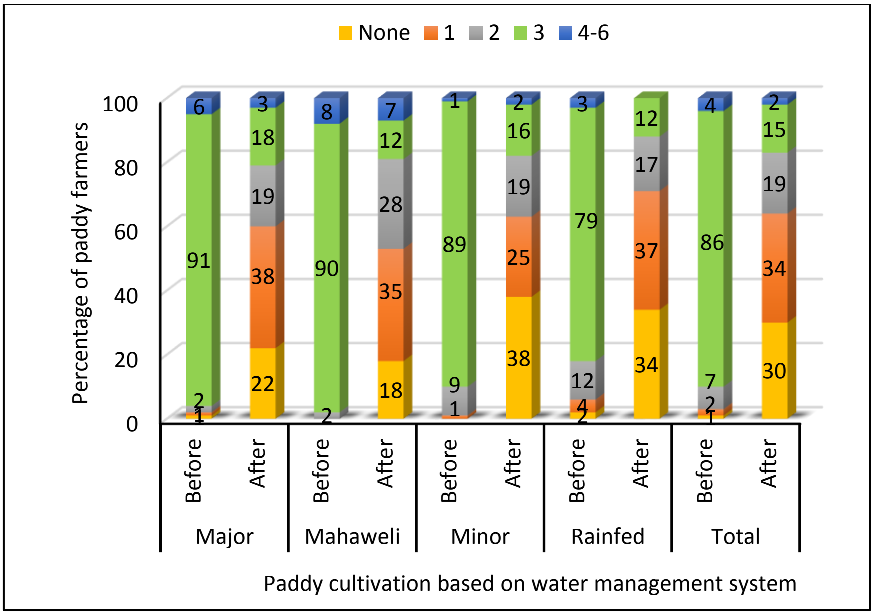
4.3 Chemical Fertilizer Usage Before and After the Import Ban

One of the main objectives to impose an import ban on agrochemicals (synthetic fertilizers and pesticides) by the government of Sri Lanka us to discourage the use of chemical fertilizers and promote the adoption of organic fertilizers. However, it is important to note that farmers already had existing stocks of chemical fertilizers that they could utilize for their cultivations, even after the ban. This section aims to describe the changes in the types of chemical fertilizers used by farmers before and after the ban, as well as the corresponding variations in the quantities applied. Specifically, the focus is on three commonly used chemical fertilizers: Urea, TSP (Triple Super Phosphate), and MOP (Muriate of Potash). The section below also explores any changes in the prices of these fertilizers.

4.3.1 Type of Chemical Fertilizers Used

Figure 4.5 provides an overview of the usage of chemical fertilizers before and after the implementation of the import ban on agrochemicals. Prior to the ban, approximately 89% of farmers in the sample were utilizing the three main types of chemical fertilizers, i.e. Urea, TSP and MOP. However, following the restriction on the market-availability chemical fertilizers, those who used the three types fertilizers dropped significantly to 15%, indicating a substantial reduction on the reliance on chemical fertilizers after the ban.

Interestingly, after the policy change, the results revealed that farmers were limited to either not using any chemical fertilizers (30%) or utilizing only a single type of chemical fertilizer (34%). This suggests that the ban resulted in a shift towards reduced usage or complete exclusion of chemical fertilizers, or leading to a more focused application of a specific type of chemical fertilizer, if used at all.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 4.5: Number of Chemical Fertilizer Types Applied Before and After the Policy Change

The application of the main fertilizers, namely Urea, MOP (Muriate of Potash), and TSP (Triple Super Phosphate), experienced significant reductions after the import ban on agrochemicals. Specifically, Urea witnessed a decrease of 43 percent in its application, while MOP and TSP saw larger reductions of 65 percent and 70 percent, respectively. Interestingly, among these main fertilizers, Urea had a relatively smaller drop compared to MOP and TSP. This indicates that Urea remained a relatively more commonly used chemical fertilizer even after the ban, albeit at a reduced rate.

Additionally, the usage of alternative Nitrogen sources was observed. Liquid Nitrogen was used by 55 percent of farmers, suggesting its adoption as a substitute for traditional chemical fertilizers. Furthermore, 11 percent of farmers utilized Nano Nitrogen, indicating a smaller but notable adoption of Nanotechnology-based Nitrogen fertilizers in agricultural practices. Overall, these findings highlight significant reductions in the application of traditional chemical fertilizers such as Urea, MOP, and TSP, as well as the emergence of alternative Nitrogen sources such as liquid Nitrogen and Nano Nitrogen.

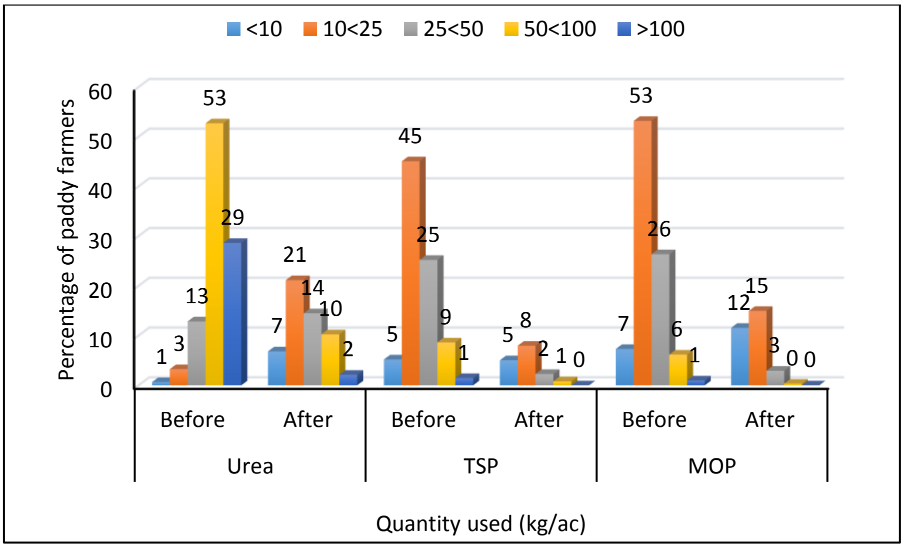
Table 4.6: Types of Chemical Fertilizer Applied Before and After the Policy Change

Chemical fertilizer	2020/21 *Maha* season		2021/22 *Maha* season	
	Count	%	Count	%
Urea	604	98	337	55
Muriate of Potash (MOP)	582	95	185	30
Triple Super Phosphate (TSP)	526	86	100	16
Paddy basal fertilizer	28	5	5	1
Ammonium Sulphate	5	1	14	2
Fertilizer mixtures	3	0	17	3
Eppawala Rock Phosphate	2	0	10	2
Micronutrients	2	0	7	1
Yaramila fertilizer complex	2	0	8	1
Liquid Nitrogen	2	0	339	55
Nano Nitrogen	0	0	67	11
Dolamite	0	0	2	0

Source: HARTI survey data, 2022

4.3.2 Quantity of Chemical Fertilizers Used

After the ban, the majority of farmers used lower quantities of Urea, TSP, and MOP fertilizers (Figure 4.6) compared to that of before the ban was imposed, while most of them used less than 25 kg/ac (100kg/ha) . It is important to note that the quantities of fertilizer used varied across the different categories before and after the ban, with some farmers shifting from higher to lower quantities and *vice versa*.



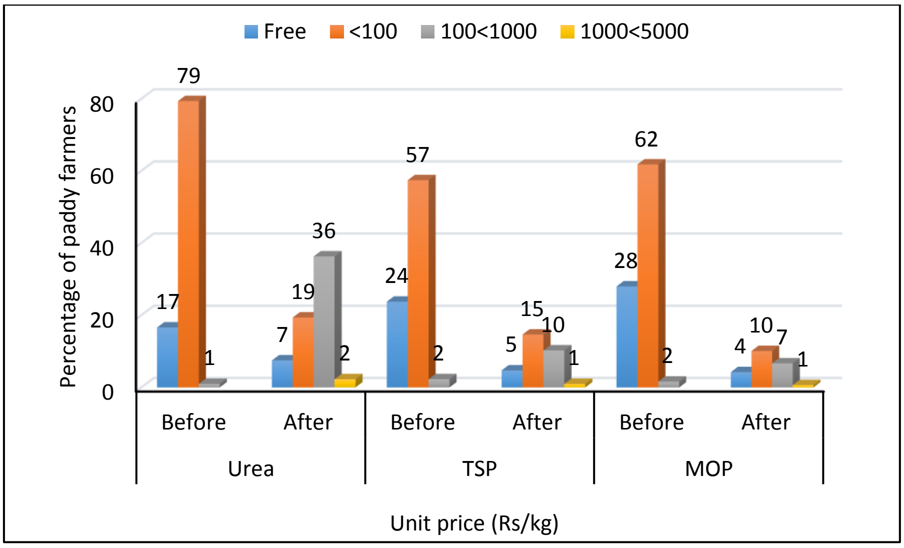
Note: TSP = Triple Super Phosphate, MOP = Muriate of Potash

Source: HARTI survey data, 2022

Figure 4.6: Quantity of Chemical Fertilizers Used Before and After the Policy Change

4.3.3 Price of Chemical Fertilizers Used

Figure 4.7 represents the distribution of farmers based on the unit price of Urea, TSP, and MOP before and after the import ban. Before the ban, a significant portion of farmers received chemical fertilizers for free, which was not the case after the ban. Further, the number of farmers using urea fertilizers in the unit price range Rs.100 to Rs.1000 per kg increased by 35% after the ban. It is important to note that there was a shift in the distribution of farmers based on the unit price of chemical fertilizers, indicating changes in availability, accessibility, and cost implications following the import ban.



Note: TSP = Triple Super Phosphate, MOP = Muriate of Potash

Source: HARTI survey data, 2022

Figure 4.7: Unit Price of Chemical Fertilizers Used Before and After the Policy Change

4.4 Weed Control Before and After the Import Ban

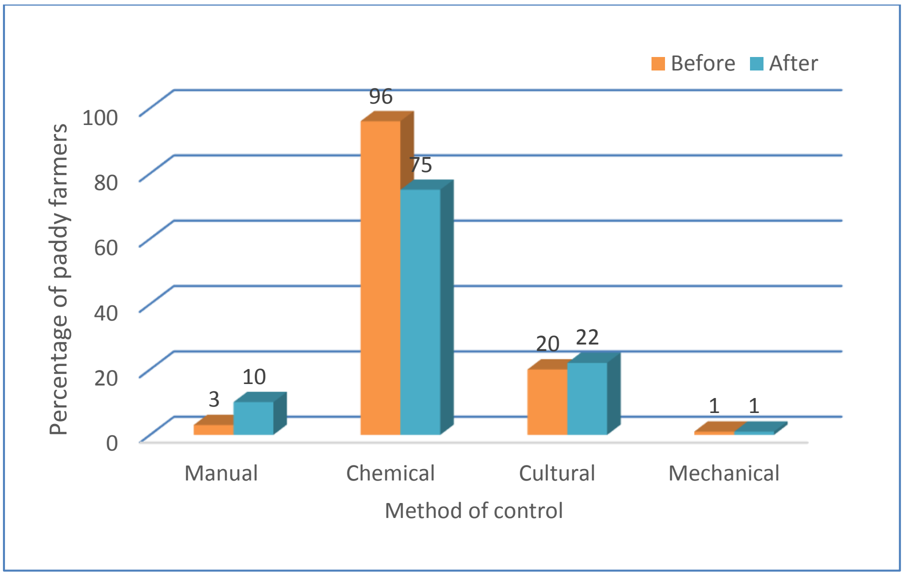
Weed control is an essential step in achieving the desired yield in paddy cultivation. Weeds are plants that compete with crops for nutrients, water, and sunlight, and can significantly reduce crop productivity if left unmanaged. Therefore, effective weed management is crucial for successful paddy cultivation. Agrochemicals, particularly herbicides, play a major role in weed management. Herbicides are chemical substances specifically designed to target and control weeds. They are formulated to selectively kill or inhibit the growth of weeds while minimizing the impact on the cultivated crop. Herbicides can be applied pre-emergence, post-emergence, or both, depending on the weed species, and the growth stage of the crop (pre-plant and post-plant).

The use of herbicides offers several advantages in weed control. They provide an efficient and cost-effective means of suppressing weed growth, allowing the cultivated crop to thrive without competition. Herbicides also offer convenience, as they can be applied in a targeted manner, reducing the need for manual labour-intensive weed removal methods. Further, herbicides can help reduce the overall weed seed bank in the soil, preventing future weed infestations.

However, it is important to note that the use of herbicides should be done judiciously and in accordance with recommended guidelines. Appropriate herbicide selection, dosage, and application timing are critical to ensure effective weed control while minimizing any potential negative impacts on the environment and non-target organisms.

4.4.1 Methods of Weed Control

Figure 4.8 provides a comparison of weed control methods before and after the import ban. Before the import ban, the predominant weed control method was chemical-based, with 96 percentage of farmers utilizing this approach. Manual weeding was also practiced by a smaller number of farmers (3%), while traditional and mechanical methods were used by only one farmer each. Water-based weed control was reported by 19 percentage of farmers.



Note: Cultural weed control - Agricultural techniques employed to promote crop well-being and suppress weed growth, devoid of the use of chemical substances

Source: HARTI survey data, 2022

Figure 4.8: Weed Control Method Adopted Before and After the Policy Change

Following the import ban, there was a noticeable shift in weed control methods. The number of farmers employing manual weeding significantly increased to 10 percent, indicating a greater reliance on labour-intensive weed removal. Chemical-based weed control, while is still prevalent, decreased to 75 percent. Traditional and mechanical methods were used by a limited number of farmers, with a minimum impact to change due to the policy change. Use of stagnant water for weed control remained relatively stable, with 20 percent of farmers using this method before and after the ban.

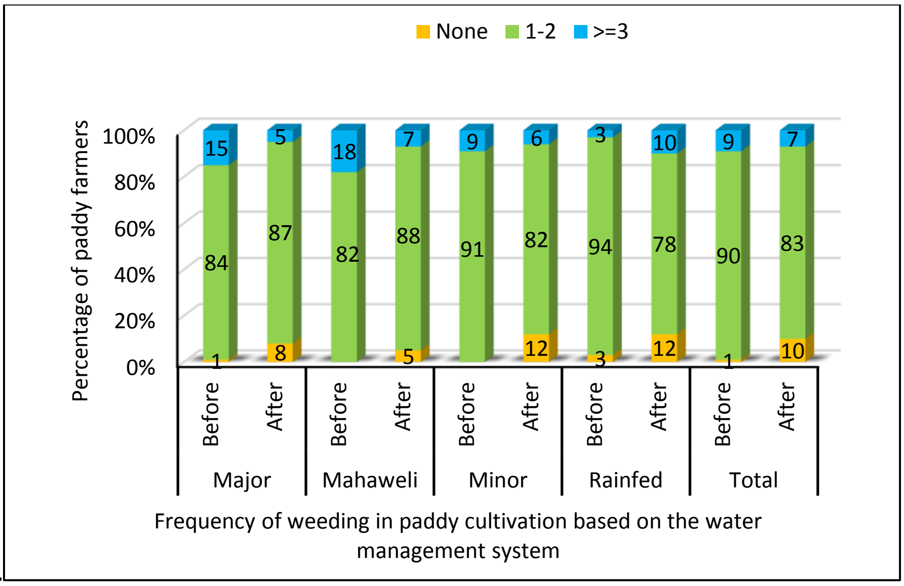
The data suggest that the import ban on agrochemicals prompted a shift in weed control practices. Farmers appeared to rely more on manual weeding, potentially due to the limited availability or increased costs of chemical herbicides. It is worth noting that the use of stagnant water for weed control, which is less dependent on agrochemicals, saw a marginal increase indicating their continued relevance in weed management. The observed changes in weed control methods highlighted the adaptability of farmers in response to policy interventions and their ability to utilize alternate strategies for effective weed management.

4.4.2 Frequency of Weeding

Figure 4.9 depicts the frequency of weeding practices before and after the import ban. The data indicates that, in general, the frequency of weeding remained relatively consistent before and after the imposing the import ban. The majority of farmers reported 1-2 times of weeding, demonstrating a prevailing trend in weed management practices.

Interestingly, there was an increase in the number of farmers (10%) who did not engage any weeding activities. This change can be attributed to the unavailability of herbicides, particularly in the areas with minor irrigation and rainfed conditions. It was evident that farmers in these regions heavily relied on chemical weed control methods prior to the import ban. The scarcity of herbicides subsequently forced these farmers to discontinue weeding in total. Moreover, the data revealed a reduction in the use of multiple weed control methods in paddy cultivation irrespective of the sources of irrigation water, except for the rainfed areas. This decline may be attributed to the limited availability of agrochemicals and the subsequent reliance on alternate weed management techniques.

The findings underscore the significant impact of the import ban on weed control practices, particularly in regions heavily dependent on chemical herbicides. The increased number of farmers abstaining from weeding altogether highlights the challenges faced in finding suitable alternatives and adjusting to new weed management strategies at least in the short run.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 4.9: Frequency of Weeding Before and After the Policy Change

4.4.3 Manual Weeding - Labour Usage

After the ban, Table 4.7 clearly shows a significant increase in the labour dedicated to manual weeding.

Before the import ban, male farmers spent an average of 1.45 labour days per acre on manual weeding, while female farmers spent an average of 2.32 labour days per acre. This suggests that female farmers were slightly more involved in manual weeding per unit of land than their male counterparts.

However, after the import ban, there was a significant change in the labour allocation for manual weeding operations. The average labour usage per acre decreased to 1.03 labour days for male farmers, while it increased to 3.04 labour days for female farmers. These figures clearly demonstrate a notable shift in labour allocation for manual weeding tasks, with a decrease in male labour days per unit area and an increase in female labour days after the ban. The import ban presented challenges for farmers in accessing herbicides, resulting in a surge in demand for manual labour. This situation disproportionately affected farmers with limited financial means, as they struggled to afford the now scarcer and more expensive herbicides. Consequently, many farmers opted for a more cost-effective solution by engaging additional female labour after the import ban, as manual weeding became a more affordable method of weed control. Regarding the daily wage rate for manual weeding, male farmers earned an average of Rs. 1311 per man day, while female farmers earned slightly higher wages at Rs. 1350 per man day before the import ban. However, after the ban, there was a substantial increase in daily wage rates for both male and female farmers. The wage rate for male farmers rose to Rs. 2331 per man day, indicating a significant increase in remuneration. Female farmers also experienced an increase in their daily wage rate, which stood at Rs. 1800 per man day after the import ban.

Table 4.7: Labour Usage and Daily Wage Rate of Manual Weeding Before and After the Policy Change

Labour Usage	*Maha* Season	Male	Female
Average labour usage (Man days/acre)	Before	1.45	2.32
	After	1.03	3.04
Daily wage rate (Rs/man day)	Before	1311	1350
	After	2331	1800

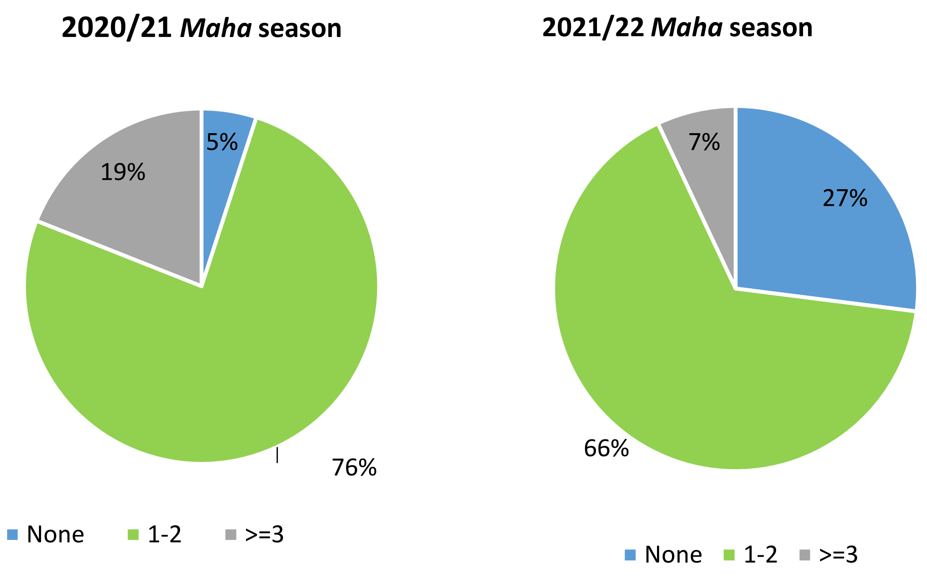
Source: HARTI survey data, 2022

4.5 Pest and Disease Management Using Chemicals Before and After the Import Ban

Pest and disease management is a critical aspect of agricultural production, ensuring the health and productivity of crops. Agrochemicals, such as pesticides and fungicides, have played a significant role in controlling pests and diseases in farming practices. However, the implementation of an import ban on agrochemicals has led to a shift in pest and disease management strategies. This section focuses on the type and number of chemicals used for pest and disease management before and after the import ban in a chosen plot. By examining these changes, with the objective of having insights into the adjustments made by farmers and the potential impact on crop protection in the chosen plot.

4.5.1 Frequency of Pesticide Application

In the 2020/21 *Maha* season, 5% of farmers reported of not using any pesticides, while the majority (76%) applied pesticides 1-2 times while a smaller portion of farmers (19%) reported of applying pesticides three or more times during the season (Figure 4.10). In the 2021/22 *Maha* season, after the import ban, a significant change was observed in the pesticide application frequency by farmers. Those who did not use any pesticides increased to 27%, probably indicating the unavailability of agrochemicals due to the import ban. Furthermore, the percentage of farmers applying pesticides 1-2 times decreased to 66%, suggesting a decrease in pesticide usage overall. Interestingly, a small proportion of farmers (7%) continued to apply pesticides three or more times, despite the ban. It is possible that these farmers found alternative sources for agrochemicals or relied on existing pesticide stocks.



Source: HARTI survey data, 2022

Figure 4.10: Frequency of Pesticide Application Before and After the Policy Change

4.5.2 Frequency of Weedicides Application

In the 2020/21 *Maha* season, before the ban was imposed, the majority of farmers (80%) applied weedicides (herbicides), indicating a high reliance on chemical methods for weed control (Table 4.8). Further, 32% of farmers used insecticides to manage insect pests, while a smaller percentage (4%) utilized fungicides for controlling fungal diseases.

Table 4.8: Types of Pesticide Applied Before and After the Policy Change

Pesticide	2020/21 *Maha* season		2021/22 *Maha* season	
	Count	%	Count	%
Weedicide	493	80	399	65
Insecticide	199	32	147	24
Fungicide	24	4	7	1

Source: HARTI survey data, 2022

Following the import ban, there were notable changes in the types of pesticides applied in the 2021/22 *Maha* season. The number of farmers using weedicides decreased to 65% of the sample, suggesting a reduction in weed control practices by using chemical means. Similarly, the use of insecticides by farmers declined to 24%.,. These findings reflect a decrease in the reliance on chemical pesticides, likely due to the none or limited availability of agrochemicals after the import ban.

4.6 Impact of Import Ban on Yield

4.6.1 Productivity Change

The paddy yield per unit of land is can vary widely depending on factors such as the type of paddy being grown (e.g. variety, age class), agro-ecological conditions, the farming practices used, and the availability of water, fertilizer and other agrochemicals. It can also be affected by the use of modern farming techniques and technologies, such as improved seeds and irrigation systems, which can help increase productivity. This study also examined the influence of fertilizer policy on productivity and two consecutive main seasons (Table 4.9) to understand the difference in yield due to import ban of fertilizer and other agrochemicals.

Table 4.9: Average Yield per Acre Before and After the Import Ban

Water Management System	**Average Yield in kg/acre (kg/ha)**		**Yield Loss (%)**
	2020/21 *Maha* season	**2021/22 *Maha* season**	
Major	1971 (7884)	896 (3584)	54
Mahaweli	2152 (8608)	967 (3868)	54
Minor	1900 (7600)	879 (3516)	53
Rainfed	1562 (6248)	757 (3028)	51
Overall	**1818** (7272)	**847** (3388)	**53**

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Table 4.9 indicates that, overall, the average paddy yield obtained in the surveyed districts was 1,818 kg/acre (7272 kg/ha) in the 2020/21 *Maha* season, but it was declined to 847 kg/acre (3388 kg/ha) in the following 2021/22 *Maha* season.

The comparison based on the source of irrigation water revealed a significant reduction of over 50% in paddy yield following the import ban on fertilizer and other agrochemicals. This reduction exceeded the figures predicted by many experts when the fertilizer ban policy was implemented (Weerahewa et al., 2021).

However, it's important to note that data released by the Department of Census and Statistics showed a notable 36% decrease in paddy yield during the 2021/2022 *Maha* season. This difference in percentage might be attributed to the larger sample size and the inclusion of data from all paddy growing districts. Results of the paired t-test carried out (Table 4.10) revealed that there was a significant reduction in obtained yield after the import ban as opposed to the previous season yield [$t(575) = -44.5351$, $p < 0.001$] with a decrease of 971 kg/acre (3884 kg/ha).

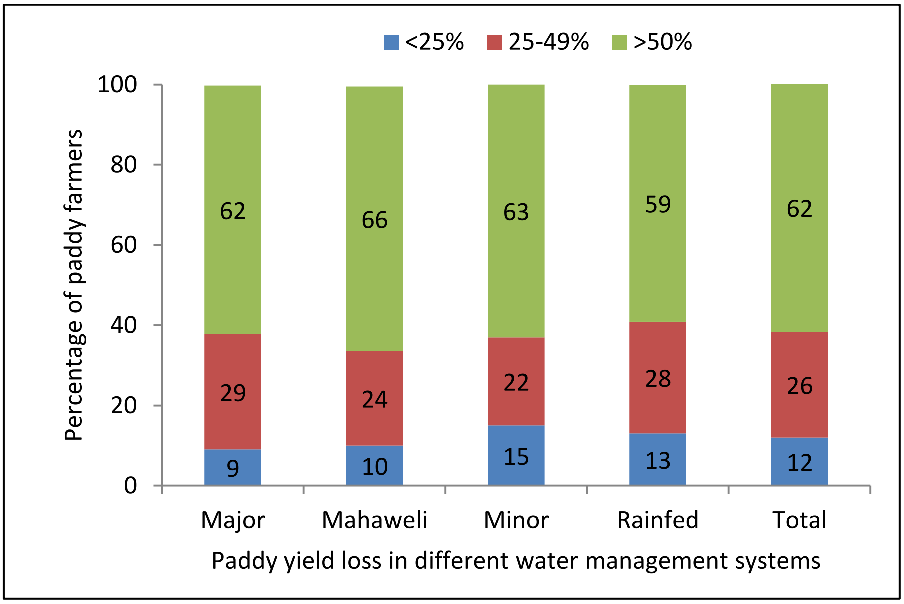
Table 4.10: Results of Paired t-Test of the Average Yield Change by the Source of Irrigation Water Irrigation

Water Management System	t value	degrees of Freedom	Probability (2-tailed)
Major	-25.2285	164	0.0000
Mahaweli	-17.2218	60	0.0000
Minor	-22.3669	133	0.0000
Rainfed	-25.7244	215	0.0000
Overall	-44.5351	575	0.0000

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 4.11 displays the yield loss experienced by farmers in the districts surveyed. The majority (62%) recorded more than a 50% yield loss. The main reason for yield loss was reported by 94% farmers was generally related to the unavailability of chemical fertilizers.



Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 4.11: Yield Loss by the Water Management System

4.6.2 Reasons for Yield Difference

Table 4.11 highlights two primary factors contributing to yield reduction. The most prevalent reason for yield loss, accounting for 54% of farmers, was the unavailability of chemical fertilizers in the required quantities. This indicates that farmers were unable to obtain the necessary amount of chemical fertilizers to meet the nutrient requirements of their crops. This shortage likely impacted the overall achievable yield potential of the crops, as absence of essential nutrients in required quantities can hinder plant growth and development.

The second major factor contributing to yield loss, accounting for 40%, was the failure to apply chemical fertilizer on time. This suggests that farmers faced challenges in adhering to the recommended schedule for fertilizer application for the paddy crop. Delayed or improper application of chemical fertilizers can result in suboptimal nutrient availability during critical growth stages of the paddy plant, leading to reduced yields.

These findings emphasize the significance of timely availability and proper application of chemical fertilizers for maximizing crop productivity. Addressing the issues of fertilizer availability and promoting timely application practices can potentially mitigate the yield losses and improve overall agricultural performance in the chosen plots of paddy.

Table 4.11: Main Reason for Paddy Yield Loss

Main Reason for Yield Loss	Count	%
Not having chemical fertilizers in required quantities	328	54
Failure to apply chemical fertilizer on time	241	40
Adverse climatic conditions	12	2
Pest and disease outbreaks	12	2
Poor quality of the organic fertilizers applied	7	1
The effect of using organic fertilizers only	5	1
Failure to apply organic fertilizer on time	4	1
Poor quality planting materials	1	0

Source: HARTI survey data, 2022

4.7 Crop Sales Before and After the Import Ban

4.7.1 Average Sale

Table 4.12 shows a considerable reduction in the average sale after imposing the ban to import agrochemicals. Specifically, in the 2020/21 *Maha* season, the average paddy sale was 2,783 kg per farmer. However, in the subsequent 2021/22 *Maha* season, it was declined to 926 kg per farmer.

A closer examination of the data revealed that the reduction in paddy sale was predominantly attributed to the source of irrigation water. When comparing the share of sale from total production, more than 10% of the sales were reduced in all except for rainfed areas. In rainfed areas, where paddy cultivation is primarily focused on self-consumption, the paddy sales remained unaffected by the import ban.

Table 4.12: Average Paddy Sales and Share of Sale of Paddy

Water Management System	Average Sales (kg per farmer)			Share of Sale from Total Yield (% per farmer)		
	2020/21 *Maha* season	**2021/22 *Maha* season**	**Sales Drop (%)**	**2020/21 *Maha* season**	**2021/22 *Maha* season**	**Share of Sale Drop**
Major	4,011	1,317	67	66	48	18
Mahaweli	3,537	1,120	68	60	42	18
Minor	2,902	798	73	52	35	17
Rainfed	1,559	652	58	24	24	0
Overall	**2,783**	**926**	**67**	**45**	**35**	**10**

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

The results of the t-test indicated (Table 4.13) a significant mean difference between the average sale before and after the import ban [t(575) = -9.7339, $p < 0.001$]; where the average paddy sale after the ban (926 kg per farmer) was significantly decreased by 1,857 kg compared to the previous season's sale (2,783 kg per farmer).

Table 4.13: Results of Paired t-Test of Average Quantity Sold by the Water Management System

Water Management Systems	**t value**	**Degrees of freedom**	**Probability (2-tailed)**
Major	-4.7874	164	0.0000
Mahaweli	-9.3847	60	0.0000
Minor	-6.8570	133	0.0000
Rainfed	-5.5637	215	0.0000
Overall	-9.7339	575	0.0000

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

4.8 Storage of Paddy Before and After the Import Ban

4.8.1 Quantity Stored for Home Consumption

Table 4.14 presents data on the average consumption of paddy in various irrigation systems during the 2020/21 *Maha* season and the subsequent 2021/22 *Maha* season.

Table 4.14: Average Storage for Consumption by Irrigation System

Water Management System	Storage for Consumption (kg)		Share of total Paddy Yield Stored for Consumption (%)	
	2020/21 *Maha* season	**2021/22 *Maha* season**	**2020/21 *Maha* season**	**2021/22 *Maha* season**
Major	881	841	14	31
Mahaweli	1,128	1,115	19	41
Minor	1,062	854	19	38
Rainfed	976	644	15	23
Overall	**985**	**799**	**16**	**30**

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Based on the data, the average consumption of stored paddy in the major and Mahaweli irrigation systems showed a marginal decrease in the 2021/22 *Maha* season compared to the previous season. However, the reduction was more pronounced in the minor irrigation schemes and rainfed areas. These regions experienced a significant decrease in stored paddy during the subsequent season, as indicated in Table 4.15.

Regardless of the source of irrigation water, there was an overall increase in the share of stored paddy from the total production by an average of 14% across all systems. This suggests that despite varying changes in stored paddy across different systems, the overall proportion of paddy stored in relation to the total production has uniformly increased.

Table 4.15: Results of the Paired t-Test of Average Quantity Consumed

Water Management System	t value	Degrees of Freedom	Probability (2-tailed)
Major	-0.9267	162	0.3554
Mahaweli	-0.0674	60	0.9465
Minor	-2.9931	129	0.0033
Rainfed	-4.6523	212	0.0000
Overall	-4.7219	566	0.0000

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

4.8.2 Quantity Stored for Seed Paddy

Table 4.16 clearly indicates that the average storage of the paddy harvest by farmers in the surveyed districts, to be used as seed paddy for the next season was reduced following the import ban. The decrease in seed paddy storage was particularly noticeable in the major irrigation's schemes and rainfed areas (Table 4.18). These regions faced a more significant decline of paddy yields compared to other areas.

Table 4.16: Results of Paired t-Test of Average Quantity Stored for Seed Paddy

Water Management Systems	Average Seed Storage (kg)		Share of Seed Storage (%)	
	2020/21 *Maha* season	2021/22 *Maha* season	2020/21 *Maha* season	2021/22 *Maha* season
Major	126	79	2	3
Mahaweli	85	79	1	3
Minor	130	104	2	5
Rainfed	223	138	3	5
Overall	**158**	**107**	3	4

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Furthermore, the share of seed paddy storage in relation to the total production has increased marginally across all regions after the import ban, despite the decrease in the overall quantity of seed paddy stored (Table 4.17).

Table 4.17: Results of Paired t-Test of the Average Quantity of Paddy Stored for Seed Paddy

Water Management System	t value	Degrees of Freedom	Probability (2-tailed)
Major	-3.2624	155	0.0014
Mahaweli	-0.9303	60	0.3560
Minor	-2.3447	126	0.0206
Rainfed	-3.6063	200	0.0004
Overall	-5.1338	544	0.0000

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

4.8.3 Quantity Stored for Future Sales

Table 4.18 presents data on the quantity of paddy stored by the farmers in the surveyed districts for future sales based on source of irrigation water in the 2020/21 *Maha* season and the subsequent 2021/22 *Maha* season. Interestingly the areas with major irrigation experienced a substantial reduction of 42% in the average quantity of paddy stored for future sales. Further, the rainfed areas saw a significant increase of 80% in the average quantity of paddy stored for future sales. In comparison, the paddy farmers in the Mahaweli irrigation scheme and minor irrigation systems showed marginal differences in the quantity stored for future sales between the two seasons.

Table 4.18: Results of Paired t-Test of Average Quantity Stored for Future Sales

Water Management System	Average Paddy Stored for Future Sales (kg)		Share of Future Sale (%) of Total Paddy Yield	
	2020/21 *Maha* season	2021/22 *Maha* season	2020/21 *Maha* season	2021/22 *Maha* season
Major	401	232	7	8
Mahaweli	318	321	5	12
Minor	389	389	7	17
Rainfed	259	466	4	17
Overall	**341**	**363**	6	14

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

It was evident that the share of paddy stored for future sales had an overall increase in all regions studied, particularly in the minor irrigation schemes and rainfed areas, where the increase exceeded 10%. Further, Table 4.19 shows that, apart from major irrigation areas, there was no strong evidence to suggest significant variations in the average quantity of paddy stored for future consumption between the two seasons. The data indicates that the differences observed in these systems could be due to random fluctuations rather than meaningful changes.

Table 4.19: Results of Paired t-Test of Average Quantity Stored for Future Sales

Water Management System	t value	Degrees of Freedom	Probability (2-tailed)
Major	-2.3384	153	0.0207
Mahaweli	0.0191	59	0.9849
Minor	0.0013	115	0.9990
Rainfed	0.7176	187	0.4739
Overall	0.2004	517	0.8413

Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

CHAPTER FIVE

Household Food Security and Wellbeing of Paddy Farming Community

Agriculture and food security are inextricably linked. Hence, agricultural policy changes may provide diverse impacts on national and household food security. Given this, the chapter delves into the impact of Sri Lanka's import ban on chemical fertilizers on paddy production for HH food security and the well-being of the paddy farming community. It also examines food and livelihood-based coping strategies adopted by them to overcome food security-related challenges.

5.1 Food Consumption

Food security is a vital component of human well-being. *"Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food, that meets their dietary needs and food preferences for an active and healthy life*" (Shaw, D.J., 2007, P 348).

Over half of the world's population relies mostly on rice as the staple food, and Sri Lanka is not an exception. Asia is where most of the world's rice is grown and consumed (Bandumula, 2018; Firdaus et al., 2020; Schneider and Asch, 2020). Rice is a major staple crop in Sri Lanka; hence the cultivation of paddy plays a crucial role in determining the country's food security. Although paddy farmers contribute significantly to the national food security, changes in fertilizer policy could potentially affect their household (HH) food security. Particularly, smallholder farming operations determine farmers HH food self-sufficiency (Kodamaya, 2011). In view of this, the following section explains the situation of food consumption among the paddy farming community in Sri Lanka in the 11 districts surveyed, taking into account the effects of the recent changes in fertilizer policy.

5.1.1 Categories of Food Consumption Score

The food security status of the paddy farmers is assessed using the food consumption score (FCS) which is the index of diversity and balanced food consumption (Isaura et al., 2018). The HHs were asked about dietary diversity and frequency of consumption over the past seven days[11] of the survey. According to FCS, the threshold levels of food security of the paddy farming community were identified (Table 5.1). Even though paddy farming HHs have undergone different shocks during the reference period, the majority of them (82%) have an acceptable food security level. Only a few households (5%) had a poor level of food consumption.

[11] Details on calculating FCS is described in the methodology section

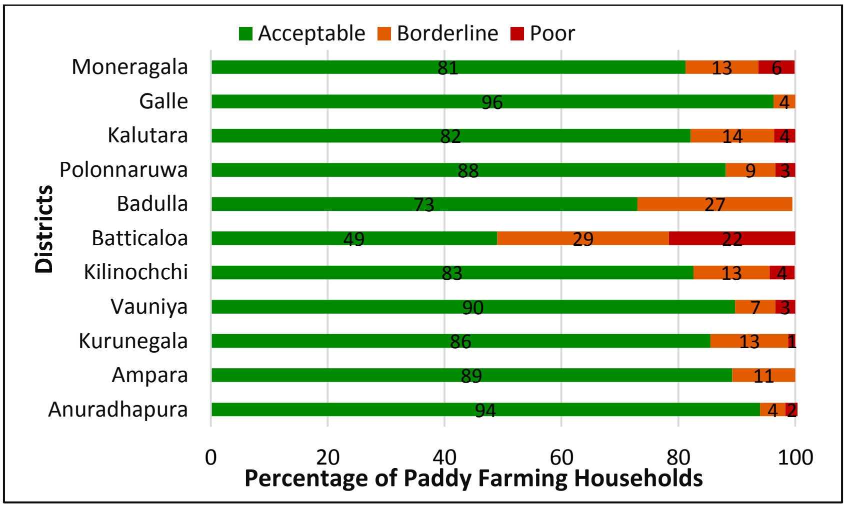
Table 5.1: Threshold Levels of Food Security of Paddy Farming Community

Food Security Threshold[12]	Profiles	Percentage
0-28	**Poor** food consumption	5
28.5-42	**Borderline** food consumption	13
Above 42	**Acceptable** food consumption	82

Source: HARTI survey data, 2022

During the phase of the import ban on chemical fertilizers, the paddy farming community appeared to be less vulnerable to a food crisis. Although some paddy farming HHs experienced food shortages during the reference period, many were able to fulfill their daily food needs to a certain extent. According to the paddy farmers in the study areas, they have adopted various strategies to secure their food needs, such as reserving a portion of the harvest for HH consumption and relying on food from home gardens and other diversified farming activities.

The fact that most paddy farming households rely mainly on their own food production for household consumption is a key reason for enabling them to recover their food consumption levels during the reference period. Moreover, since many of these households are not entirely reliant on farming operations, they are less likely to face extreme food shortages. As a result, they are able to strike a reasonable balance between their own food production and alternative food sources, maintaining somewhat sufficient dietary patterns over the reference period. Figure 5.1 depicts the food security threshold levels for paddy farmers across districts.



Source: HARTI survey data, 2022

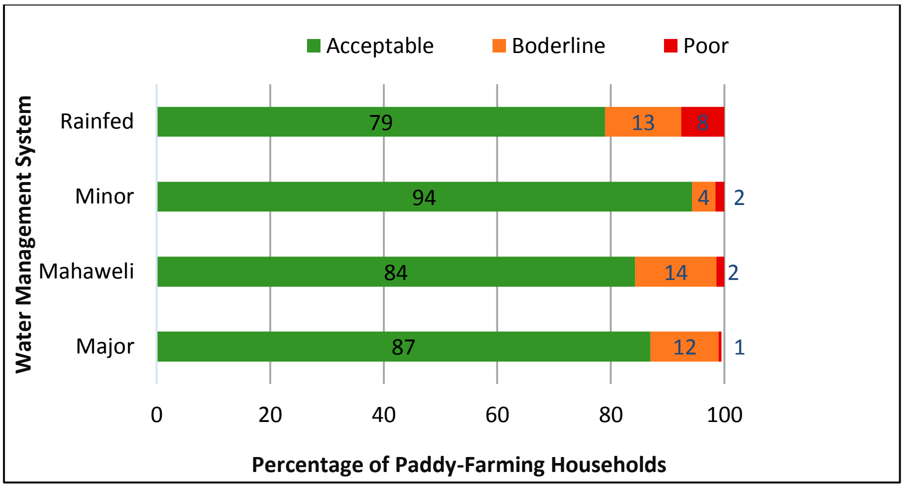
Figure 5.1: Food Consumption Levels across 11 Districts Surveyed

[12] A score of 0-28 indicates poor food security, a core of 28.5-42 indicates borderline food security, and a score greater than 42 is considered an acceptable food security level (WFP, 2015)

The study found that major paddy cultivation areas such as Anuradhapura, Vavuniya, Ampara, Polonnaruwa, and Galle districts, among the 11 districts surveyed, had notably higher levels of food security than the other districts included in the study. If this is the case, these districts may have a higher likelihood of having greater dietary diversity and nutrient adequacy. Particularly in Anuradhapura and Galle districts, more than 90% of HH recorded an acceptable level of food consumption. However, paddy farmers in the Galle district showed a main concern with respect to the HH food security. Besides, a considerable number of farmers have other income-generating activities to satisfy their HH needs and thus, had a greater ability to maintain HH food security. Support from family members is also regarded as a crucial factor for maintaining sound food security levels during the crisis period. Particularly, as observed, the role of home gardens in supplying HH dietary needs is remarkable for all well-off districts. Crop diversification and income diversification were also found to be beneficial in achieving high levels of food security in these districts.

However, compared to other districts, paddy farming HHs in the districts of Batticaloa, Kalutara, and Monaragala indicated lower levels of food security. Around half of the HHs in the Batticaloa district could not reach a satisfactory level of food security, and recorded a higher percentage of households with poor food security levels (22%). Batticaloa is one of the districts with high poverty incidences in the Eastern Province. Further, the poverty level is diverse across varied Divisional Secretariats in Batticaloa district and poverty rates varied widely from 5.3% to 45.1%. Moreover, some of the poorest Division Secretariats in Sri Lanka belonged to the Batticaloa district (DCS and World Bank, 2015). Therefore, policy changes referred to in this study may have triggered poverty conditions among the poorest sectors of paddy farmers by curtailing their livelihood activities. Further, the study revealed a significant contrast in food security levels between households in the Badulla district, suggesting that there may not be enough food available in the district to provide a diverse range of food options for certain segments of the community. Approximately one-fourth of HHs (25%) were classified as food insecure in the Badulla district, while 73% of HHs had an acceptable level of food security. Yet, the reasons for lower levels of food security conditions seem to be quite complex and obscure in certain districts necessitating a more comprehensive study to make rational level interventions.

Taking into account the sources of irrigation water used by the paddy farming HHs (as illustrated in Figure 5.2), rainfed farmers were marginally less food secure compared to other groups, while farming HHs in minor irrigation systems demonstrated a higher level of food security.



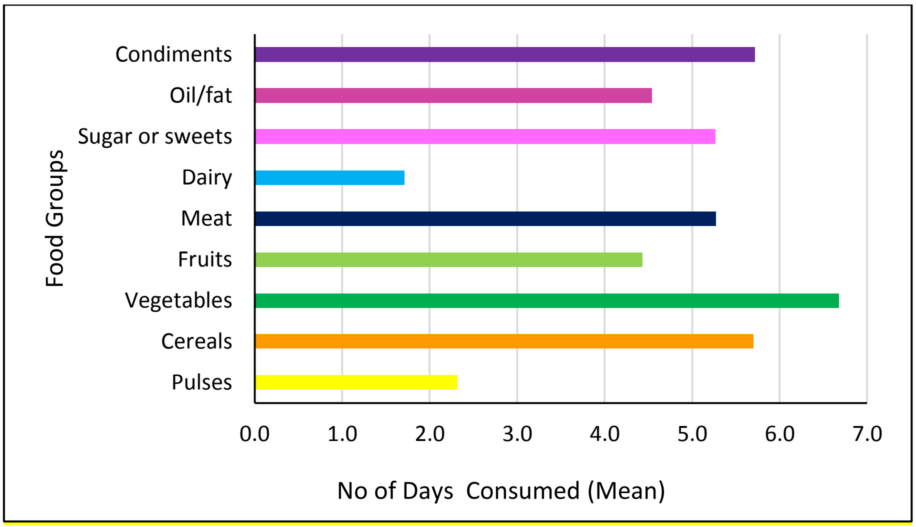
Note: Major = Major irrigation systems excluding Mahaweli scheme, Mahaweli = Mahaweli Irrigation Scheme; Minor = Minor irrigation systems

Source: HARTI survey data, 2022

Figure 5.2: Food Consumption of Paddy Farming HHs Across the Difference Water Management Systems

5.1.2 Consumption of Different Food Groups

Figure 5.3 depicts the consumption of different food groups among paddy farmers in Sri Lanka. Vegetables, cereals, and condiments were consumed for more than five days by the paddy farming HHs in the surveyed areas, during the recall period. Cereal consumption was considerably higher among the many of the HHs in mainstream paddy-growing areas. All of the HHs surveyed, particularly in the Polonnaruwa and Galle districts, consumed cereal for all seven days of the recall period. This indicates the higher dietary diversity and food availability in well-off districts in paddy farming.



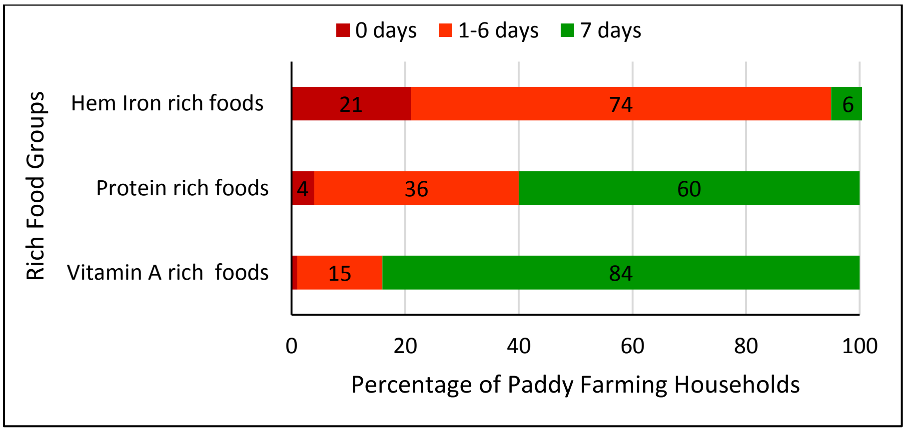
Source: HARTI survey data, 2022

Figure 5.3: Consumption of Different Food Groups

Yet, the same scenario cannot be found in every paddy farming district and HH when considering dietary diversity. As such, consumption of major staples was found to be low in the districts of Batticaloa and Kalutara. Less accessibility to foods due to widespread poverty conditions, lower levels of self-sufficiency, less sustainable farming operations, and monotonous dietary patterns are among the determinants for the consumption of different food groups. Among some ethnic groups, the dietary patterns did not merely rely on major staple (rice) as their food preference was different. For example, pulses such as Balckgram plays a vital role in food consumption in some districts, particularly in Northern and Eastern parts, of Sri Lanka. Further, dairy and pulses consumption was significantly lower among paddy-farming HHs, in general. The consumption of different food groups in the recall period might not be the pattern of food consumption on a typical week. As observed, many farming HHs have shifted their dietary patterns to cope with day-to-day consequences brought by the fertilizer policy changes at the time of the survey.

5.2 FCS – Nutrition

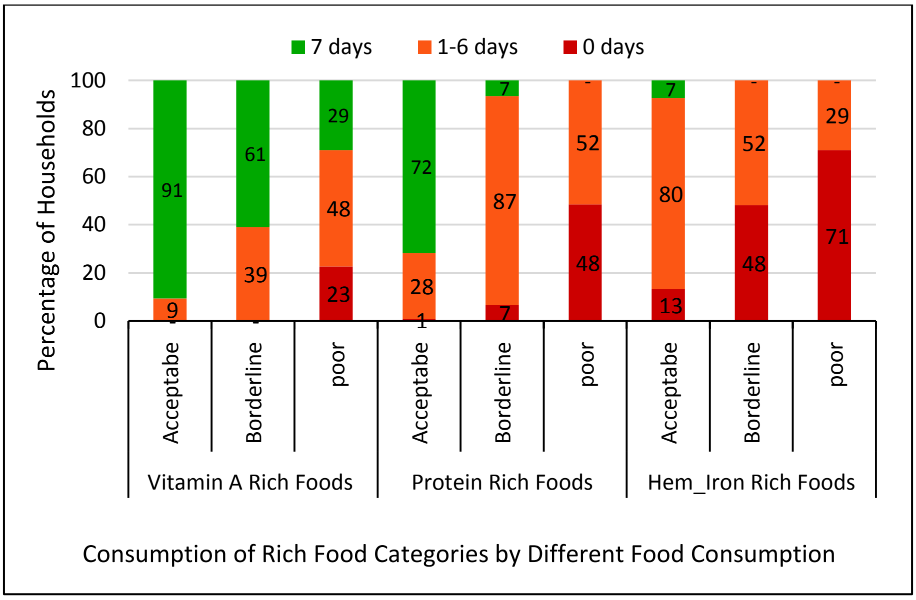
Food Consumption Score - Nutritional Quality Analysis (FCS-N) is a measure of the HHs adequacy of key macro and micronutrient-rich food groups. In this analysis, the consumption of Vitamin A, Protein and Hem-iron food are considered. Vitamin A and iron are being investigated due to widespread deficiencies in these which lead to chronic undernutrition. Protein has been considered since it is essential for growth, mainly in preventing wasting and stunting (WFP, 2015). According to the findings, HH consumption of vitamin A-rich foods was somewhat at adequate level, and consumption of protein-rich foods was also at a satisfactory level (Figure 5.4). The frequency of consuming hem-iron-rich food was, however, noticeably lacking.



Source: HARTI survey data, 2022

Figure 5.4: Frequency of Rich Food Groups' Consumption Among Paddy Farmers

Owing to economic difficulties resulting in from the fertilizer-policy changes, many HHs have chosen to consume their own-produced food as much as possible. Animal-derived foods high in protein and hem-iron are less likely to be consumed in such circumstances. The HHs with an acceptable level of food consumption had a greater ability to fulfill nutritional needs when compared to borderline and poor food consumption groups (Figure 5.5).

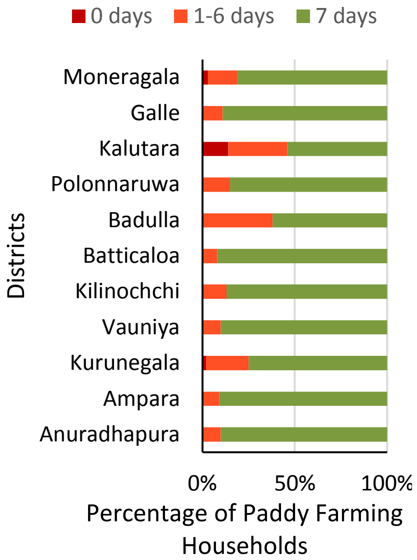


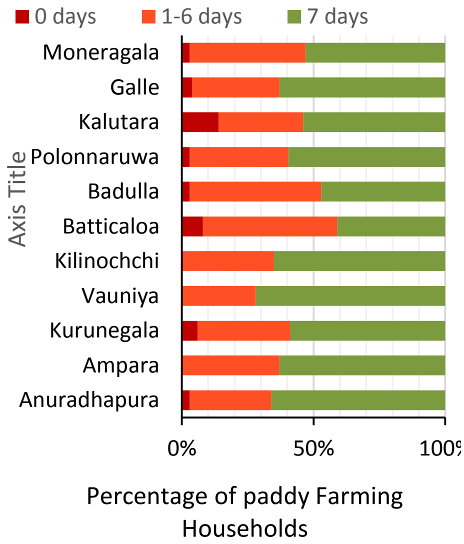
Source: HARTI survey data, 2022

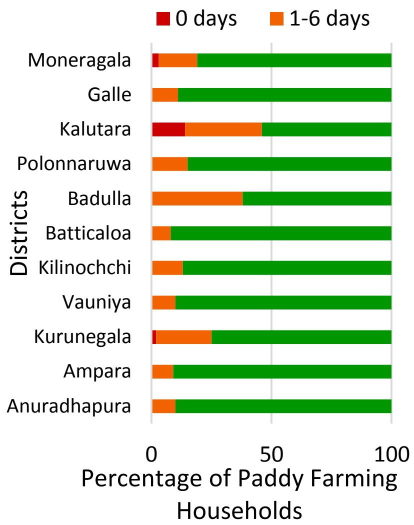
Figure 5.5: Frequency Consumption of Vitamin A, Protein, and Hem-Iron-Rich Food Groups Across Different Food Consumption Groups

In contrast, the nutrient-dense food intake of poor food consumption segments is inadequate. Even though the consumption level of vitamin A-rich food was somewhat satisfactory, their protein and hem-iron-rich food intake was found to be lower. As depicted in Figure 5.5, nearly half of the HHs with poor food consumption never consumed protein-rich foods, whereas 71% of them never consumed hem-iron-rich foods during the recall period. In addition, households with borderline food consumption showed a significant deficiency in the consumption of hem-iron-rich foods, which may lead to adverse effects on their nutrient intake and increase the likelihood of nutrient deficiencies.

As illustrated in Figure 5.6, with the exception of a few districts, vitamin-A-rich food consumption was at an adequate level, as evident in the major paddy-growing areas like Anuradhapura, Polonnaruwa, and Ampara. Yet, in Kalutara, Badulla, and Kurunegala districts, consumption of vitamin-A-rich foods among certain HHs was limited.

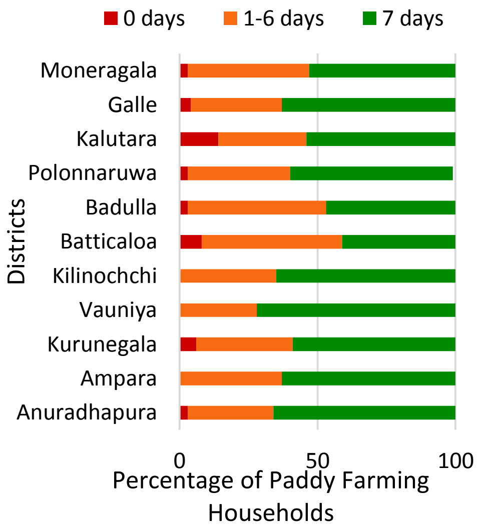






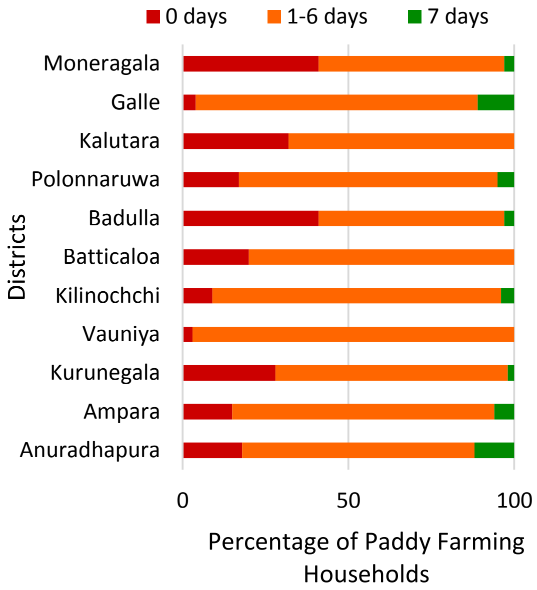
Source: HARTI survey data, 2022

Figure 5.6: Consumption of Vitamin A Rich Food among Paddy Farmers across



Source: HARTI survey data, 2022

Figure 5.7: Consumption of Protein Rich Food among Paddy Farmers across



Source: HARTI survey data, 2022

Figure 5.8: Consumption of Hem-Iron Rich Food among Paddy

Protein-rich food consumption is also at a fairly satisfactory level in study areas (Figure 5.7). However, in Batticaloa and Badulla districts' protein-rich food consumption was relatively lower in the recall period. Consumption of hem-iron-rich food was significantly minimal in all districts (Figure 5.8). Hem-iron, food only contains animal flesh, such as meat, poultry, and shellfish (Harvard School of Public Health, 2023) One of the causes of low intake was found to be the unaffordability due to economic hardships. This was well evident during the period of field data collection.

5.3 Coping Strategies Adopted due to Food Shortage

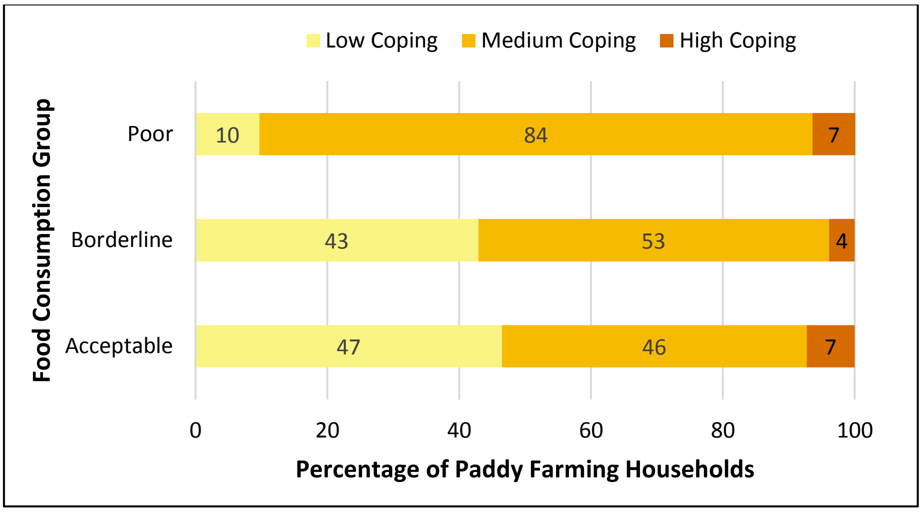
Farming HHs may adopt different approaches to cope with the situation. The basic types of coping strategies are two-fold. Short and intermediate short-term changes in the dietary pattern are one type of strategy. These kinds of measures are connected with food-based coping strategies. The second type is associated with long-term strategies related to income accumulation, food production patterns, and adapting reversible coping measures like asset sales (Maxwell et al., 2003).

Food-based strategies could be focused on obtaining more food or improving access to it, such as relying on food aid or using their own produced food, based on rationality. Otherwise, when there are insufficient food supplies, people often turn to coping mechanisms that limit both food quality and quantity (Asesefa et al., 2018). In essence, the coping mechanisms can take various forms depending on the nature of the challenge and the resources available to the individual or community.

To evaluate food-based coping strategies, four fundamental categories were examined: i.e. encompassing dietary adjustments, short-term measures to augment household food supplies, short-term measures to reduce the number of individuals to feed, and rationing or managing the shortfall. As widely recognized, food insecure households often use one of these four various forms of consumption coping mechanisms (Maxwell et al., 2003). Dietary changes can be the better solution to deal with a food insecurity situation rather than enabling them to acquire more and more food in such a situation. This is mostly due to the requirement to meet nutritional needs through food consumption (Pinstrup-Andersen, 2009).

5.3.1 Categories of rCSI (reduced Coping Strategies Index)

Coping Strategies Index (CSI) is an indicator of household food security that correlates well with more intricate measures of food security. This method can be used to determine if household food security is improving or declining (Maxwell et al., 2003). As revealed, the majority of paddy farming HHs in each food consumption group had low or medium coping abilities (Figure 5.9). Eighty-four of the HHs in the poor food consumption group belonged to medium coping categories while only 10% were in low coping categories. However, there was no noticeable difference in coping categories between HHs belonging to the acceptable and borderline food consumption groups.



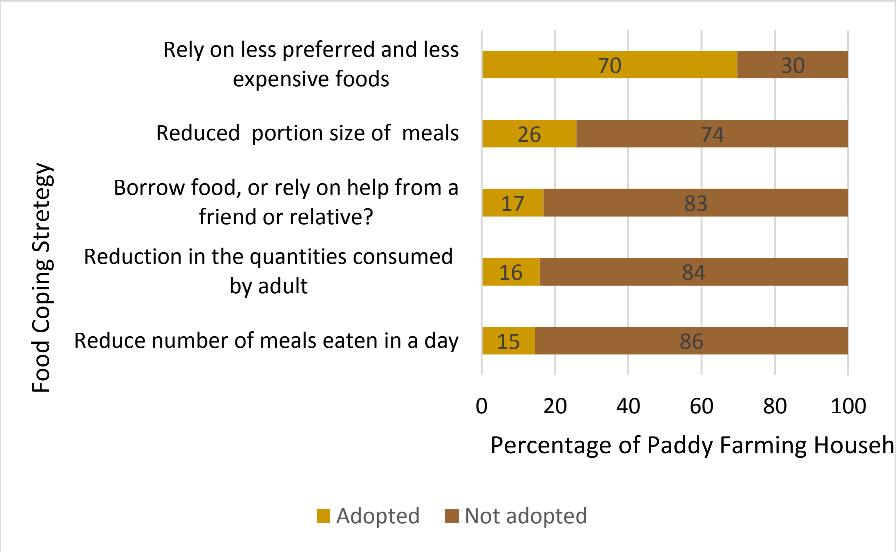
Source: HARTI survey data, 2022

Figure 5.9 Food-based Coping Strategies by Food Consumption Group[13]

[13]The level of coping is classified into three categories using the total rCSI score. No or low coping (rCSI<Less than 3), medium coping (rCSI = 3-18, high coping (rCSI >18).

5.3.2. Frequency of Coping Strategies Adopted

The present study investigates how paddy farmers have implemented food-based coping mechanisms to endure the challenges posed by recent fertilizer policy changes on their food intake (as depicted in Figure 5.10). In this regard, the research identified five distinct food-based coping strategies.

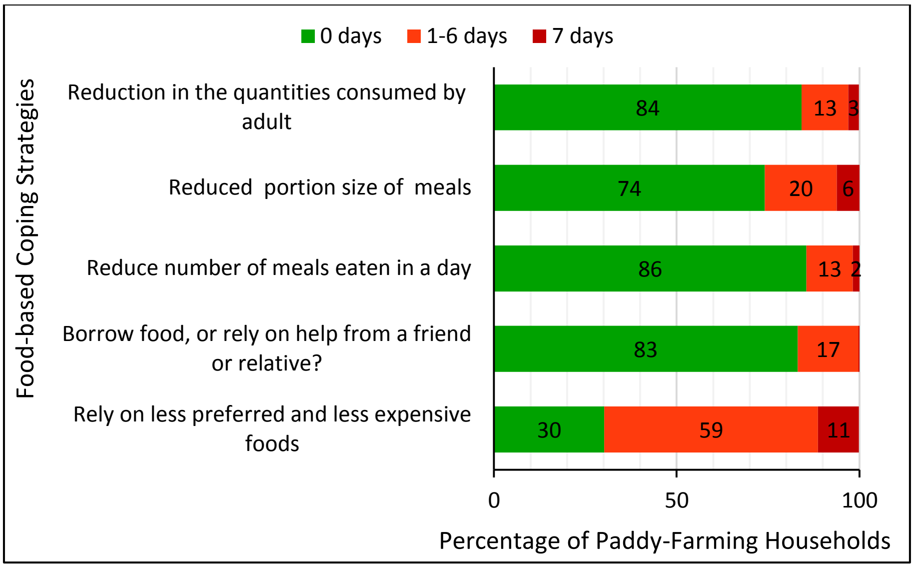


Source: HARTI survey data, 2022

Figure 5.10: Food-Based Coping Strategies among Paddy-Farming Households

The most common response to face the deteriorating HH food security among paddy farmers was to consume less preferred and less expensive foods (70%). As observed, the most promising option for them was to reduce food expenses, regardless of their food preference. Adopting this strategy allows them to consume sufficient quantities and avoid skipping meals, which is rational. Further, a considerable number of HHs (26%) had reduced their portion size as a coping strategy. The other three coping strategies were the least commonly employed by the paddy farming HHs.

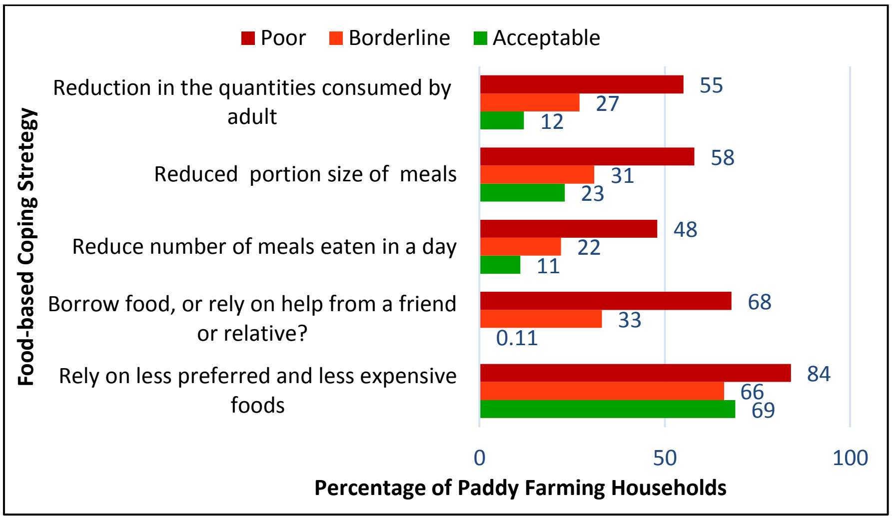
Figure 5.11 depicts the number of days that HHs adopted food-based coping strategies. The majority of farmers relied on less preferred and less expensive food for at least one day in the recall period. As it was evident, many of the strategies were not adapted on a regular basis, showing the least adaptation of food-based coping strategies.



Source: HARTI survey data, 2022

Figure 5.11: Frequency of Adaptation of Food-Based Coping Strategies among Paddy-Farming Households

Notably, there are substantial differences between food consumption categories in adopting food-based coping strategies (Figure 5.12). However, to a large extent, all food consumption groups relied on less-preferred and less-expensive food during the recall period.



Note: Percentages are not equal to 100% since multiple responses were allowed

Source: HARTI survey data, 2022

Figure 5.12: Adopting Food-based Coping Strategies across Food Consumption Groups

Paddy-farming HHs in the poor food consumption category are more likely to shift their dietary patterns and means of acquiring food when confronted with economic shocks that limit or change access to food. The borderline food consumption group also suffers from food shortages. Hence, they have attempted to adopt all food-based coping strategies in the recall period to considerable levels. As observed, many HHs were dissatisfied with the way they had to fulfill their dietary needs. Yet, to balance their HH expenses more rationally amid economic hardships geared by fertilizer policy changes, they had to adopt particular food coping mechanisms over the period.

As recognized elsewhere, sudden and unexpected changes in economic conditions can have significant impacts on a household's income and well-being (Ellis, 1998; Kochar, 1995). Farm families often rely on their agricultural production as their most trustworthy source of income accumulation. Therefore, any negative changes in the agricultural sector or broader economy can have a direct impact on their livelihoods. Similarly, an increase in input costs, such as fuel or fertilizer, leads to a decrease in profit margins. This is well evident in the field situation which in turn has affected HH food security, which determines the well-being of farm families to a great extent.

In addition to the direct impacts of economic shocks on farm families, there may also be indirect impacts. For example, if there is a decline in economic activity in a country due to economic shocks, this could result in reduced demand for goods and services. These scenarios affect farm families, particularly those fairly relied on off-farm income. It highlights the need for more intense-coping strategies owing to the fact that the economic shocks may create a profound and far-reaching impact on HH food security in the long run.

5.4 Food Security Status

The adequacy of HHs' food consumption at the time of the survey was measured. For this, food consumption was measured by using the indicators, i.e. Food Consumption Score (FCS) the reduced used Coping Strategies Index (rCSI**).**

Accordingly, 46% of the paddy farmers in the districts surveyed were found to be food secure, and a sizable proportion (36%) were marginally food secure, indicating a lesser vulnerability in crisis situations and adapting rational coping mechanisms (Figure 5.13). Notably, severe food insecurity was recorded at a low level among the surveyed paddy farming HHs.

Food Secure	Marginally Food Secure	Moderately Food Insecure	Severely Food Insecure
46	36	13	5

Source: HARTI survey data, 2022

Figure 5.13: Prevalence of Food Security among the Paddy Farming Community in Sri Lanka - According to the Current Status Domain[14]

5.5 Livelihood-based Coping Strategies (LCS)

"The Livelihood Coping Strategies – Food Security (LCS-FS) is an indicator used to understand medium and longer-term coping capacity of HHs in response to lack of food or lack of money to buy food and their ability to overcome challenges in the future" (WFP, 2021b). For calculation purposes four stress strategies, three crisis strategies, and three emergency strategies had to be selected at minimum, which are appropriate to the context. The following livelihood-based Coping Strategies were used for this study.

Stress Strategies

Spent savings due to lack of food.
Sent household members to eat elsewhere due to lack of food.
Purchased food/non-food on credit.
Sold household assets/goods.

Crisis Strategies

Withdrew children from school due to lack of food.
Reduced expenses on health or education due to lack of food
Sold productive assets.

Emergency Strategies

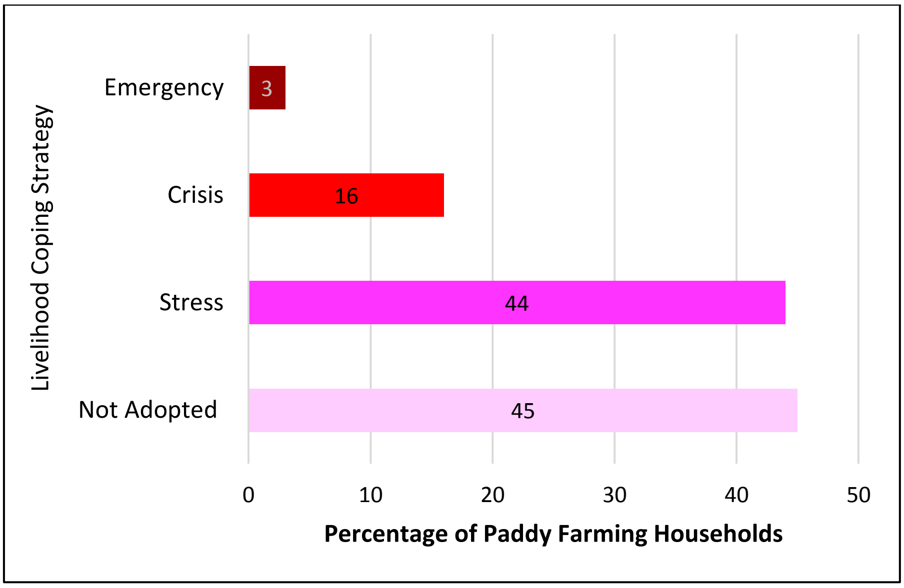
Engaged in illegal income activities due to lack of food
Mortgaged/Sold house or land due to lack of food
Begged and/or scavenged

5.5.1 Categories of LCS

In this study, to assess livelihood-based coping strategies, 10 strategies as identified by WFP (2021b) were considered. However, 45% of paddy farming HHs from the total

[14] The current state domain of CARI console measures food consumption using two indicators: Food Consumption Score (FCS) and reduced Coping Strategies Index (rCSI). CARI Stands for Consolidated Approach for Reporting Indicators of Food Security (CARI)

have not used any of the coping strategies while others have used at least one coping strategy during the reference period (Figure 5.14)



Source: HARTI survey data, 2022

Figure 5.14: Adoption of Livelihood-based Coping Strategies by the HHs (Percentage from the Total HHs)

Stress strategies were the most commonly used LCSs by the HHs to endure food insecurity conditions during the reference period. Although certain HHs employed crisis management strategies, the adaptation of emergency strategies was minimal. It is evident that the food insecurity condition among the paddy farming community was in the stress phase. The majority of the paddy-farming HHs had not reached the crisis or emergency phases during the reference period. Even though farmers encountered many obstacles due to fertilizer policy change, food availability from previous harvests, availability of basic agricultural inputs (even to a certain extent), family savings, and other income sources, and notably Household food production, have contributed to relax food security conditions and enhance resilience.

5.5.2 Frequency of Adoption of Livelihood-based Coping Strategies by Severity

Table 5.2 shows the frequency at which people had to use livelihood-based coping strategies during the recall period. Savings was the major endowments that the paddy-farming HHs had to minimize the worsening of food insecurity. Accordingly, 37% of HHs used their savings to ensure sufficient food for their HHs. Purchased food/non-food items on credit (17%) and selling HH assets/goods (13%) were other coping strategies adopted by paddy-farming HHs. The least common stress strategy employed by the HHs was the sending HH members to eat elsewhere due to lack of food.

Table 5.2: Livelihood-based Coping Strategies Used by HHs and Severity

Severity	Coping Strategy	(%)*
Stress	Spent savings due to lack of food	37
	Sent household members to eat elsewhere due to lack of food	1
	Purchased food/non-food on credit	17
	Sold household assets/goods	13
Crisis	Withdrew children from school due to lack of food	1
	Reduced expenses on health or education due to lack of food	14
	Sold productive assets	3
Emergency	Engaged in illegal income activities due to lack of food	0
	Mortgaged/Sold house or land due to lack of food	3
	Begged and/or scavenged	0

*Percentage indicates the HHs adapted the LCSs from total HHs in the sample.

Source: HARTI survey data, 2022

Health and education are among the key indispensable expenses that typical farming HHs must endure. Yet, certain paddy-farming HHs (14%) had to cut down on health and education expenses in order to meet the costs of their food needs. A few HHs have sold their productive assets to cope with the food shortage. The only emergency strategy used by paddy-farming HHs due to lack of food was to mortgage or sell their house or land.

As food insecurity deepens, families have a greater tendency to utilize less reversible coping mechanisms, resulting in a more severe type of coping and increased food insecurity (Maxwell and Caldwell, 2019). The scenario may be relevant to the paddy-farming HHs' food security situation. Many paddy-farming HHs in this study had rationally adopted to the situation because they had a certain level of resource endowment to accomplish this, such as using their own food production for consumption, and diversified farming activities. Yet, if the available resources are depleted eventually, there could be a tendency to adopt less reversible coping mechanisms, such as selling-off their assets. Hence, attention should be paid to minimize food insecurity before it deteriorates further and severely affects their livelihoods irreversibly.

CHAPTER SIX

Conclusion and Policy Implications

6.1 Conclusion

- Firstly, it highlights the lack of representation from women and young farmers in this sector, with the majority of principal farmers being male and above 50 years. Additionally, a significant proportion of principal farmers have attended school below Grade 11, which could limit their access to information, comprehension, and opting for modern farming practices.
- The study also reveals a growing trend towards smaller family units within the paddy-farming community, which has implications on labour availability, farm management practices, and resource allocation. While crop farming serves as the primary employment for most principal farmers, there is a need for diversification of income sources to mitigate risks and explore other opportunities for sustaining livelihood. This is because smaller family units are more vulnerable to economic shocks, such as crop failures or price fluctuations. By diversifying their income sources, farmers can reduce their dependence on crop farming and improve their overall financial security.
- Sole ownership was the most common among paddy farmers. The study also found that different types of land plots are used for paddy cultivation, with lowlands being preferred due to their water retention ability.
- Despite the ban on chemical fertilizers, a certain percentage of farmers still applied some form of chemical fertilizers. This suggests challenges in obtaining sufficient quantities or acquiring fertilizers at the right time at affordable prices. Farmers generally favoured a hybrid approach involving both organic and chemical methods for supplying plant nutrients, indicating a preference for a combination of approaches rather than a complete transition to organic farming. This highlights the complexity of transitioning to more sustainable agricultural practices.
- Pesticide usage in paddy cultivation remained prevalent even after the ban on imports, indicating considerable availability of pesticides in the market. Farmers faced challenges in controlling weeds and managing pests (weeds and insect pests) and diseases after the import ban, leading to the adoption of various strategies to overcome these issues.
- Interestingly, a significant portion of farmers were already using organic fertilizers before the implementation of the import ban on chemical fertilizers, indicating awareness and utilization of organic fertilizers as an alternative. Farmers used a variety of organic fertilizers to improve soil health and increase crop yield, with reliance on government-provided organic fertilizers being

common, except in the areas under the Mahaweli Irrigation scheme where farmers produced their own organic fertilizers.

- The import ban on agrochemicals resulted changes in paddy farming practices and land utilization among farmers. There was a decrease of 5% in paddy cultivation in the 2021/22 *Maha* season compared to the previous *Maha* season. However, a substantial increase was reported in the adoption of organic fertilizers, with 89% of farmers utilizing organic fertilizers after the ban compared to 13% before the ban. Compost emerged as the most common organic matter of choice, though considered by farmers as an organic fertilizer rather than a soil conditioner.
- The usage of chemical fertilizers significantly decreased, with only 15% of farmers using Urea, TSP, and MOP after the ban, compared to 89% before the ban. Manual weeding became more prevalent due to the limited availability or increased costs of chemical herbicides, resulting in an increase in labour requirements and daily wage rates for manual weeding. Pesticide usage and frequency of application also decreased, with more farmers choosing not to use any pesticides after the ban. In general, there was a reduction in the use of weedicides, insecticides, and fungicides.
- The import ban resulted in a significant reduction in paddy yield, with an average yield loss of over 50% across different sources of irrigation water in the 11 paddy-growing districts surveyed. The primary reasons for yield reduction were the unavailability and delayed application of chemical fertilizers. Paddy sales also decreased by approximately two-thirds after the ban, primarily due to the lower yields achieved due to import restrictions on the agricultural inputs. The average consumption of paddy also decreased marginally among the paddy-farming HHs, while the quantity of seed paddy stored showed a reduction. However, there was an increase in the proportion of paddy stored for future sales from the total production, indicating a rise in the quantity of paddy stored for future sales across different irrigation systems, except for major irrigation areas. Overall, the increase in the proportion of paddy stored for future sales is a sign that farmers are facing uncertainty and are taking steps to protect themselves. This is a worrying trend, as it suggests that the agricultural sector is becoming less resilient.
- Food security analysis assessment revealed that the majority of paddy-farming households (HHs) have an acceptable level of food consumption, despite the fact that they encountered significant economic shocks during the reference period. This signifies greater dietary diversity and a higher likelihood of obtaining essential nutrients of the paddy-growing HHs. Yet, the dimensions of consuming nutrient-rich foods varied considerably among different food consumption groups. The HHs with an acceptable level of food consumption have a stronger ability to fulfill nutritional needs than those in the borderline and poor food consumption groups. Yet, the greater reliance on self-produced foods among paddy-farming HHs made a significant contribution to ensuring their HH food security.

- A shift in consumption patterns implies negotiations made by the HHs in response to the food shortages. Consumption of less-preferred and less-expensive foods was the most commonly employed food-based coping strategy by the paddy-farming HHs. More than half of the HHs used livelihood-based coping strategies to avoid further deterioration of the food security conditions. Adopting stress strategies is significantly more widespread than using crisis and emergency-response measures. This indicates the need for rational interventions with a priority response to enhancing food security among vulnerable HHs and to lessen future food crises.

6.2 Policy Implications

Based on the findings of the study on paddy cultivation, several policy implications can be derived:

- Gender Equality: Governments should implement policies that promote gender equality in the agricultural sector. This could include providing women farmers with secure access to land, access to credit facilities, and targeted training programmes to enhance their skills and knowledge.
- Addressing the Ageing Population: Governments should develop policies to address the aging population of farmers. Incentives should be provided to attract young people into farming, such as offering financial support for agricultural education and training. Additionally, investing in programmes that enhance the skills of older farmers and facilitate their transition to retirement or alternative livelihoods should be considered.
- Improving Education and Training: Policies should be implemented to improve the education levels of farmers. Financial assistance should be provided to support farmers' access to education, and tailored training programmes should be developed to meet the specific needs of farmers.
- Raising Awareness: Government-led public education campaigns should be launched to raise awareness of gender inequality in the agricultural sector. Encouraging women farmers to share their success stories and experiences can also help highlight their contributions and challenges.
- Supporting Women's Organizations: Governments should actively support and collaborate with women's organizations that work towards promoting gender equality in agriculture. These organizations can provide valuable resources, training, and support to women farmers.
- Empowering Young Farmers: Special attention should be given to empowering young farmers to participate in the agricultural sector. Providing access to land, credit facilities, market opportunities and targeted training can create a conducive environment for their active engagement and future success.

- Enhancing farmers' financial security and mitigating risks requires a significant focus on income source diversification. This entails exploring alternative revenue streams beyond conventional crop farming. Governments has a vital role in facilitating this diversification by extending financial assistance, providing training, and improving market access for farmers. Additionally, supportive policies, financial aid during the transition, and targeted training programmes are essential components to equip farmers with the necessary skills for successful income diversification.
- Supporting more sustainable agricultural practices: The government should adopt a gradual and phased approach towards the transition to any system from the conventional farming approach. This approach would involve providing support for farmers to access and utilize organic fertilizers effectively, while simultaneously ensuring a consistent supply of chemical inputs for balance the nutrient requirements. It is crucial to address the challenges faced by organic fertilizer producers, such as the availability of raw materials, to facilitate their production and distribution. While acknowledging the challenges, efforts should be made to promote more sustainable practices by providing training, awareness and incentives for the effective use of organic fertilizers, reducing reliance on chemical inputs, and encouraging integrated pest management (IPM) techniques and organic soil improvement/conditioning methods. By implementing these measures, the government can facilitate a smooth transition towards sustainable agriculture while considering practical constraints and diverse preferences of farmers.
- Address challenges in availability of synthetic fertilizers and pesticides: The study identified challenges in obtaining sufficient quantities of fertilizers and controlling weeds and insect pests after the import ban on agrochemicals. Measures should be taken to ensure a consistent supply of organic fertilizers and promote effective weed and pest management strategies. This can include improving distribution networks, facilitating access to quality-assured-agrochemicals and other agricultural inputs, and providing technical support.
- Enhance storage and marketing facilities: The import ban on agrochemicals resulted in reduced paddy yields and sales. Efforts should be made to improve storage facilities and post-harvest infrastructure, including better transportation, to minimize yield losses and ensure better market access for paddy farmers. This can include supporting the construction of proper storage facilities, promoting collective marketing initiatives, facilitating value-added processing, and a well-coordinated transport system.
- Strengthen food security among paddy-farming households: Despite economic shocks, paddy-farming HH generally have an acceptable level of food consumption. However, interventions should focus on improving dietary diversity and ensuring access to nutrient-rich foods. Support can be provided through programmes that promote nutrition education, diversification of food sources, and income generation activities.

- Target vulnerable households: Strategies should prioritize vulnerable HH, particularly those with poor or borderline food consumption levels. Interventions should focus on providing social safety nets, livelihood support, and crisis response measures to enhance their food security and resilience if such groups to any food crisis situation in the future.
- Continuous monitoring and research: Regular monitoring and research efforts are essential to track the progress of paddy cultivation, identify emerging challenges, and evaluate the effectiveness of interventions. This will enable evidence-based decision-making and facilitate the development of targeted policies and programmes.

By implementing these policy implications, policymakers, agricultural stakeholders, and development partners can work towards improving the sustainability, productivity, and food security of paddy farming community in Sri Lanka while addressing the specific challenges identified in the study.

REFERENCES

Aponso, G.L.M., Magamage, C., Ekanayake, W.M. and Manuweera, G.K. (2003). Analysis of water for pesticides in two major agricultural areas of the dry zone. Annals of the Sri Lanka Department of Agriculture, 5, pp.7-22.

Asesefa Kisi, M., Tamiru, D., Teshome, M.S., Tamiru, M. and Feyissa, G.T. (2018). Household food insecurity and coping strategies among pensioners in Jimma Town, South West Ethiopia. *BMC public health*, *18*, pp.1-8.

Balasooriya, B.M.J.K., Chaminda, G.G.T., Ellawala, K.C. & Kawakami, T. (2017). Comparison of groundwater quality in Southern province. 5th International Symposium on Advances in Civil and Environmental Engineering Practices for Sustainable Development (ACEPS-2017), pp. 153-160.

Bandumula, N. (2018). Rice production in Asia: Key to global food security. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 88(4), pp.1323-1328.

Bogodage, J.N., Dharmadasa, R.A.P.I.S., Senaratne, A. and Samaraweera, W.G.R.L., 2021. The Evidence of Agricultural Self-Employment Decisions Making in Sri Lanka.

Buhary, R., Weerakkody, R., Dharmawardhana, T., Dissanayaka, A., Kuruppu, V., Ratnayake, D. (2021). *Mobile based solution for pest and disease management in paddy cultivation: Lessons learnt from deployment.* Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo.

Central Bank of Sri Lanka (2020). Annual Report 2020, Colombo: Central Bank of Sri Lanka

Chaminda K.G.S., Marapana R.A.U.J., Serasinghe R.T. & Karunagoda R.P. (2012). Environmental impact and use of agro chemical in cattle feed and its effect on milk in Magastota, NuwaraEliya, Sri Lanka. Centre for Environmental Justice/Friends of the Earth Sri Lanka. First National Symposium proceedings. pp. 27-30.

Dabbert, S., Haring, A.M., Zanoli, R. (2004). Organic farming: Policies and prospects. London: Zed Books.

DCS (2019). Agricultural Household Survey 2016/17. Department of Census and Statistics, Colombo

DCS and World Bank (2015). The Spatial Distribution of Poverty in Sri Lanka. Department of Census and Statistics, Colombo

Department of Census and Statistics (2021) Paddy statistics. Department of Census and Statistics, Ministry of Economic Policies and Plan Implementation, Government of Sri Lanka. http://www.statistics.gov.lk/Agriculture/StaticalInformation/rubpaddy. Accessed 15 Oct 2021

Department of Sensors and statistics. (2021). National Accounts Estimate of Sri lanka 4th quarter and annual 2020. Ministry of Finance Sri Lanka. http://www.statistics.gov.lk/NationalAccounts/StaticalInformation/Reports/press_note_2020q4_en

Ekanayake, H.K.J. (2006). 'The Impact of Fertilizer Subsidy on Paddy Cultivation in Sri Lanka', Staff Studies, 36(1& 2), pp.73-101.

Ellis, F. (1998). Household strategies and rural livelihood diversification. Jourml of Development Studies, 35(1),1-38

Fairweather, J.R. (1999). Understanding how farmers choose between organic and conventional production: Results from New Zealand and policy implications. Agriculture and Human Values; 16(1), pp. 51-63.

FAO (1996). 'Rome Declaration on World Food Security and World Food Summit Plan of Action', World Food Summit 13-17 November 1996. Rome.

Feuerbacher, A., Luckmann, J., Boysen, O., Zikeli, S., and Grethe, H. (2018). Is Bhutan destined for 100% organic? Assessing the economy-wide effects of a large-scale conversion policy. PloS one, 13(6), e0199025.

Firdaus, R.R., Leong Tan, M., Rahmat, S.R. and Senevi Gunaratne, M.(2020). Paddy, rice and food security in Malaysia: A review of climate change impacts. Cogent Social Sciences, 6(1), p.1818373.

Haque, A.N.A., Uddin, M.K., Sulaiman, M.F., Amin, A.M., Hossain, M., Zaibon, S. and Mosharrof, M. (2021). Assessing the increase in soil moisture storage capacity and nutrient enhancement of different organic amendments in paddy soil. *Agriculture*, 11(1), p.44.

Harvard School of Public Health (2023). The Nutrition Source. Retrieved on February, 2023, from https://www.hsph.harvard.edu/nutritionsource/iron/

Herath, H.H.M.A.U., Wijesundera, R.L.C, Chandrasekharan, N.V. and Wijesundera, W.S.S. (2017). Exploration of Sri Lankan soil fungi for biocontrol properties. African Journal of Biotechnology, 16(20), pp. 1168-1175.

IFOAM. (2014). The IFOAM norms for organic production and processing: Version 2014. International Federation of Organic Agriculture Movements, Bonn, Germany

Isaura, E.R., Chen, Y.C. and Yang, S.H. (2018). The association of food consumption scores, body shape index, and hypertension in a seven-year follow-up among Indonesian adults: A longitudinal study. *International Journal of Environmental* Research *and Public Health*, *15*(1), p.175.

Kadupitiya, H.K., Madushan, R.N., Gunawardhane, D., Sirisena, D., Rathnayake, U., Dissanayaka, D.M.S.B., Ariyaratne, M., Marambe, B. and Suriyagoda, L., 2022. Mapping productivity-related spatial characteristics in rice-based cropping systems in Sri Lanka. Journal of Geovisualization and Spatial Analysis, 6(2), p.26.

Kochar, A. (1995). Explaining household vulnerability to idiosyncratic income shocks. *The American Economic Review*, *85*(2), pp.159-164.

Kodamaya, S. (2011). Agricultural policies and food security of smallholder farmers in Zambia. *African study monographs. Supplementary issue.*, *42*, pp.19-39.

Lakshani, P.W.Y., Rajapaksha, M.K.L.K., & Sendthuran, K. (2017). Pesticide residues in selected vegetables in several growing areas by GC/MS using QuEChERS technique.Annals of Sri Lanka Department of Agriculture, 19(2), pp. 188-208.

Marasinghe, J.P., Magamage, C., Shiromi, M.G.D. and Aravinna, A.G.P. (2011). Organophosphate pesticide residues in food commodities in Sri Lanka: a review. Annals of Sri Lanka Department of Agriculture, 13, pp.81-94.

Maxwell, D. and Caldwell, R. (2008). The Coping Strategies Index: Field Methods Manual. 2nd. *Cooperative for Assistance and Relief Everywhere Inc. USA*.

Maxwell, D., Watkins, B., Wheeler, R. and Collins, G.(2003). The coping strategies index: A tool for rapidly measuring food security and the impact of food aid programs in emergencies. *Nairobi: CARE Eastern and Central Africa Regional Management Unit and the World Food Programme Vulnerability Assessment and Mapping Unit*.

Padmajani, M.T., Bandara, M.A.C.S. and Aheeyar, M.M.M. (2014). Assessment of pesticide usage in up-country vegetable farming in Sri Lanka. HARTI Research Report No. 164, Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo, Sri Lanka.

Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food security*, *1*(1), pp.5-7.

Piran-Qeydari, M. H., Heidarabadi, A., and Farzaneh, S. (2022). Investigating the effects of alienation and social networks on women's social health in 22 districts of Tehran. Women's Studies Sociological and Psychological.

Ponisio, L.C., M'Gonigle, L. K., Mace, K. C., Palomino, J., De Valpine, P., and Kremen, C. (2015). Diversification practices reduce organic to conventional yield gap. Proceedings of the Royal Society B: Biological Sciences, 282(1799),

Rheingans, R., Anderson, J.D., Luyendijk, R. and Cumming, O. (2014). Measuring disparities in sanitation access: does the measure matter?. Tropical Medicine & International Health, 19(1), pp.2-13.

Sandika, A.L., and Dushani, S.N. (2011). Growth performance of rice sector: the present scenario in Sri Lanka. Tropical Agricultural Research and Extension, vol. 12(2).

Schneider, P. and Asch, F. (2020). Rice production and food security in Asian Mega deltas—A review on characteristics, vulnerabilities and agricultural adaptation options to cope with climate change. *Journal of Agronomy and Crop Science*, *206*(4), pp.491-503.

Shantha, A.A., 2017. The Impact of Uneven Access to Water on Divergence of Income among Paddy Farmers in the Dry Zone of Sri Lanka. Australian Academy of Business and Economics Review (AABER), 3(2), pp.99-112.

Shaw, D.J., 2007. World food summit, 1996. In World Food Security: A History since 1945 (pp. 347-360). London: Palgrave Macmillan UK.

Watawala, R.C., Liyanage, J.A. and Mallawatantri, A. (2010). Assessment of risks to water bodies due to residues of agricultural fungicide in intensive farming areas in the up- country of Sri Lanka using an indicator model. In Proceedings of the National Conference on Water, Food Security, and Climate Change in Sri Lanka, BMICH, Colombo, June 9-11, 2009. Volume 2. Water quality, environment, and climate change (Vol. 2, p. 69). IWMI.

Weerahewa, J., and Dayananda, D. (2023). Land use changes and economic effects of alternative fertilizer policies: a simulation analysis with a bio-economic model for a Tank Village of Sri Lanka. Agric. Syst. 205, 103563. doi: 10.1016/j.agsy.2022.103563

Weerahewa, J., Kodithuwakku, S.S. and Ariyawardana, A. (2010). Fertilizer subsidy in Sri Lanka. Case Study No.7- 11 of the food policy for developing countries: the role of government in the global food system, Cornell University, Ithaca, New York.

Weerahewa, J., Senaratne, A. and Babu, S.C. (2021). Reforming fertilizer import policies for sustainable intensification of agricultural systems in Sri Lanka: Is there a policy failure? PRCI Policy Research Notes 3. East Lansing, MI: Michigan State University.

WFP (2008). Food consumption analysis technical guidance sheet: Calculation and use of the food consumption score in food security analysis. WFP, Rome Retrieved on Novermber 2022 from https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf

WFP (2015). Food Consumption Score Nutritional Analysis (FCS-N) Guidelines, WFP, Italy

WFP (2016). Corporate Results Framework (2017 – 2021). Exec Board Second RegulSess Rome, November 14-18, 2016. Rome: World Food Programme

WFP (2019). reduced Coping Strategies Index Retrieved on February 2023 from https://resources.vam.wfp.org/data-analysis/quantitative/essential-needs/livelihood-coping-strategies-essential-needs

WFP (2021a) The Livelihood Coping Strategies – Food Security, VAM resource Centre, Retrieved on December 2022 from https://resources.vam.wfp.org/data-analysis/quantitative/essential-needs/livelihood-coping-strategies-essential-needs

WFP (2021b). Technical guidance for the Consolidated Approach for Reporting Indicators of Food Security (CARI), Third Edition, WFP, Italy. Retrieved on December 2022 from https://docs.wfp.org/api/documents/WFP-0000134704/download/?_ga=2.112054211.678095800.1691992971-1153779513.1677418717food-security

Wijesooriya, N. and Senerath, M.D.L. (2021) *Converting to organic farming: assessing the biomass availability* [Unpublished HARTI Report] Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo.