RESEARCH REPORT

NATIONALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS (NIAHS) OF SRI LANKA: RECOGNITION, APPLICABILITY AND CONSERVATION

Uthapala Jayasinghe
P.B. Dharmasena
D.D. Prabath Witharana
Malathi Rambodagedara
Rasika Wijesinghe

HARTI
Hector Kobbekaduwa Agrarian Research and Training Institute

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

Telephone : +94 11 2696981
+94 11 2696437

Fax : +94 11 2692423

Email : director@harti.gov.lk

Web page : www.harti.gov.lk

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FOREWORD

The concept of Nationally Important Agricultural Heritage Systems is relatively novel to Sri Lanka. According to historical manifestations, the first human settlements were established along the major riverbanks in the North Central Province of Sri Lanka, and it was evident that the human society coevolved with the country's agricultural development. The best example for this is the ancient hydraulic civilization of the country. To endure harsh dry spells, which are typical to the dry zone, a remarkable and unique wealth of wisdom of irrigation and water management has developed, which helped fulfill society's need for water, food and other livelihood requirements. Starting from the dry zone, development spread throughout the country, adapting to climatic, social, economic and political variations, resulting in to various diverse, advanced, remarkable and unique agricultural systems and structures. These outstanding agricultural landscapes, systems and structures can be identified as the Nationally Important Agricultural Heritage Systems of Sri Lanka.

Given the diversity and distinctiveness of the nation's agricultural knowledge, its application to agricultural systems at the present and in the future is substantial. It is especially relevant during this period where public attention has been drawn to the importance of environmentally-friendly farming techniques to produce safe and high-quality food. In the absence of national policy to recognize, develop and conserve these systems, this initiative aims to systematically identify NIAHS by proposing a definition and selection criteria, and to recommend a conservation plan to preserve these systems as one of the key national priorities of the country.

Therefore, I am sure that this study will act as a key preliminary analysis and will provide a firm foundation to conduct future activities, in addition to provide policy-makers with clear guidance to develop and protect these systems.

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

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Uthpala Jayasinghe
P.B. Dharmasena
D.D. Prabath Witharana
Malathi Rambodagedara
Rasika Wijesinghe

EXECUTIVE SUMMARY

The rich, sustainable, indigenous and ingenious agricultural knowledge systems which have passed down from generation to generation from a history of over 2500 years while, successfully adapting to diverse environmental, climatic, social and economic variations over the time can be considered as NIAHS of Sri Lanka. However, these agricultural heritage systems are at the verge of disappearance due to varied reasons, without identifying their scientific background and possibility of using them as a favourable base on which sustainable modern agriculture systems could have been developed.

In the absence of a national policy and mechanism to define, identify, collect and conserve these systems this study proposes to systematically identify nationally important agricultural heritage systems of Sri Lanka by developing a definition and appropriate selection criteria, and to provide policy guidance to develop a national policy towards identifying, collecting, storing and conserving the Sri Lankan agricultural heritage systems. The study conducted a comprehensive literature review, key informant discussions with practitioners, panel discussions with subject matter experts and a validation workshop to develop and validate the definition, selection criteria and policy guidance framework.

“Nationally Important Agricultural Heritage Systems (NIAHS)” is a novel concept to Sri Lanka. Inspired by the concept “Globally Important Agricultural Heritage Systems” of United Nations’ Food and Agricultural Organization (FAO) only China, Japan and South Korea are the countries in the world at present with the declared NIAHS at national level.

The process of developing selection criteria for NIAHS of Sri Lanka has adopted several steps. Firstly, the purpose of systematic identification of NIAHS was recognized. Then the key base factors to develop the definition and selection criteria were identified. Finally, based on those factors the selection criteria were developed. The main purpose of systematic identification of NIAHS is to recognize and conserve the proudest and time-tested, outstanding traditions of human ingenuity in harnessing precious resources to provide safe food, and livelihoods and protect unique ecosystems and to maintain the balance between conservation, sustainable adaptation and socio-economic development through multi stakeholder supports. The four base factors to develop definition and selection criteria include: 1) Identification of operational structure, functions, and governing principles of NIAHS; 2) Identification of economic implications of NIAHS; 3) Identification of food security implications of NIAHS; and 4) Sustainable agriculture systems concept. The operational structure, functions and governing principles of NIAHS were identified by analysing village tank system complex using social ecological systems framework.

The selection criteria developed, include two major criteria types as: 1) Common criteria; and 2) Specific criteria. Common criteria provide a basic guidance to select a potential NIAHS. It includes five sub criteria as: 1) Historical and contemporary

relevance; 2) Uniqueness; 3) Location specificity; 4) Sustainability and time-tested nature; and 5) The system approach based on functionality.

Specific criteria illustrate more detail and specific characteristics that can be observed in a NIAHS. It consists of seven major specific criteria namely: 1) Operational structure and functions; 2) Ecosystem and biodiversity; 3) Social value system; 4) Governance system; 5) Cosmo spiritual dimension; 6) Food security and alternative markets; and 7) Historical dimension and conservation needs. Each major specific criterion includes several sub specific criteria, where total number of sub specific criteria is 28.

The proposed definition of NIAHS is “Outstanding and unique, landscapes, waterscapes, knowledge systems, or structures, which are locally adapted, time tested, and ensure social, cultural, ecological, spiritual and economic goods and services to humankind on sustainable basis, whilst preserving the associated ecosystem”.

The study suggests that NIAHS monitoring and conservation policy should be realistic, comprehensive and long term. It consists of multiple steps, which include development of definition and selection criteria, establishment of government authorised body to declare NIAHS, awareness creation, collection of potential NIAHS, evaluation and declaration of NIAHS and way forward including research and application, dynamic conservation, development and monitoring, and propose as GIAHS site as appropriate.

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LIST OF ABBREVIATIONS

CAS	Complex Adaptive System
FAO	Food and Agricultural Organization (of the United Nations)
GIAHS	Globally Important Agricultural Heritage Systems
GS	Governance Systems
INRM	Integrated Natural Resource Management
IUCN	International Union for Conservation of Nature
NIAHS	Nationally Important Agricultural Heritage Systems
RS	Resource System
RU	Resource Units
SES	Social-Ecological System
SESF	Social Ecological Systems Framework
UNESCO	United Nations Educational, Scientific, and Cultural Organization

CHAPTER ONE

Introduction

1.1 Background

Sri Lanka, a country having written history of more than two thousand five hundred years is inherited with a rich agricultural history, which even runs beyond the recorded history. The country once known as the 'Granary of the East' has been evolved with a wealth of agricultural knowledge, passed from generation to generation till to date, successfully adapting to diverse environmental, climatic, social and economic variations over the time. These agricultural knowledge systems were enriched and thrived over the climatic, environmental, social and economic upheavals and able to provide food, fodder and fibre for human needs sustainably converging with the natural systems by preserving and integrating agro-biodiversity as well as the biological diversity. Therefore, these sustainable systems which bear immense amounts of ingenious knowledge can be considered as the National Agricultural Heritage of Sri Lanka.

The Food and Agricultural Organization of the United Nations (FAO), in 2002 introduced the concept called Globally Important Agricultural Heritage Systems (GIAHSs). It is defined as "*Remarkable land use systems and landscapes, which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development*" (Food and Agricultural Organization of United Nations (FAO), n.d., p:3). These systems have evolved over the millennia among farming communities engaging in farming, animal raring, aquaculture, and forest products, which are complex, heterogeneous and locally adjusted. These systems grew as a result of evolution of biophysical, economic and socio-cultural resources of an area under certain ecological and socio-cultural constraints to generate outstanding landscapes. Following major five criteria were the base for selecting GIAHSs (FAO, n.d).

1. Their significance for the delivery of local food security
2. Maintenance of high levels of agro- biodiversity[1] and associated biological diversity[2]
3. Store of indigenous knowledge and ingenuity of management system
4. The biophysical, economic and socio-cultural resources have evolved under specific ecological and socio-cultural constraints to create outstanding landscapes.

[1] The FAO definition for the agro-biodiversity is "the result of natural selection processes and the careful selection and inventive developments of farmers, herders and fishers over millennia". (United Nations Food and Agricultural Organization, 2019). Agro-biodiversity is a vital sub-set of biodiversity.

[2] The biological diversity is the variety of life found in a place on earth or often the total variety of life on earth" (Encyclopaedia Britannica, 2019). A common measure is the count of species in an area which is known as species richness.

5. Landscapes and seascape features

Currently, FAO has declared 62 systems in 22 countries as GIAHS sites. In 2018 the cascaded Tank-Village System or the "*Ellanga gammana"* was recognized as a GIAHS site at the International forum and Award ceremony for new GIAHS in Rome. This is the only declared GIAHS site of Sri Lanka, whereas certain countries such as China have 15 GIAHS sites (FAO, 2021).

Despite the availability of many agricultural heritage systems in Sri Lanka, the concept Nationally Important Agricultural Heritage Systems (NIAHS) is new to the country. NIAHS concept has implemented as a national policy, only in three countries in the world namely China, Japan and South Korea.

Circular for China NIAHS was firstly announced in year 2012. The selection criteria for China NIAHS include six basic characteristics namely: 1) active; 2) adaptable; 3) composite; 4) strategic; 5) versatile; and 6) endangered. It also considers quantitative criteria as well such as the selected systems should at least have 100 years of history and participation rate of more than 50 percent inhabitants. However, it can be observed that different countries have unique characteristics that they emphasize on. For example, China NIAHS mainly focus on agricultural history and culture (Evonne, Akira and Kazuhiko, 2016).

Concept of Korea Nationally Important Agricultural and Fishery Heritage Systems was also implemented in March 2012. This is their national system to conserve the resources in rural areas, which they have inherited over time so that they can efficiently utilize them for regional branding and tourism. Korea NIAHS is defined as "*both tangible and intangible agricultural and fisheries systems that farmers and fishing people have built over a long period of time while adapting to the local environment, society and customs*" (Evonne, Akira and Kazuhiko, 2016). Selection criterion of Korea NIAHS mainly focuses on three factors. The first one is value of heritage, which is measured on the basis of the historical value, representativeness and characteristics. The second one is the partnership of stakeholders, which is measured in terms of cooperation and participation. The last one is the effectiveness, which is measured in terms of ability for branding and ability for revitalization and improve biodiversity (Evonne, Akira and Kazuhiko, 2016).

Apart from these, Japan is also in the process of defining NIAHS for Japan (Evonne, Akira and Kazuhiko, 2016) while India is also has recognized the importance of having identified NIAHS in a systematic scientific manner to face current and immerging challenges in the modern agricultural systems (Singh and Rana, 2019).

Considering rural farmers of Sri Lanka where most of the poverty incidences are reported, farmers are struggling to make the best out of limited resources they have. The challenges such as rising population, adverse weather conditions, climate change repercussions, limited availability of resources and opportunities have made their struggles even worse. Since the independence, different policy initiatives such

as ‘green revolution’ have been taken to uplift the living standards of farming communities. However, even with the benefits of the green revolution to improve the food security of the country, there is rising concern about the profitability and the sustainability of agricultural practices. Regardless of the increasing cost of production, reducing profitability, productivity stagnation and issue of climate change, scientists are afraid of whether these systems will be able to give a continuous yield with the existing deteriorating agricultural and associated biological environment (Daleus, 1988).

However, with regard to traditional agricultural systems, despite the technological advancements, market developments, population growth, political and policy changes, they were able to sustainably supply food for people along with socio-economic turbulences and environmental variations. Therefore, scientists suggest that traditional systems have the ability to provide solutions for unpredictable changes happening at present in the midst of climate change, energy and economic crisis (Ulluwishewa 1994; Howard et al, 2008; Koohafkan & Altieri, 2019).

Despite their importance, these agricultural heritage systems are at the verge of disappearance due to varied reasons. One of the major reasons is poor promotion of diversified environmentally compatible farming and management practices, which are adopted in these farming systems. Further to that, there are lesser concerns on research and development related to indigenous agriculture systems. Deterioration of rural values which have helped preserve these systems mainly as a result of out-migration and loss of youth, over usage of resources, decrease of productivity, introduction of exotic cultivars which lead to severe genetic erosion are some of other causes for fading away of these local knowledge systems. However, apart from the above, negative spill over effects among rural marginalized communities will lead them to encroach wild bio-diversity to create farm lands (Koohafkan & Altieri, 2019).

These threats will lead to the disappearance of traditional indigenous and ingenious knowledge systems. With the alarming climate change issues leading to high levels of poverty among rural poor farming communities as stated by Koohafkan and Altieri (2019), there is a need to develop new farming models for near future that includes farming methods which are “more bio-diverse, local, resilient, sustainable and socially just.”

To develop such farming models, it is vital to develop the modern farming methods on the roots of traditional and ecologically rational farming systems since the success and sustainability of the novel farming models will highly be subject to major components of biodiversity and ecosystem services. Therefore, these traditional farming systems will provide a promising base to develop modern farming methods to increase farm productivity and uplift rural livelihoods (Koohafkan and Altieri, 2019).

1.2 Research Problem

As a country which has over a two thousand years of agricultural history, a wealth of knowledge has developed and passed from generation to generation where we have inherited with diverse, unique, ingenious, locally evolved farming and farm management techniques and systems which are well integrated with the natural environment and local climate. However, with the rapid evolution of commercial intensive agriculture, these systems are dying out even without identifying their scientific base and possibility of using them as a favourable base to develop sustainable modern agriculture systems.

At present in Sri Lanka there is no national policy guideline, mechanism or a plan to define, recognize, collect and dynamically conserve these vulnerable nationally important agricultural heritage systems. Especially for conservation and sustainable management of these precious natural resources.

Identifying the timely importance of this issue the Department of Agrarian Development made a request from HARTI to study the effects of agricultural heritage systems on the sustainability of rural agriculture in Sri Lanka. Further to that, the document of National Research Priorities on Socio-economics and Policy Analysis 2017-2021 prepared by the Sri Lanka Council for Agricultural Research Policy has identified “conducting in-depth research to understand traditional knowledge systems with respect to sustainable use of natural resources” as a priority research area.

1.3 Purpose of the Study

The main purpose of this study is to provide a solid base to identify, recognize, wise-use and conserve proudest and time tested traditions of human ingenuity in harnessing precious resources to provide food and livelihood safety and protect unique eco-systems to maintain the balance between conservation, sustainable adaptation and socio-economic development through multi stakeholder approach.

1.4 Objectives

1.4.1 Overall Objective

The overall objective of this study is to systematically identify nationally important agricultural heritage systems of Sri Lanka, and to suggest ways to conserve them.

1.4.2 Specific Objectives

To achieve the overall objective, the specific objectives are as follows.

1. To develop a definition and appropriate selection criteria to identify nationally important agricultural heritage systems.
2. To provide policy guidance to develop a national policy towards identifying, collecting, storing and conserving agricultural heritage systems in Sri Lanka and way forward.

CHAPTER TWO

Literature Review

The literature review focuses on the GIAHS concept, selection criteria of GIAHS, concepts and selection criteria of NIAHS of other countries and a potential conceptual framework to analyse NIAHS to identify their operational structure, functions and governing principles. In depth understanding of above mentioned information is used to formulate the methodology of the study.

2.1 Globally Important Agricultural Heritage Systems

2.1.1 Goal of Establishing GIAHS

The overall aim of the GIAHS initiative is to "*identify and safeguard GIAHS and their associated landscapes, agricultural biodiversity and knowledge systems through catalysing and establishing a long term programme to support such systems and enhance global, national and local benefits derived through their dynamic conservation, sustainable management and enhance viability (FAO, n.d. p. 4)*". To achieve that the major objectives are (FAO, n.d.).

1. To support global and national recognition of the importance of agricultural heritage systems and institutional assistance to protect them.
2. Capacity building of local farming communities and national institutions to conserve and manage GIAHS, generate income and induce value addition by sustainable means.
3. To encourage allowing regulatory policies and incentive environments to assist the conservation, evolutionary adaptation and viability of GIAHS.

Developing GIAHS programme has considered several features to identify potential GIAHS sites. The one of the key feature is "historical and contemporary relevance". Other than this five other features are also considered. 1) Agricultural systems that contribute to food and livelihood security; 2) Rich and unique agro biodiversity; 3) Traditional knowledge and technologies; 5) Strong cultural values and collective forms of social organizations and value systems for resource management and knowledge transmission; 5) Remarkable landscapes and seascapes stemming from ingenious systems and technologies of land and water management (FAO, 2018).

2.1.2 Selection Criteria of GIAHS

Other than above discussed features, five key selection criteria have been developed to identify a system as a GIAHS based on inherent qualities of the system. The five criteria are as follows (Howard et al, 2008).

1. System ingenuity and remarkability.
   This strictly concerns the agriculture systemic level. This criterion mainly looks at the diversity and complexity, system efficiency, adaptive capacity, economic conditions, level of integration, ingenuity/level of innovation, economic viability and sustainability and human ecological sustainability of the system.

2. Outstanding characteristics.
   This criterion consists of five major groups of key resource endowments, goods and service and other features of the system which are mentioned below.
   1) Biodiversity and ecosystem functioning
   2) Landscapes and land and water resource management
   3) Food and livelihood security
   4) Social organization and culture
   5) Knowledge systems and farmer's technologies
   6) Other goods and services generated by the system

3. Proved history of sustainability.
   This criterion emphasises on the heritage value of the system to the world based on the economic viability and sustainability, adaptive capacity and human ecological sustainability.

4. Global significance.
   This criterion considers the significance of the system as a global public good and value of global benefits.

5. Representation.
   This criterion includes five elements in terms of representation namely ecosystems and eco-regions, systemic, scalar impacts, geography and demonstration value.

2.2 Nationally Important Agricultural Heritage Systems in Other Countries of the World

As mentioned in the chapter 1, China, South Korea, and Japan are the only three countries in the world that have identified NIAHS as a national policy. However, since they have mainly identified them as a sub group of GIAHS, respective countries have not prepared definitions for NIAHS. However, they have developed selection criteria for NIAHS which are somewhat similar to the criteria of GIAHS. Yet, they have included country specific criteria as well.

2.2.1 NIAHS for Japan

Considering NIAHS for Japan, though they have mainly followed the criteria of GIAHS, they have also included their own special concerns as well which mentioned as follows (Evonne, Akira and Kazuhiko, 2016).

1) Social aspects concerning participation of multiple stakeholders

This implies the NIAHS of Japan should be participated by multiple stakeholders and should promote institutions. Therefore, they look for the participation and corporation of local stakeholders including women and young people and their entities. There should be sufficient framework and organizational arrangements for conservation of agriculture systems while creating favourable environment to carry on these activities.

2) Environmental aspects concerning resilience against change

This implies that the proposed NIAHS should have the ability to recover early from natural disasters, changes in the environment at present and those which are possible to occur in the future. Furthermore, there should be mechanisms to conserve this knowledge for future generations.

3) Economic aspects of “New business models” (Japan referred to this as sixth industries).

This is one of the key features for Japan. While developing countries are focusing on how these systems can be used to cope with current development challenges, developed countries perceive these as how to use these systems to increase resilience to future challenges and to develop them as business models.

2.2.2 NIAHS for South Korea

The specialty of NIAHS for South Korea is they define it as traditional agriculture and fisheries systems and landscapes formed by these systems worth conserving and maintaining. They decide on the value of the heritage system based on seven criteria as follows (Evonne, Akira and Kazuhiko, 2016).

1) **Historical value:** This implies that the Korean agricultural and fisheries systems should have at least more than 100 years of history. Also they consider about the ability to project the system inherent values such as sustainability in to future.
2) **Representativeness:** This implies they recognized systems should have a field level, regional level, international and national level representativeness. In addition they should be remarkable landscapes which have tourism, recreational and merchandizing potential.
3) **Characteristics:** The selected system should have a unique and outstanding land use and water resources management features.

4) **Cooperation:** Should have a maintenance management plan which includes municipalities and residents showing their willingness for cost sharing.
5) **Partnership:** This implies there should be an active participation from the community for preserving, maintenance and transmission of the heritage system.
6) **Branding:** This implies the selected systems have the ability to improve brand value and regional image depending on the type of heritage site.
7) **Revitalization and biodiversity:** This implies the selected systems should have the ability to contribute to local economy by promoting urban rural exchange by tourism promotion. Further, the process should help improve biodiversity and production of unique agricultural products.

2.2.3 NIAHS for China

NIAHS for China should have six major qualitative factors of concern as the selected systems being 1) Active, 2) Adaptable, 3) Composite, 4) Strategic, 5) Versatile, and 6) Endangered. In addition, selected systems should possess two quantitative factors as 1) Sites must have at least 100 years of history 2) Should have a participation rate of more than 50 years (Evonne, Akira and Kazuhiko, 2016).

Selection criteria for China have developed based on two major categories as shown in table 2.1.

Table 2.1: Selection Criteria for NIAHS of China

Category	Criteria	Features
1. Basic criteria	• Historical criterion	• Historical origin, length of history
	• Systematic criterion	• Subsistence and products • Ecosystem services • Technical knowledge and system knowledge maintenance • Landscape and esthetics • Spirit and culture
	• Persistent criterion	• Natural adaptation • Human development
	• Endangered criterion	• Trends • Stress factors
2. Secondary Criteria	• Demonstration criterion	• Participation • Accessibility • Reliability
	• Supporting criterion	• Organization building • System building • Preparatory planning

Source: Evonne, Akira and Kazuhiko, (2016)

Based on the above mentioned definitions and selection criteria, to develop the same for Sri Lanka, first has to identify the purpose of systematic recognition of NIAHS, underlying special features of NIAHS existing in Sri Lanka. For that it is important to systematically analyse NIAHSs of Sri Lanka, to understand features, structures and underlying complex interactions within agricultural heritage systems of Sri Lanka. To do this systematically a potential scientific framework should be identified that can analyse components and interactions of the system, feedback loops, resilience and adaptability within an agriculture heritage system. Process of selecting the analytical framework is explained in the following section.

2.3 Tools to Analyse NIAHS

2.3.1 System Approach to Analyse Agricultural Heritage Systems

A system is a group of interacting, interdependent parts connected together by interchanging energy, matter and information (Costanza et al, 1993) which will ultimately produce its' own pattern of behaviour (Meadows, 2008). A special feature of a system is that it is dynamically interlinked parts produce outcomes different from what the individual parts will not produce (Preiser et al, 2018).

2.3.1.1 A Complex System and Complex Adaptive System (CAS)

A complex system can be defined as "*studying about how relationships between parts give rise to collective behaviours of a system, and how the system interacts and forms relationships with its environment* (Bar-Yam, 2002, pp. 3)". Complex systems have following special characteristics (Costanza et al, 1993). 1) Strong interactions between parts; 2) Complex feedback loops that make it difficult to distinguish cause from effect; 3) Significant time and space lags; 4) Discontinuities; 5) Thresholds and limits; A complex adaptive system is a special case of complex systems where it has the ability to adapt its' behaviour and evolve over time based on experience/changes happening within system parts or the environment (Sammut and Webb, 2017, Preiser et al, 2018).

2.3.1.2 A Social-Ecological System (SES)

The concept Social - Ecological Systems (SES) firstly emerged about 50 years back. However, it has recognized as a framework to analyse human and natural systems since 20 years of time (Colding and Barthel, 2019). The first detail explanation for SES concept was done by a Russian microbiologist namely B.L. Cherkasskii based on social ecology, systemic approach and fundamental principles of cybernetics. He explains it as "*epidemiological socio-ecological system consisting of two interacting subsystems: the biological (epidemiological ecosystem) and the social (social and economic conditions of life of the society) subsystems where the biological subsystem plays the role of the governed object and the social acts as the internal regulator of these interactions* (Cherkasskii 1988, pp 321)". Following to this Berkes and Folke (1998) came up with the first analytical framework for SES to examine linkages

among ecosystems and institutions. In contrast to biological ecology where humans are treated as external component to the ecosystem SESs consider humans as an integral part of the system, more precisely in the social subsystem (Liu et al, 2007).

Both the terms of social-ecological systems and socio-ecological systems have been utilized among scholars (Berkes, 2011). Main reason to use the term social-ecological system is to give both the subsystems an equal importance. The term socio-ecological systems which has emerged later, indicates less than equal status for the social subsystem (Berkes and Folke, 1998; Colding and Barthel, 2019). However, as our study gives an equal importance to both the subsystems here onwards the report will stick to the term social-ecological systems.

There are many number of definitions for SES ranging from more basic ones to more detailed and advanced ones (Colding and Barthel, 2019). Thomas et al (2012) defines SES as "*a system of people and nature* (Thomas et al, 2012. pp. 69)". del Mar Delgado-Serrano et al (2015) defines SES as "*coupled human nature systems* (del Mar Delgado-Serrano et al, 2015, pp. 1)". Petrosillo et al (2015) defines "*systems where social, economic, ecological, cultural, political, technological, and other components are strongly linked are known as socio-ecological systems, emphasizing the integrated concept of the 'human nature' perspective*" (Petrosillo et al, 2015, pp 1). Redman et al, 2004 gives a detail several definitions for SES as follows. "*SES is a coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner. It is a system that is defined at several spatial, temporal and organizational scales, which may be hierarchically linked; It is a set of critical resources (natural, socio economic, and cultural) whose flow and use is regulates by a combination of ecological and social systems; and a perpetually dynamic, complex system with continuous adaptation*" Redman et al, 2014, pp. 163).

An important characteristic of SES is that these systems are definitely interconnected and coevolving across spatial and temporal scale while the ecological component provides the essential that the society needs (Petrosillo et al, 2015). In a SES landscapes changes as a result of natural causes and anthropogenic activities where human activities are identified as the major causes for changes in the natural systems. The impact of human activities might cause considerable changes in the ecosystem services and the biodiversity.

Petrosillo et al, (2015) says that since the SES theory first originated diverse scientific schools start developing this concept. However, all the SES theories are based on the concepts such as adaptive cycles, resilience, adaptability, transformability and hierarchy. del Mar Delgado-Serrano et al, (2015) explains key characteristics of SES as follows. 1) Integrated bio geophysical and socio-cultural processes. 2) Self-organization. 3) Non-linear and unpredictable dynamics. 4) Feedbacks between social and ecological processes. 5) Changing behaviour in space (special thresholds and time thresholds). 6) Legacy behavioural effects with outcomes at very different time scales. 7) Emergent properties. 8) Impossibility to extrapolate the information from one SES to another. Liu et al, (2007) explains four complexities of social-

ecological systems as follows. 1) Reciprocal effects and feedback loops 2) Nonlinearity and thresholds 3) Surprises (due to lack of understanding on the complexity) 4) Legacy effects and time lags.

2.3.1.3 Complex Adaptive Systems and Social-Ecological Systems

Social-ecological system itself is a complex system where in a social-ecological system macroscopic consequences arise from a specific local action can spread up to other levels and parts of the system due to the collective behaviour of system agents. These consequences will then feedback and will shape the options and behaviour of other agents of the system which will create changes in the system. However these possible major changes, unseen slow structural changes, special variations and strategic behaviour[3] of agents of the system are mainly related to management and policy challenges connected to complex adaptive system properties (Levin et al 2013; Petrosillo et al, 2015). Therefore, Preise et al (2018) says that major principles of social-ecological systems' research are based on the complex adaptive systems (Liu et al, 2007; Levin et al 2013; Rogers et al 2013). There are number of studies that have conducted to study social-ecological systems based on concepts of complex adaptive systems. Based on the many number of literature Preise et al (2018) has developed six organizing principles which includes basic, generally accepted features of complex adaptive systems which gives guidelines to develop suitable methods and approaches to study social-ecological systems. The six principles are as follows.

1) Complex Adaptive Systems (CASs) are established relationally literature.

   One of the key features of CAS are that they are identified mostly by the interactions existing among system agents rather than the functions of system agents themselves. Relations can be either process of engagement or outcome of the process of engagement. Either way CAS are analysed based on relations. The relations will mould the structure and functions of the system. System structures can be either connected, nested or arranged in to levels representing the relations at diverse scales. This implies that CAS considers process reliant interactions at multiple scale. Due to these relations the CAS have become self-organized and consisted with adaptive, dynamic and emergent behavioural forms.

2) CASs have adaptive capacities

   CAS has the ability to learn and adapt over time scale based on feedback loops (Liu et al, 2007). Feed backs are received based on the interactions between the system agents and between system agents and the environment.

[3] Strategic behaviour implies decision make after taking in to consideration actions and reactions of other agents of the system

3) Dynamic processes generate CAS behaviour.

   The interactions within CAS and with the environment are non-linear (Liu et al 2007; Petrosillo et al, 2015). Therefore, the quantity of the system outputs are not directly proportionate to the scale of the cause effect.

4) CASs are radically open.

   CASs are well open systems where things (energy, information and material) can be moved within as between system and environment exchange freely. Defining system boundaries is not an easy task as at some occasions it is found difficult to distinguish between components belong to the system and not as the interactions the system components with the environment is significantly strong. Therefore, defining the system boundary depend on the observer.

5) CASs are contextually determined

   The inner structure of the CAS is determined by the both patterns of dynamic interactions between the system components and between system components with its environment. In contrast to linear processes, the system boundaries are ambiguous since the system interactions are very strong within the system and with the environment. Therefore, the system are contextually determined based on its functions and context. Once the context change the system will change and the functions of the system components will change.

6) Novel qualities and emerge through complex causality

   This implies that the cause and effect relationship in CASs are neither one directional nor linear. They are complex, recurring and shows a causal path way. Output of one system function can be an input to another interaction whilst small action may cause in to a large and wide impacts. These emergent impacts shows by the system as a whole, difficult to predict and cannot assigned to an isolated system component.

2.3.2 Implementing SES into Principles of CAS

The SES carefully explains the link between the human system (which includes the associated societies, economy, institutions, political system, technology and etc.) and natural system (which includes ecosystem) in a two-way causal relationship (Berkes et al 2014).

CHAPTER THREE

Methodology

3.1 Conceptual Framework

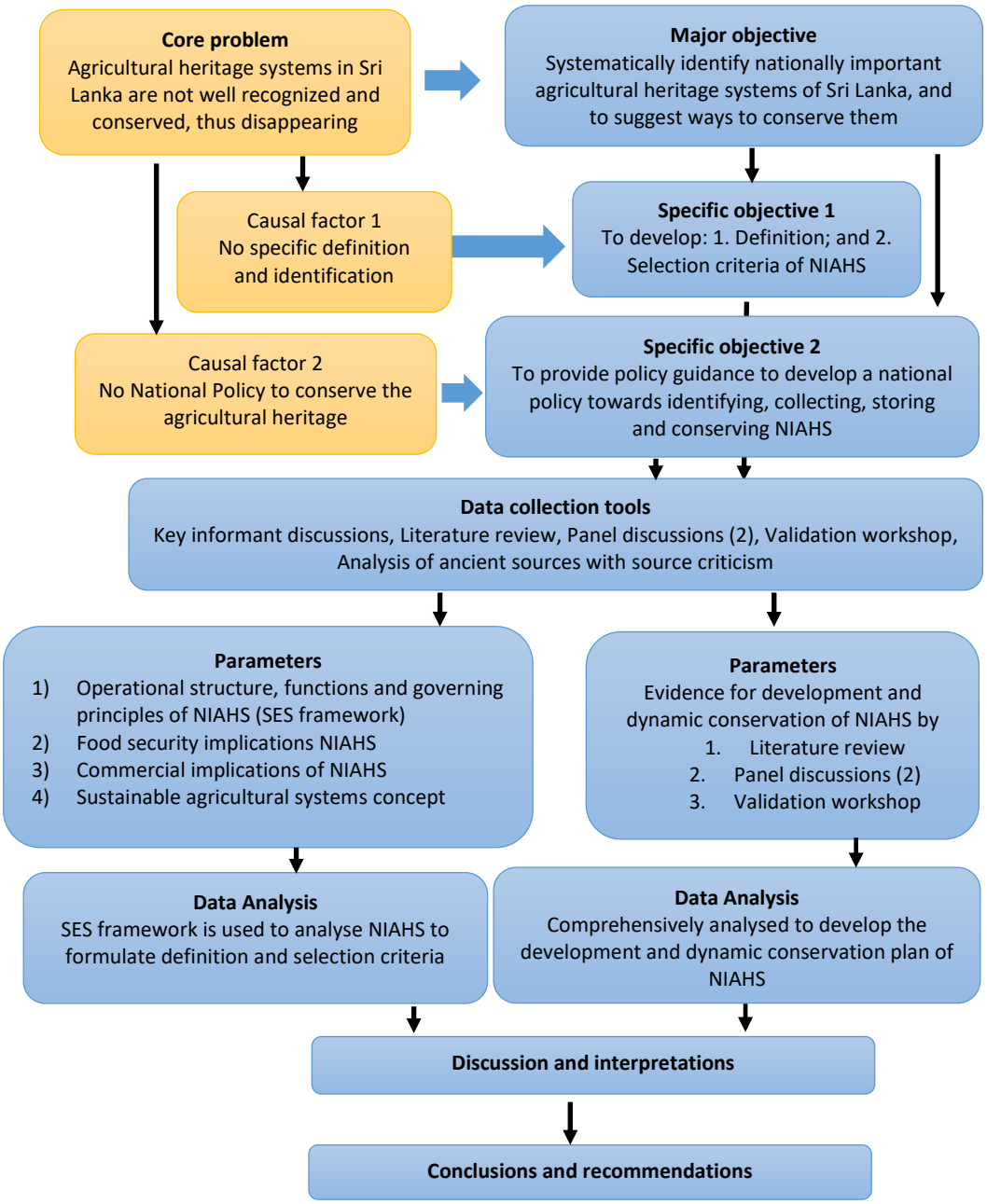


Figure 3.1: Conceptual Framework

3.2 Data

Entire study was mainly depended on qualitative data.

3.3 Data Collection

Both the objectives were carried out by conducting

1. **Literature review**
   A comprehensive literature review was conducted to 1) understand the concepts, definitions, selection criteria and conservation plan of GIAHS and NIAHS of other countries; 2) Existing major agricultural heritage systems of Sri Lanka and their concepts, principles and applications; 3) Identify potential analysis framework to analysis NIAHS of Sri Lanka

2. **Key informant discussions**
   Ten key informant discussions were carried out with practitioners and subject experts those who are engaged in traditional agriculture.

3. **Panel discussions**
   Two panel discussions were conducted to develop the draft definition, selection criteria and to construct policy suggestions towards development and conservation of NIAHS. The two Panel Discussions consisted of 9 members including practitioners of traditional agriculture and subject experts covering all the areas related to traditional agriculture.

   Firstly, a draft definition and selection criteria were prepared based on existing literature and preliminary discussions held with key informants and fine-tuned with the support of subject experts. Afterwards, two panel discussions were held with the selected group of subject experts to discuss the draft definition and selection criteria where their criticisms, comments and concerns could be received. The definition and selection criteria have been then redrafted based on the comments and opinion of the panel members and were circulated among them for their further comments to prepare the final draft.

4. **Validation workshop**
   Once the final draft of the definition, selection criteria and policy suggestions for development and conservation of NIAHS were developed after the two panel discussions, in order to validate and finalise the draft document a validation workshop was held. Participants of the validation workshop included subject experts and potential key stakeholders of development and conservation of NIAHS.

3.4 Data Analysis

Objective 1

Social Ecological Systems Framework (McGinnis and Ostrom, 2014) was used to identify operational structure, functions, governing principles, system sustainability, food security and implications of NIAHS which has ultimately utilized to develop selection criteria and the definition.

Objective 2
By comprehensively analysing information gathered from literature review, key informant discussions and suggestions and opinions given at the panel discussions and validation workshop, the policy suggestions for development and conservation of NIAHS of Sri Lanka was developed.

3.4.1 NIAHS and Social Ecological Systems

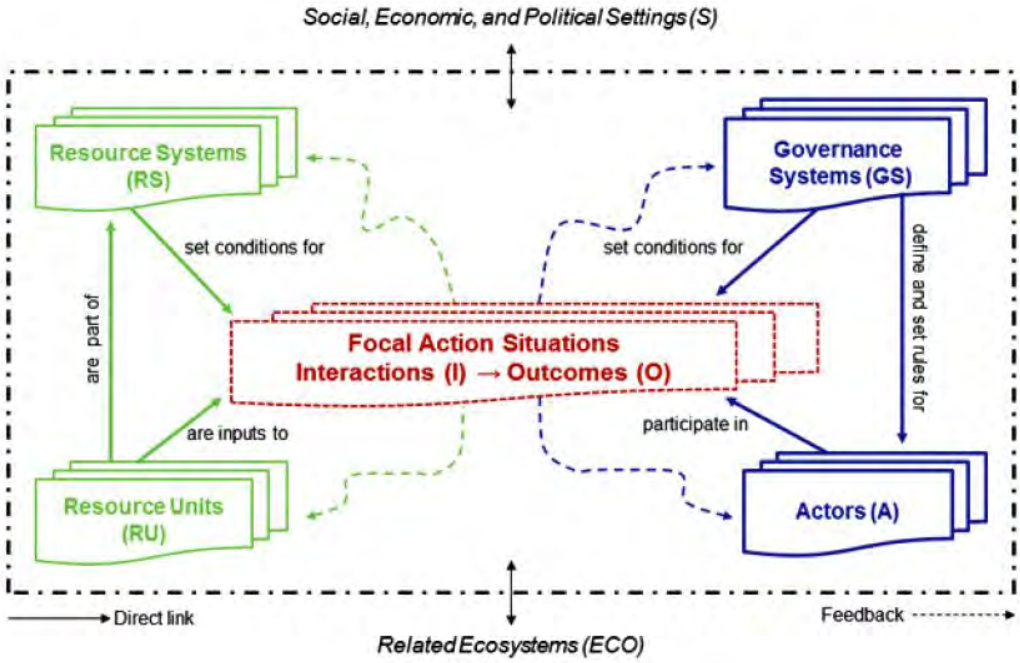
National agricultural heritage systems are social-ecological systems where human system and ecological system interact with each other. As the study objectives imply, to develop the definition and selection criteria of NIAHS, has to recognize the operational structure, functions, governing principles, and food security and food security implications of existing agricultural heritage systems of Sri Lanka. This will allow to recognize their special features and characteristics. SES model is the best way to systematically assess this, as this model helps understand complex interactions and feedback between human and natural systems including relations of people's knowledge, norms, values, economic and political and environmental impacts (Berkes et al 2014). Hence the analysis will help scientifically understand underlying principles for NIAHS, construct selection criteria and understand implication and conservation needs.

There are several existing frameworks to understand and analyse different aspects of SES (Berkes et al, 2014; Petrosillo et al 2015), which are constructed based on diverse research disciplines that SES studies have carried out. For the case of NIAHS Social Ecological Systems Framework developed by McGinnis and Ostrom (2014) was considered as the best suitable framework.

3.4.2 Social-Ecological Systems Framework

Social Ecological Systems Framework (SESF) developed by Ostrom, (2007) a Nobel laurite, has designed to identify the importance of conceptual tiers and linkages among variables of social-ecological systems. The general framework of the SESF includes the top tier variables that scientists can identify when analysing a social-ecological system (Ostrom, 2007; McGinnis and Ostrom, 2014 and Ostrom, 2017). In this system the social system and the ecological system are linked in a way that the interdependencies between the bio-geo-physical system and actors within the social system are visible and can be included and explained. It gives a clear analysis of the complex, nested, multi-resource systems operating over numeral scales. In the first tier it differentiates between components of Resource System, Resource Units, Governance System, Actors and Interactions and Outcomes within Action Situations. Each of these components provides a broad and rough heading to more specific variables which can increase the level of detail for the way that the system can be explained. It includes inputs that will be using, conditions that have impacts on each specific interactions and outcomes at the centre of the framework while the interactions and outcomes deliver feedbacks which will have an impact on any of the variables/components.

Other than this in the SES framework Social, Economic, and Political Setting, and Related Ecosystems are considered as exogenous drivers that have an impact on the environment in which the Resources System and Resource Units, Governance Systems and Actors interact which enable this framework to understand the complexity of the problem which is considered.



Source: McGinnis and Ostrom (2014)

Figure 3.2: Social Ecological Systems Framework

Figure 3.2 depicts a graphical illustration of the Social Ecological Systems Framework (McGinnis and Ostrom, 2014). The tiers indicate different logical categories where lower level tiers consisted with subdivisions of the respective higher tier variable. For an example, from the first tier category "Resource Systems" second tier categories denote subdivisions of the first tier category such as size of the resource system, type of the resource system, clarity of system boundaries. The third tier categories include the sub divisions of the respective second tier category. For instance, considering the second tier category of resource size, third tier variables can include, geographical expansion, number of species interacting in the system (McGinnis and Ostrom, 2014).

Solid boxes denote first tier categories which denotes as follows. 1) RS- Resource System; 2) GS- Governance Systems; 3) RU- Resource Units; 4) A- Actors; 5) S- Social, economic, and political setting; 6) ECO- Related ecosystem; 7) Action situations: Interactions(I)→Outcomes (O) (McGinnis and Ostrom, 2014).

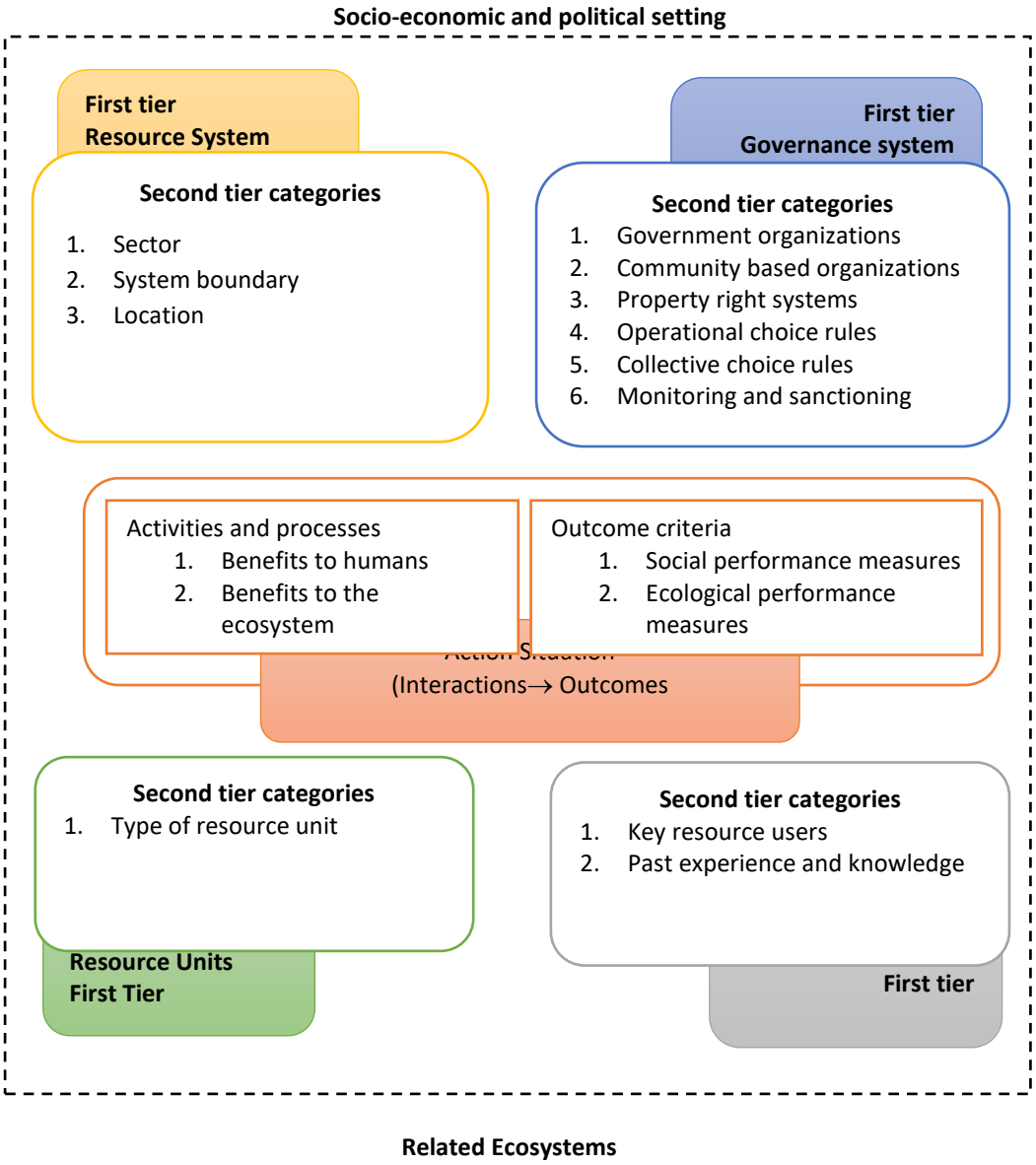


Figure 3.3: Analyzing Village Tank System Complex Using Social Ecological Systems Framework

They have multiple variables at the second tier and lower levels. Action situation is where all the actions take place as inputs are transformed by actions of multiple actors into outcome. Dashed arrows denotes feeds back from action situations to each of the top tier categories. Dotted and dashed line that surrounds the interior elements of the figure indicates that focal SES can be considered as logical whole but exogenous influences from related ecological systems or social-economic-political settings can affect any component of the SES. Exogenous influences might emerge form dynamic operation of processes at larger or smaller scales than that of the focal SES (McGinnis and Ostrom, 2014).

In this study the village tank cascade system complex was used as the potential NIAHS which was analysed using SES framework to identify operational structure, functions, governing principles, system sustainability, food security and sustainability implications of NIAHS which have finally utilized to develop selection criteria and the definition. Figure 3.3 shows a graphical illustration of how village tank cascade system will be analysed using SES framework and what variables of first and second tier categories will be used.

CHAPTER FOUR

Overall Description of Major Traditional Agriculture Systems of Sri Lanka

4.1 Paddy Cultivation Systems

Paddy has been the staple food of the country for centuries. Hence a separate wealth of knowledge has been developed in association with rice farming in the country. Most of the traditional cultivation systems, water management systems, pest and disease management systems, weed management techniques, livestock management systems, land use patterns, soil management techniques, post-harvest handling and plant breeding systems of the country have been developed having a connection towards paddy farming activities.

Traditional paddy farming systems in Sri Lanka include irrigated lowland paddy cultivation (wet sowing, dry sowing/*Kekulama*) and rainfed upland paddy cultivation. Land use patterns of these paddy farming systems are different in different areas based on weather patterns, availability of irrigation facilities and the topography.

This section briefly explains the common agronomic practices and rituals associated with paddy farming in Sri Lanka in general. According to Bell (1882) paddy farming in traditional Sri Lanka always accompanied semi religious rituals and ceremonies. One of the key components with regards to paddy farming is traditional seed systems. According to the key informant discussions had with traditional rice farmers, the breeding system in traditional paddy cultivation is quite interesting. Common practice of traditional farmers is when they go for observation visits to field, if they could find a specific rice plant in the field with superior qualities (Example: Higher number of panicles per plant, higher number of seeds per panicle, pest and disease tolerance, drought or flood tolerance) they collect it separately for breeding purposes. This is applicable to post harvest qualities, palatability and nutritional qualities as well. Therefore, every farmer contributed for breeding activities in this manner and new varieties were found very frequently and continuously. As a result at present there are many traditional rice varieties of diverse properties such as medicinal properties, better taste and aroma, high yielding, pest and disease tolerance, drought/flood tolerance, salinity tolerance, and varieties with diverse maturity ages (Seneviruwan, 2017).

Land preparation for paddy cultivation begins at an auspicious time as advised by the astrologer. Paddy lands, bunds, irrigation channels, jungles near the field are cleared jointly with all farmers. Then the land is ploughed using buffalos. Once the first plough was accomplished the field is left to soak for 18 days before the second plough. Ploughing and water management themselves do the initial weed control in the field. It is interesting to observe that land preparation and field irrigation activities have been developed in a manner that initial weed control activities are also integrated into these activities.

Depending on the water availability dry sowing (*Kekulama*) or wet sowing of seed paddy (pre germinated seed paddy) can be practiced (Endagama and Dayananda, 1998). Availability of diverse types of seed paddy also facilitates this activity. Land preparation was mainly done by buffalos. Therefore, animal husbandry was also an integral part of paddy farming (Ulluwishewa et al, 1996).

Depending on the area of cultivation farmer implements are also found depending upon the soil types present in respective areas. Therefore, equipment such as mamoty and plough had specific shapes in different areas of the country.

Farmers possessed a significant level of knowledge with regards to pest and disease management. Some of those knowledge were written, while some of them were verbally transmitted. Speciality of these pest and disease control methods are that, they use environment friendly methods or ingredients to control them. It can be either physical methods such as water control or day today household ingredients such as wood ashes or extracts of certain tree compounds. These methods only targeted to control the specific pest or disease only. Even when considering the pest control, rather than eradicating the entire population it only tried to maintain the pest population under a certain level where the damage to the paddy crop is minimal. Therefore, the biodiversity in the field was maintained at an equilibrium level (Seneviruwan, 2017).

As mentioned above, traditional paddy farming accompanied semi religious rituals and ceremonies, it also includes various charms which are mainly introduced to cope with emergencies where practical methods are of no avail (Endagama and Dayananda, 1998). Therefore, astrology, spirits and gods, Pirith chanting, Mantras, Yantra, Kem Karma are a separate school of knowledge associated with traditional paddy farming (Dharmasena, 2010).

Traditional paddy cultivation practices also have addressed the seasonal water scarcity issues and other resource limitation in a very practical manner. Bethma cultivation is one of such methods practiced in certain parts of the country which is adopted when the water availability in the tank is not sufficient to cultivate the entire paddy tract. Under Bethma system farmers voluntarily take a collective decision to limit individual cultivation extents and temporary redistribute the upper portion of the paddy tract in a way that each farmer will get mostly a similar portion of land for cultivation (Dharmasena, 2010 and Weerasinghe and Zubair (n.d)).

Thattu Maru and Katti Maru are some other tenure systems which are practiced to avoid over fragmentation of lands when there are multiple owners to same plot of land. The major concept behind *Thattummaru* is that when the same plot of land is shared among two or more people, without physically dividing the land among owners it preserves the right to cultivate for every owner in an annual rotation. Under the *Katti Maru* cultivation practice, land is subdivided among each owner however, rather than giving a permanent ownership to a specific plot of land, it is subdivided in a way that every owner gets to cultivate every plot of land in turns (Moor and Wickramasinghe, 1978).

Water and irrigation management in ancient agriculture systems shows a remarkable milestone of indigenous knowledge. The evolution and development of ancient irrigation system can be broadly categorized into four stages. 1. Small rain water tanks (*Wew kotu*) mostly owned by individuals or family. 2. Village tanks owned and managed by the village community (*Gamica wawi*). 3. Major tanks with fairly big watershed that control by the government (*Maha wawi).* 4. Major tank with comparatively small watershed and inflow and augmented by diversion and feeder canal from a river (*Dana wawi)*.

Out of this, village tank cascade system in the dry zone area is an outstanding and unique product in water resources development. The Department of Agrarian Development defines village tank cascade system (*Ellangawa*) can be defined as "*Hydrologically interconnected series of tanks hanging along the same water way* or network to produce *an ecosystem, where land and water resources are organized within the meso-catchment of the dry zone landscape to generate return flow, recharge ground and perch water and facilitate high degree of water use efficiency through bio-remediation on sustainable basis".* In Sri Lanka there are about 1166 tank cascade systems distributed in North and North Central, North Western, South and South Eastern Provinces and also in 20 major dry zone river basins of Sri Lanka. Tank cascade system can be described as a well-integrated human ecological system where the system ensures a fair, controlled and continuous supply of water to fulfil the needs of both humans and surrounding ecosystem.

Tennakoon (1995) states that key features of tank cascade system can be identified as 1) Each tank in the tank cascade system has adequate volume of water in most of the tanks even in a year of below–normal rainfall. 2) Instituting a regulated flow of water from one tank to another downstream evading temporary detention to minimize breaking of tank bund. 3) Having certain tank which helps to stabilize water table and water holes such as Godawala to fulfil the water needs of village cattle and wildlife. Therefore, the ancient tank cade system can be identified as a combination of multiple systems operating at an equilibrium rather than one single system, which has evolved for centuries by harmonising man made various irrigation structures with agro ecosystem, society and culture, governance system and the ecosystem at large with the aim of not only to fulfil water, food and livelihood security of people but also to fulfil water and various other needs such as food and habitat of the entire ecosystem.

When compared with the dry zone irrigation systems, those in the central province of Sri Lanka show somewhat different features especially due to the topography of the area. A remarkable ingenuity has shown by traditional farmers in the hilly areas of Sri Lanka in the nature of irrigation on steep mountain slopes. The mechanism that they have adopted included scarping of the hills and bringing forward the earth hence removed the front edge of the levelled ground and using of that to construct shallow dams. This has been the main cause to build paddy terraces in hilly areas. Apart from this, they have supplied irrigation water to these paddy terraces by keeping thousands of tiny lakelets. The watercourses of mountain tops had been

carefully studied and every stream is bent to serve every single farmer in the paddy tract. Water channels linking lakelets and streams with paddy fields were done using various materials such as stones, mud, and bamboo and supplied water even for long distances.

4.2 Traditional Upland Farming

Chena cultivation is one of the traditional upland farming methods. It can be described as systematic clearing of the forest and cultivating there for nearly two to three seasons. After two to three seasons the lands are left fallowed allowing to regenerate the forest which will facilitate to restore the forest ecosystem including vegetation cover, soil structure and properties. In addition traditional farmers have divided forest areas into several categories based on the vegetation and the topography as follows. 1) *Mukalana* - Major Forest areas where biodiversity and soil fertility are high. Traditional farmers avoid clearing these forests. 2) *Navadeli Chen-Parshall forest* areas. 3) *Athdandu Chena* - These are forest areas consisted with Chenas left fallowed about ten years back. It consists of forest areas with trees with the girth size of arm of an adult man. Fallow period allows those areas to regain the lost soil fertility and to regenerate the ecosystem. 4) *Landu Chena/Pillewa* - These are the Chena lands situated in the middle of the forest 5*) Illuk Chena - These* are the areas that are covered mostly with grasses probably due to poor soil fertility due to heavy erosion. 6) *Kanathu – Chena* cultivation done very recently. Other than this certain fertile lowland areas covered with grasses are called Deniya (Bandara, 2007; Panampitiya, 2018).

Land use pattern of Chena cultivation can be categorized in to two 1) *Mul Keta Hena* and 2) *Iravili Hena. Mul Kata Hena* implies that a group of farmers cultivate in lands surrounding same epicentre. *Iravili Hena* implies farmers cultivate lands situated horizontally adjacent to each other (Seneviruwan, 2017). According to Bandara (2007) forest clearing process for chena cultivation followed “three tier system of lopping of branches in trees” namely 1) Branch lopping 2) Eye level clearing and 3) Ground level under growth clearing. This has facilitated fast regeneration of the forest cover and restoration of soil fertility.

Crops that are cultivated in Chenas include cereals such as finger millet, Kodo millet *(Amu*), Proso millet (*Meneri*), foxtail millet (Thana hal), green gram, black gram, maize etc., Oil crops such as sesame, vegetables such as ladies finger, tomato, leafy vegetables, spices such as chillie, and upland paddy varieties (Al wee) (Bandara, 2007). Cultivation in traditional chena lands begins with the second inter-monsoonal rains occurred in mid-September (*Binara Kaluwa*). Traditional farmers tend to sow a mixture of crop seeds in the chena lands thus, they can get yield throughout the cultivation season upon the maturity of each crop). According to Ulliwishewa et al (1994) during years with poor rainfall chena cultivations are the major form of production and survival of local people. However, other than ensuring livelihood security maintaining crop diversity had other benefits as well such as easy pest and disease control, maintenance of regular and continuous ground cover to prevent soil

erosion during heavy monsoonal rains and ensuring food and nutritional security. Cotton plants will be the last plants remaining in the chena lands and according to folklore traditional villagers harvest these cotton plants to weave cloths. However, even an abandoned chena land can help ensure food security to people to a certain extent since villagers could harvest freely growing vegetables in the fallowed chena lands such as ladies fingers, cucumber and pumpkins. Once the cultivation season is over farmers allow the land to fallow and they will return to the same land again after several years. Thus, it can be observed, that special ways of land management among chena cultivations where ecological balances within these lands were preserved (Seneviruwan, 2017).

Seed requirement for chena cultivation was met by farmers themselves. They have preserved the seeds for next season by keeping them in *Dum Massa* and *Atuwa* after careful sorting from the current season harvests. Apart from this they have used bamboo containers, *Labu Kataya* and *Wee Bissa* to store seeds. To prevent damages from various insects and pests they have placed medicinal leaves inside these containers (Ulliwishewa et al, 1994).

Apart from physical and manual methods, similar to paddy cultivation religious rituals, ceremonies, charms and *Kem Krama* were also used in pest and disease management of chena cultivations as well (Bandara, 2007).

4.3 Home Gardens

Depending on the geographic location, cultural background, and socio-economic condition of the households, home gardens have been developed in different areas of the country. It is an ideal form of land use by combining agriculture, forestry and livestock. Home gardens in Sri Lanka can mainly be divided into two groups as wet zone forest gardens and dry zone home gardens. Dry zone home gardens consist of diverse combination of trees, shrubs, vines and herbaceous plants. Compared to forest gardens the tree density is lower in the dry zone home gardens. However the species diversity is high due to presence of multi-layered diverse plant species (Ginigaddara, n.d).

Forest gardens are situated around the mid country region of Sri Lanka covering the districts of Kandy, Matale, Kegalle Kurunegala and Ratnapura. It represents an extremely diversified group of perennial mixed cropping system comprised of various tree crops with numerous uses and to lesser extent livestock. It is a century old sustainable agricultural system. It consists of perennial food crops, fruit crops, vegetables, root and tuber crops, medicinal plants, spices, and timber crops. The functionality of this system ensures food and nutritional security of the households whiles giving livelihood opportunities by providing wide range of marketable and subsistence products which help households to get economic benefits. Further, it provides large number of ecosystem services for humans and habitat for wildlife (Pushpakumara et al, 2010).

4.4 Livestock Systems

In traditional Sri Lankan agriculture, livestock was mainly used for agricultural purposes, transportation and to fulfil the nutritional requirement of farming households. Both cattle and buffalos were used in livestock management (Ariyasena, 2009; Ulluwishewa, 1996). They were managed in the free range system and when they are not used for any activity they were allowed to roam in areas of the village that are designated for them (hamlet buffer) and feed. This has in return help increase the soil fertility of the hamlet buffer (Dharmasena, 2010).

Both cattle and buffalo were used in land preparation and threshing crop harvesting activities. They were mainly used for ploughing and harrowing. In addition to land preparation, walking them on the paddy field help formation of the soil hard pan which is vital for water retention in the field. In addition, their excreta help increase the fertility of the soil (Ulluwishewa, 1996).

Livestock was also essential for household nutritional security. The general perspective of the traditional society was that households who own livestock are comparatively well off. Livestock has contributed to ensure nutritional security by providing milk, curd and gee for households (Ariyasena, 2009; Karunaratne, 2004).

Other than above the livestock was also used for transportation and to operate instruments such as oil extractors (Ariyasena, 2009).

Due to social norms and values influenced by religious believes, despite the uses taken from livestock they were treated with respect and never reared for meat (Ariyasena, 2009). A separate knowledge system has been developed based on the medicines given to illnesses of livestock which is known as ethno-veterinary practices (Ariyasena, 2009; Karunaratne, 2004).

4.5 Fisheries Systems

According to rock inscriptions inland fishery systems in Sri Lanka dates back to third century BC. The inland fisheries sector in Sri Lanka was mainly developed in association with reservoirs and channels in the Anuradhapura era. According to stone inscriptions there had been situations where certain tax is charged for the share of fish caught in the channels. The tax was called as “Matera majibaka” (Siriweera, 1996).

The major equipment to catch fish includes hook (*Bili*), net (*Jala),* karaka and the long basket fish trap called *Kemana*. This long basket of fish trap was positioned in flowing water in channels and streams. The fish that entered into the basket cannot find a way to escape so people can catch them. One of the other methods of catching fish is practiced during drought period by introducing different toxic inedible fruit species into water holes. Consequently, the fish become unresponsive which makes it easy to catch them (IUCN, 2002).

CHAPTER FIVE

Developing Definition and Selection Criteria for NIAHS of Sri Lanka

5.1 Developing Definition and Selection Criteria for NIAHS of Sri Lanka

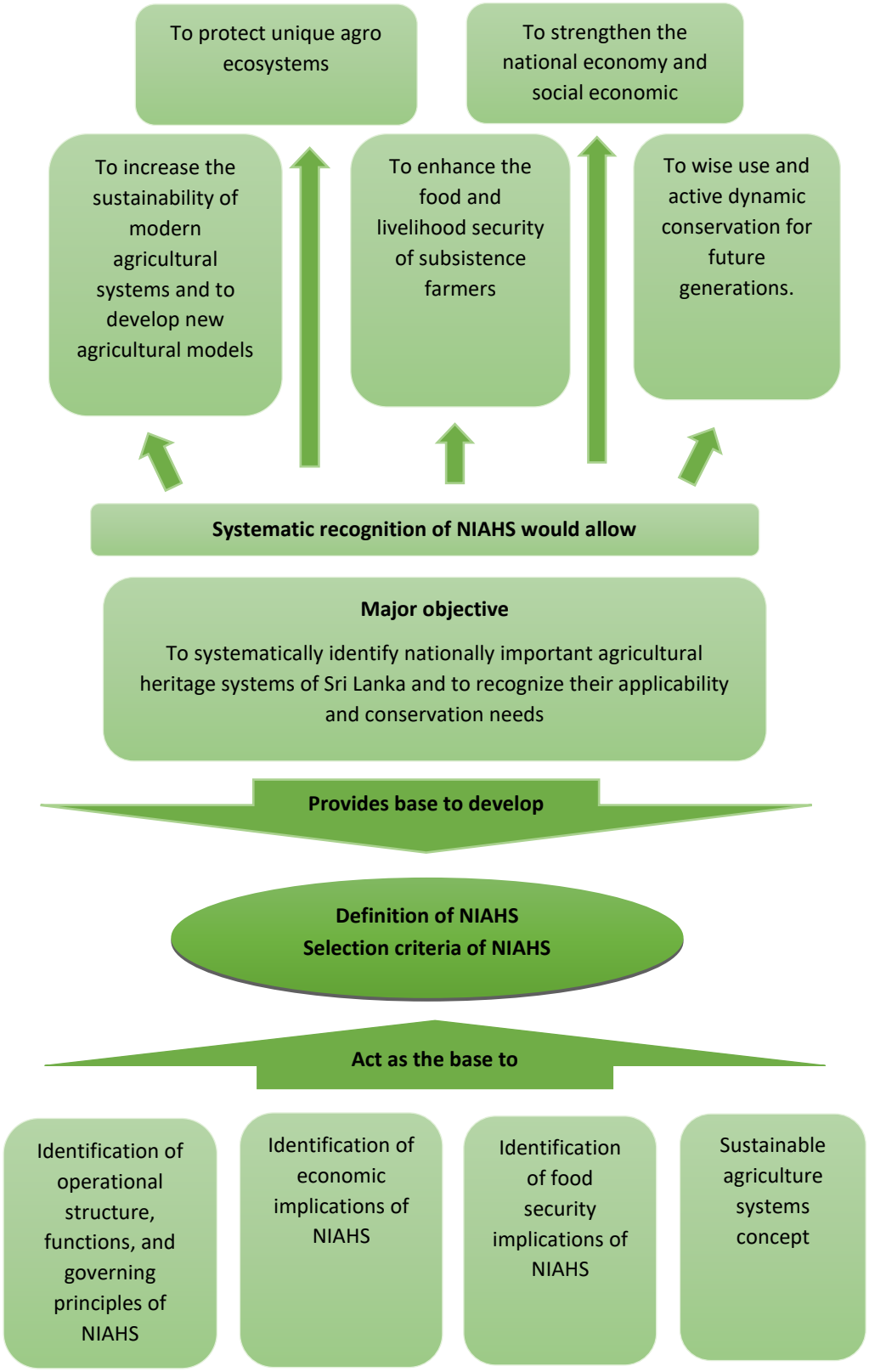
As discussed in the Methodology Chapter with the understanding of the social ecological systems framework to analyse NIAHS and common traditional agricultural systems of Sri Lanka this section focuses on developing the definition and selection criteria for NIAHS of Sri Lanka.

The Definition and selection criteria provide a commonly agreed framework for evaluating and selecting NIAHS of Sri Lanka. Figure 5.1 illustrates the framework designed by the study team to develop the definition and selection criteria for NIAHS.

Developing the definition and selection criteria primarily focused on two factors. Firstly, the main purpose or the expected outcomes of the study. The definition and selection criteria should have the ability to meet this purpose or the expected outcomes of the study. Secondly, base factors that can be used to develop the definition and selection criteria. The base factors considered in developing definition and selection criteria are identified as shown below.

1. Identification of operational structure, functions, and governing principles of potential NIAHS.
2. Identification of economic implications of NIAHS.
3. Identification of food security implications of NIAHS.
4. Implications of sustainable agriculture systems concept.

The following sections explain the above factors in detail.



Source: Conceptualized by the Authors

Figure 5.1 Framework for Developing Definition and Selection Criteria of NIAHS

5.2 Main Purpose of Systematic Identification of NIAHS

The main purpose of systematic identification of NIAHSs can be broadly described as to recognize and conserve glorious and time-tested, outstanding traditions of human ingenuity in harnessing precious resources to provide safe food, and livelihoods and protect unique ecosystems and to maintain the balance between conservation, sustainable adaptation and socio-economic development through multi stakeholder support. Systematic study of these systems in detail would pave the way to understand the knowledge embedded in agricultural heritage systems comprehensively. That would help adapt and use them wisely under the present scenario and conserve them for present and future generations for their active and passive use, as explained below.

1. To increase the productivity, coping power, resilience, and sustainability of existing modern agricultural systems and to develop new agricultural models.
2. To protect unique agro ecosystems
3. To enhance the food and livelihood security and living standards of subsistence farmers.
4. To strengthen the national economy and socio economic development by providing opportunities for ecotourism and agro-tourism. This will be further helpful in improving income levels and living standards of traditional farmers, ultimately contributing to rural development.
5. To dynamically conserve them for future generations for their active and passive use.

5.3 Selected Base Factors to Develop Definition and Selection Criteria of NIAHS

Once the importance of systematic recognition of NIAHSs is understood, the study has examined the factors to be taken as bases to develop selection criteria. The principle is that the definition and selection criteria should possess the ability to serve the expected outcomes of the systematic identification of NIAHS. Therefore, the base factors should give a comprehensive understanding of the unique characteristics of traditional agricultural systems, their implications on wise and active use at present, and conservation needs. Therefore, after careful consideration, following four factors were identified as base factors.

1. Identification of operational structure, functions, and governing principles of NIAHS.

Identification of operational structure, functions, and governing principles allows to understand the functioning, dynamics, inter-linkages, and feedback mechanisms of these sustainable systems, which are necessary to comprehend their unique characteristics or system ingenuity. The “Village tank system” a well-known traditional agricultural system that encompasses a depth of ingenuity, was selected and studied for this purpose using the Social-Ecological Systems framework.

2. Identification of economic implications of NIAHS.

An agricultural system will have a value when the agricultural activities are continued. For agricultural activities to continue, farmers or practitioners must actively engage in farming activities. For that, a conducive environment should be created for farmers to engage in traditional agricultural activities (Seung-Seok, 2021) continuously. Since these systems are at the verge of disappearance due to widely spreading commercial agriculture, one of the potential ways to keep practitioners continuously engaged in traditional agriculture is to make them into income-generating activities. Due to these systems' ecological, cultural, and aesthetic value, there is a high potential of using them in agro-tourism and ecotourism activities. It will not only uplift the income levels of farmers thus contribute to rural development but also can contribute to the national economy. Nevertheless, it also can contribute to the dynamic conservation of these systems.

3. Identification of food security implications of NIAHS.

As discussed in previous chapters, these systems have ensured traditional subsistence farmers' food and livelihood security for centuries amid various climatic, social, economic, political, and cultural upheavals. In the present context, where the food and livelihood security of the majority of resource-poor farmers are prone to external shocks, the ability of these systems to ensure food security during external shocks is a notable factor to be considered as it has applicability to the current scenario.

4. Sustainable agriculture systems concept.

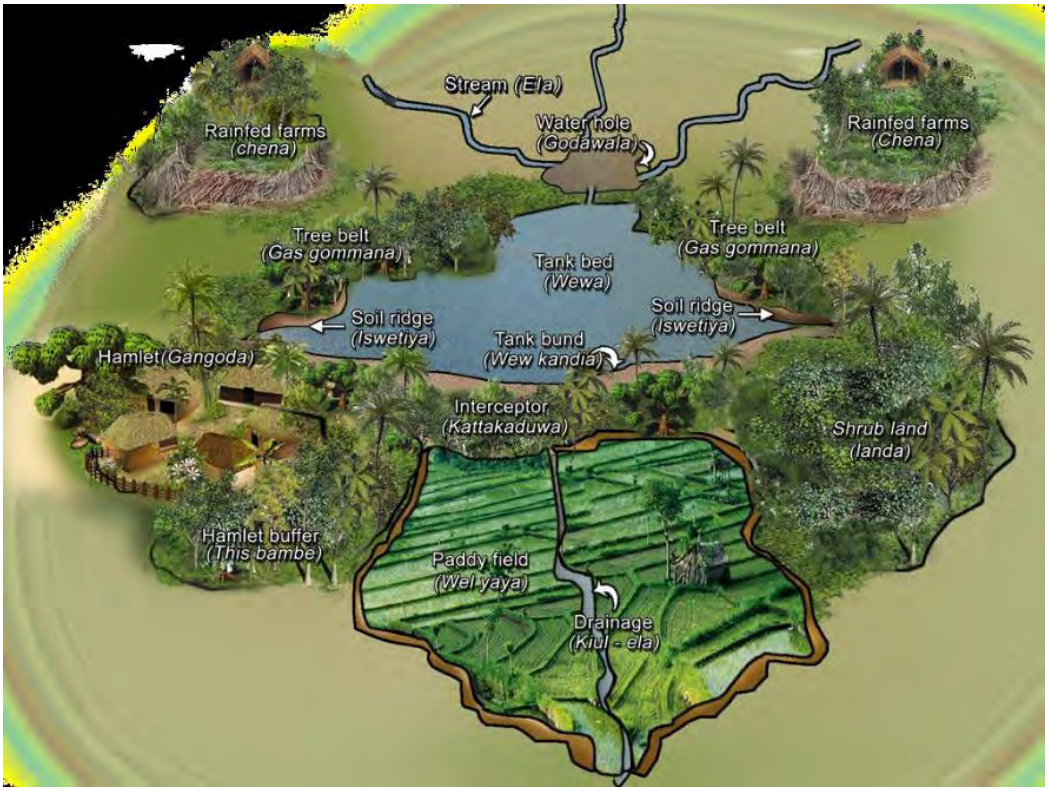
According to FAO, sustainable agriculture implies "*meeting needs of present and future generations, while ensuring profitability, environmental health, and social and economic equity* (FAO, 2021)." It includes five key principles as follows. 1) Increase productivity, employment and value addition in food systems. 2) Protect and enhance natural resources. 3) Improve livelihoods, and foster inclusive economic growth 4) Enhance the resilience of people, communities and ecosystems. 5) Adapt governance to new challenges.

Since one of the critical implications of NIAHS is their nature of sustainability, concepts and principles of sustainability forms the final base factor when developing selection criteria for NIAHS of Sri Lanka.

5.4 Identification Operational Structure, Functions and Governing Principles of Agricultural Heritage Systems Using Social-Ecological Systems Framework

5.4.1. Identification Operational Structure, Functions and Governing Principles of Village-Tank System Using Social-Ecological Systems Framework

Dry Zone village tank system which can be also identified as a village-agro-eco complex (Ulluwishewa, 1996) is one of the key agricultural heritage systems in Sri Lanka. Village tank system can be identified as a complex social-ecological system, which consists of diverse components.



Source: Dharmasena, 2010

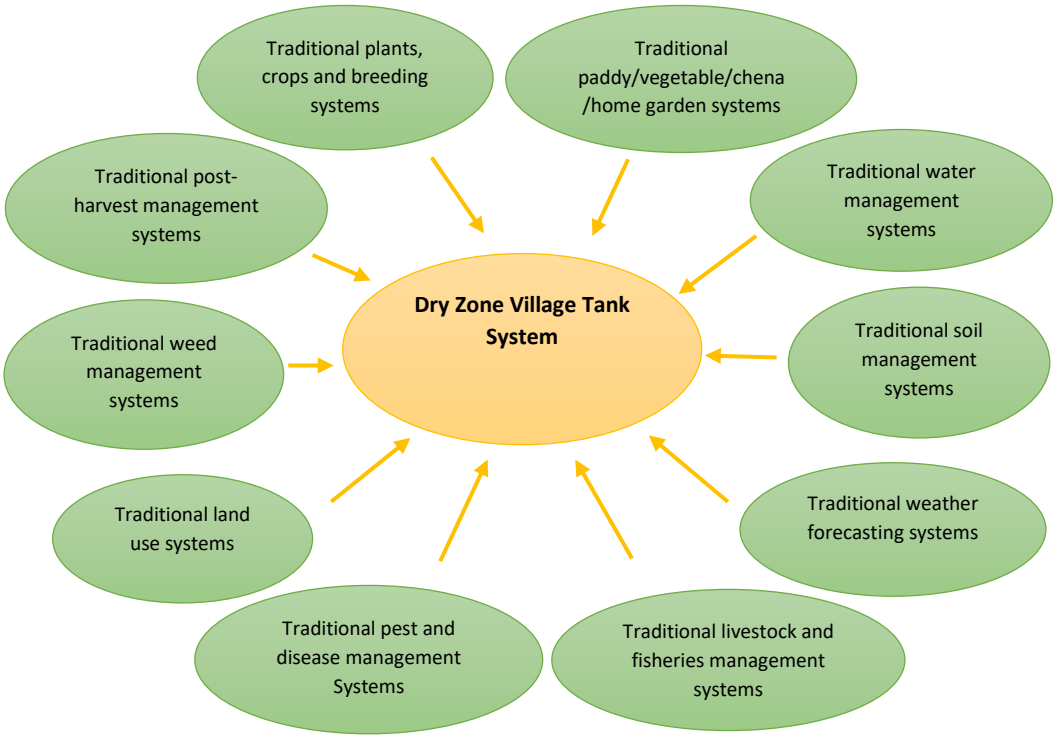
Figure 5.2: Village Tank System in the Dry Zone of Sri Lanka

The village tank system was evident in most of the dry zone areas of the country. It is believed that the pioneering people who have started settling in the dry zone of Sri Lanka, started constructing small structures to store water to use during dry seasons. Eventually with the time, the villagers have developed a unique and ingenious knowledge to construct tanks to store water. Sustainable village or Village tank cascade needs precise identification of location that should qualify with required surface as well as sub-surface conditions to cater the human as well as environmental needs. How, the ancient people identify such location and trace the required gradient for long irrigation canals including *yoda- ela* are still unknown. Depending on the location where the tank is constructed, a tank-village complex is built by the villagers which consists of diverse interdependent and interactive components. As depicted in figure 5.2 major components of the village tank system can be identified Watershed area, tank bed, tank bund including sluices and spillways come under headworks, Irrigable area (Paddy tract), irrigation canals, canal structures, drainage canal (*Kiul ela*), etc. come under command area and tree belt at the periphery with meadows, water hole, Interceptor (*Kattakaduwa)*, Soil ridge (*Iswetiya)*, Shrub land, Hamlet buffer (*Thisbambe*) and Village hamlet (*Gangoda)* are some of the ecological components identified so far. Tank bed area is sub-divided in

to four layers as *mada kaluwa* (Dead storage), *Diya Gilma* (Full supply level), *Wan Gilma* (High flood level- normal) and *Thawalla* (High flood level- cyclonic). Every component of village tank system has been designed to perform diverse tasks to operate collectively and to give multiple outputs (Dharmasena, 2010).

Chena cultivation was practiced in the uplands situated in the either side of the watershed. Paddy fields were situated in the immediate downstream area of the tank allowing a space for interceptor. The village hamlet was situated in the side of the paddy fields. Most of the households owned few cattle and buffalos which are used for cultivation activities, transportation and to fulfil nutritional requirements. Hamlet buffer area was used as their feeding grounds and resting place. There were certain structures associated with the tank such as interceptor (water purification before entering in to paddy fields and as a wind barrier), soil ridge to control surface runoff that leads to soil erosion and sedimentation, tree belt that works as a wind breaker to reduce evaporation from tank bed and minimize tank bund erosion, waterhole (up stream sediment trap) which have designed to perform a specific task. (Dharmasena, 2010). All these ecological elements are identified as bioremediation techniques introduced to acquire high degree of water use efficiency and durability of irrigation structures.

However, as shown in the figure 5.3 including the above discussed physical structures, village tank system can be identified as a combination of multiple systems operating as a whole to give multiple goods and services to the associated human-ecological system. Figure 5.4 illustrates how to analyse village tank system using Social-Ecological Systems Framework.



Source: Conceptualized by the Authors

Figure 5.3 Associated Systems of Village Tank System

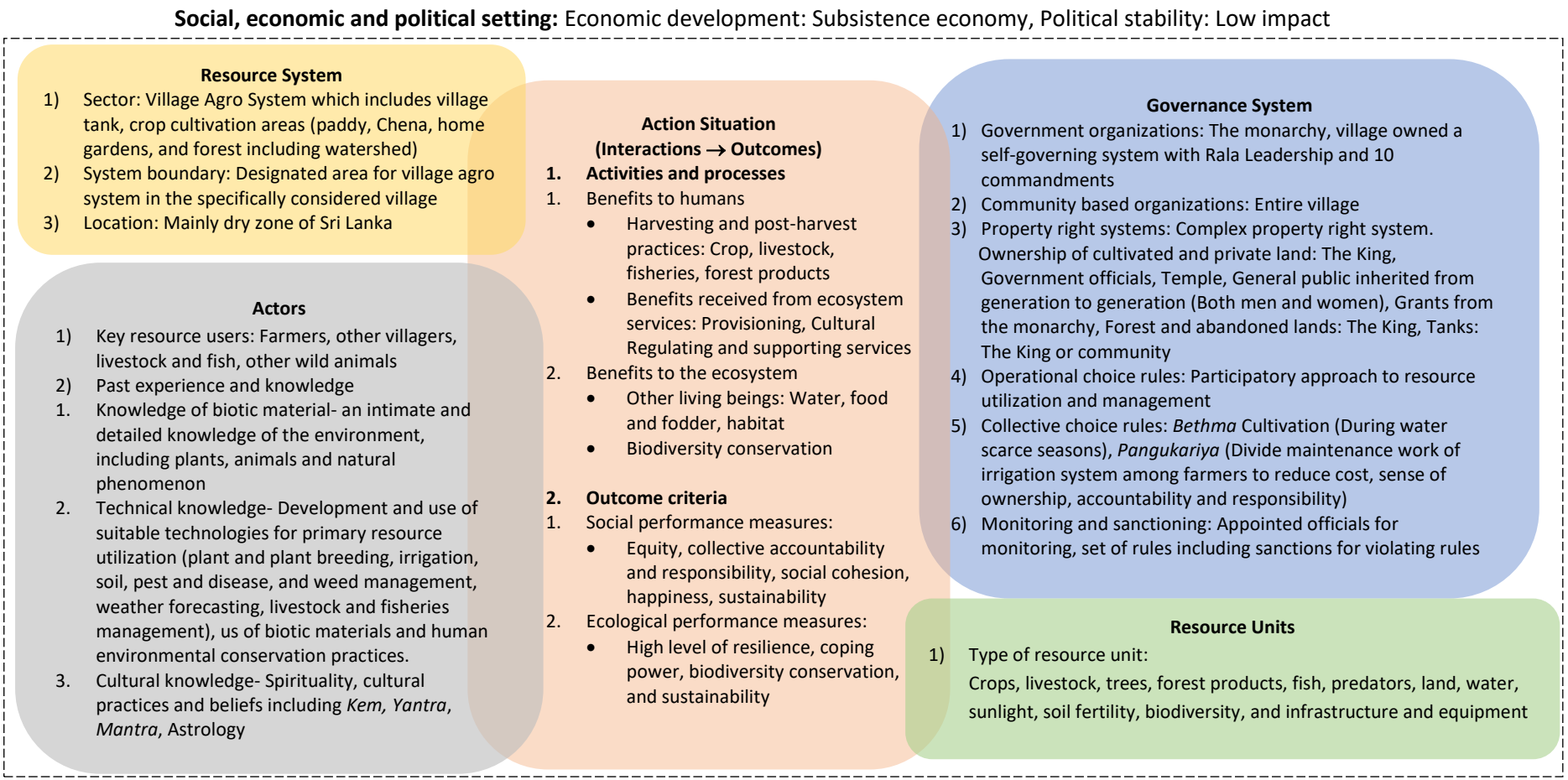


Figure 5.4: Traditional Village Tank System Complex Analyzed Using the Social Ecological Systems Framework

1. Resource System (RS)

Village tank system is a complex social ecological system consisting of multiple resource systems such as Tank environs, Chena cultivation systems, Paddy land system, Home garden systems, Forest and watershed areas, and Human settlement areas. It spreads over the whole tank cascade system. The system contains many tanks as a cluster. However, all these systems operate together as a whole. The village boundary is the boundary of this whole system. Size of the resource system depends on the size of the village and other system components.

RS1: Human constructed facilities.
There are many human constructed facilities in this resource system. As we believe entire tank based irrigation system is human constructed. Further, paddy lands, Chena cultivations, village hamlet are also constructed by humans. All the designing and constructions are done based on the knowledge and experience received from generation to generation.

RS2: Productivity of the system
The agricultural production mainly focuses on fulfilling **subsistence needs** of people. It ensured food and **nutritional requirements of subsistence farmers** throughout the year irrespective of the climatic variations and variations of the exogenous factors such as political, economic and social setting. In addition to food and nutritional needs, the system provided other basic needs of people such as water, raw materials for housing and other household item construction. However, one of the key factors is, other than fulfilling human needs, the system provided food, fodder, water and habitats for other wild animals. This emphasizes **respecting the rights of whole living beings** in the system. Even though the productivity is relatively low compared to modern agricultural systems **input usage is also low**. Therefore, in the case of a crop failure, **loss to the farmer is minimal**. The usage of external resources are also minimal in the system. Inputs are produced within the system and after consumption of out puts rest is recycled or reused. Therefore, the system is more or less a **circular system**. Therefore, the system is environmentally friendly. Emission or usage of non-renewable energy sources is minimal. Thus, it **operates within the green stripe of the earth**.

However, in terms of ecological productivity, and social productivity derived by the additional social value immerging from better social relationships are high in this system which is an addition to the generally spoken economic productivity.

RS3: Equilibrium properties
An equilibrium is a steady state that the system is operating at where all the organisms of the ecosystem are in balance with their environment. In a village agro complex human intervention to change the population density of other living beings is minimal. Unlike modern agricultural systems, especially during pest and disease management where most of the target eradication of insect pests are happening, in

traditional agriculture pest and disease control methods use **environmentally friendly techniques or ingredients**. It can be either physical methods such as water control or day to day household ingredients such as wood ashes or chemical methods such as extracts of certain tree compounds. Even when considering the pest control, **rather than eradicating** the entire population it only tried to maintain the pest population under a certain level where the damage to the crop is minimal and the natural pest-predator ratio is maintained (Dharmasena, 2010). Other than this they have also kept the paddy fields and surrounding areas in a way that **life cycles and food chains are operating in the natural manner**. Therefore, system itself keep insects and pests under control using natural predators without letting it reaches threshold level. These methods only targeted to control the specific pest or disease only. Therefore, the biodiversity in the field was **maintained at an equilibrium level**.

RS4: Predictability of system dynamics

System dynamics include systems resistance/coping power and resilience. Resistance or the coping power implies the systems' ability to remain at its' equilibrium after facing an external shock. Resilience is the speed at which the system can reach to its' original equilibrium after a shock. Since these village agro eco complex systems have been remained same for centuries along with all the climatic, political, economic, social changes even without human interventions it implies these systems are both **resistant (which indicates its' coping power)** and **resilient** to external shocks.

RS5: Location

These systems are very prominent in the dry zone of Sri Lanka where the advantage of North east monsoon cannot be fully utilized. They were developed to withstand extreme water scarce situations where humans defeat a great environmental challenge in the world in a sustainable manner.

2. Resource Units (RU)

Crops, livestock, fisheries, trees, non-timber forest products, water, solar radiation, soil fertility and biodiversity can be taken as major resource units.

RU1: Interactions among resource units

There is a high level of **interaction and interdependency** between these resource units (Ulluwishewa, 1996).

1. Crop-livestock

Crops and livestock can be identified as interacting and interdepending resource units which also can be identified as a system. Buffalos and cattle were used in land preparation and transportation. Meanwhile excretes of buffalos and cattle were used for soil fertility improvement. Walking of cattle and buffalo in the fields helped

formation of hard pan in the field which is vital for field water retention. Crop residue were fed to cattle and buffalos ((Ulluwishewa, 1996).

2. Crop-fisheries Systems

Paddy fields are kept filled with water time to time for weed management during every season. Therefore, along with irrigation water, fish species also enter into the paddy fields. These fresh water fish species have the ability to survive in low water levels and breathe atmospheric oxygen. Therefore, village communities tend to catch these fish species during dry spells and fulfil their protein requirements (Ulluwishewa, 1996).

Other than that, fish species living in the paddy fields feed on certain insects and pests which is helpful in insect pest management. In addition, fish excretes help increase soil fertility. Movement of fish species inside the field increase soil aeration (Ulluwishewa, 1996).

However, even though separate interactions and inter dependencies can be identified among diverse resource units they operate as **one whole integrated multitier system** and fulfil needs of both humans and animals (Ulluwishewa, 1996).

3. Actors (A)

Farmers, other villagers, livestock and fish, other wild animals can be identified as key resource users.

A1: Socio economic attributes

Mainly consist of village level farming community at subsistence level

A2: Leadership

Traditional leadership was accepted and granted to a well experienced and knowledgeable farmer who will maintain equity based justice and wise-use policy. Leadership consists of few village champions *Gamarala, Kapurala, Danumathi rala, Siwurala, nekethrala*. This is the *Rala* Leadership.

A3: Past experience and knowledge

Villagers are inherited with traditional indigenous and ingenious knowledge and technologies which are evolved based on experiences. **They kept what is useful while removing what is not suitable** (Dalupotha, 2011). This philosophy was inbuilt with their agriculture and day to day activities in terms of traditions and customs in the rural agricultural society which seems unique and remarkable.

The **knowledge that traditional farmers** possess can be divided into three key areas as follows (Kumaran, 2007).

1. **Knowledge of biotic material**- this includes an intimate and detailed knowledge of the environment, including plants, animals and natural phenomenon (Kumaran, 2007).
2. **Technical knowledge**- Development and use of suitable technologies for primary resource utilization such as plant and plant breeding techniques, irrigation, soil management, pest and disease management, and weed management, weather forecasting, livestock and fisheries management, use of biotic materials and human environmental conservation practices (Kumaran, 2007). For example center of the system was the tank. Construction of tank was based on the topography and geological characteristics of the land. Gently undulating to undulating land surface that is characterized by the occurrence of large number of small inland valleys are perfect for construction of small reservoirs or tanks (Panabokke et al, 2002). Other than this the soil type and geology of the area is also considered. For example, even though a low lying area with a continuous water supply will not be suitable to construct a land unless suitable soil qualities are there (Witharana, 2021). Based on the location of the tank rest of the components are designed and constructed. Therefore, these systems are **well designed to fit into the natural environment**.

3. **Cultural knowledge** - Apart from above two knowledge bases, traditional cultivation practices were also based on spirituality, which was adopted from Buddhist philosophy. In addition, this was also accompanied by semi religious rituals and ceremonies, including various charms which are mainly introduced to cope with emergencies where practical methods are of no avail (Endagama and Dayananda, 1998). Therefore, Pirith chanting, astrology, worshipping spirits and Gods, *Mantras, Yantra, Kem Krama* are a separate school of knowledge associated with traditional paddy farming (Dharmasena, 2010). This is the cosmo-spiritual dimension of traditional knowledge systems. This dimension is important not only in terms of the knowledge embedded in these systems, but also had it provided psychological strength, relief and happiness to face during uncertainties.

4. Governance System (GS)

GS 1: Government organizations
Villages were governed under the monarchy and there were local government representatives at village level

GS 2: Community based organizations
Entire village acts as an organization in collective work

GS 3: Property right systems
Property right system was very complex in traditional villages. Cultivated and private lands in the village can be owned by either the king, government officials, temple, villagers as they inherit land from their ancestors, and as village grants received from the king. However, both men and women could own lands which represents **gender**

equality prevailed in Sri Lankan culture compared to other cultures in the world (Siriweera, 1993).

Common properties such as forest and abandoned lands were mainly owned by the king. The tank can be either community owned or owned by the king (Siriweera, 1993).

GS 4: Water Right
Water right for agriculture is an inbuilt part of land right in traditional agriculture system in Sri Lanka. Truly speaking, it is not a just right but a privilege acquired by villagers by undertaking responsibility based on the duty (*Rajakartiya*) what is accepted as the first priority in their life. Those who are entitle to use tank water are also compelled to undertake irrigation maintenance works, water distribution and protection of farm-lands from the wild animals etc.

G 5: Operational choice rules
During resource utilization primarily participatory approach was used. Starting from tank construction, maintenance, land preparation until harvesting participatory and labour sharing approaches were adopted.

GS 5: Collective choice rules
When the resources are scarce **fair division of resources** could be observed. *Bethma* cultivation is one of such methods which is adopted when the water availability in the tank is not sufficient to cultivate the entire paddy tract. *Pangukariya* is another such method which divides maintenance work of irrigation system among farmers to **reduce the cost**, while giving **shared sense of responsibility, accountability and ownership** to villagers (Siriweera, 1993).

GS 6: Monitoring and sanctioning
There were appointed officials such as *Gamarala* for monitoring tanks and cultivation lands. There were **set of rules to practice** which will enhance the **longevity resources** and **optimum resource utilization**. For example, in the village there were ten orders for villagers to obey which is known as "*daha ana"*. These orders cover all aspects including maintaining water security, environmental protection and food security (Dharmasena, 2012). Rules also included utilizing tank water for livestock, household activities such as drinking, washing and bathing which have focused on maintaining water quality and quantity. There were also set of rules to be practiced during tank bund clearing which focuses on the longevity of tank bund. There were methods of sanctioning for violating rules (Siriweera, 1993).

5. Action situation

This section illustrates where interactions happen between all the system components which give rise to collective outcomes.

Activities and processes (I)
With regards to activities and processes in this system, two types of activities can be identified considering humans and the entire ecosystem.

I 1: Benefits to humans
Major activities can be identified as harvesting and post-harvest practices of crops, livestock, fisheries and forest products. Unlike in the case of modern agricultural systems, since the entire system is considered as a one whole well balanced ecosystem, system provides all the **provisioning, cultural, regulating and supporting services to humans rather than merely harvest of agricultural products.**

I 2: Benefits to the ecosystem
System provides food, fodder, water, and habitats for other living beings while conserving the biological diversity.

5.5 Outcome Criteria (O)

O 1: Social performance measures
High level of equity (in terms of resource use, decision making and gender), Collective accountability, Collective responsibility sharing, Collective decision making, Social cohesion, Contentment, Satisfaction and happiness, Respect to life, and Sustainability. Rural farmers who were spiritually guided by the monastery believed that satisfaction is the most valuable wealth in their life.

O 2: Ecological performance measures
Resilience, Resistance/coping power, Biodiversity conservation, Autonomous cycle, Bio remediation, Sustainability

5.6 Formation of Sustainable Indigenous and Ingenious Agricultural Systems

Based on the above comprehensive analysis of the village tank system complex the process of formulating a sustainable, indigenous, and ingenious agricultural system can be illustrated as shown in the figure 5.5.

Initially there is the human system and the environment. At any given time, environment provides four major types of services as provisioning, regulating, cultural and supporting to humans. However, based on the human needs (food, water, shelter, livelihoods, security, health and social relations) they interact with the environment and change the environment. Based on that, the services provided by the environment can be changed. This is typical for any type of human-environment system.

In the case of traditional agriculture systems of Sri Lanka, considering village tank system of the dry zone, people have interacted with the environment to fulfil their needs. However, when considering their interaction, they started doing considerable

changes in the environment due to hardships that they faced when fulfilling their needs. Especially with regards to food, water and livelihood security which are always at a stake due to frequently occurring dry spells in the dry zone. Yet, when making adjustments to the environment they have followed certain principles which include norms, values, and customs mainly moulded by Buddhist religious principles such as vital human values of loving kindness, compassion, empathetic joy and equanimity. This has made the changes done, non-destructive to the nature or to the rest of the living beings.

These interactions that the villagers had with the surrounding agro-ecological system have led to gradually develop into three separate major knowledge systems as mentioned below.

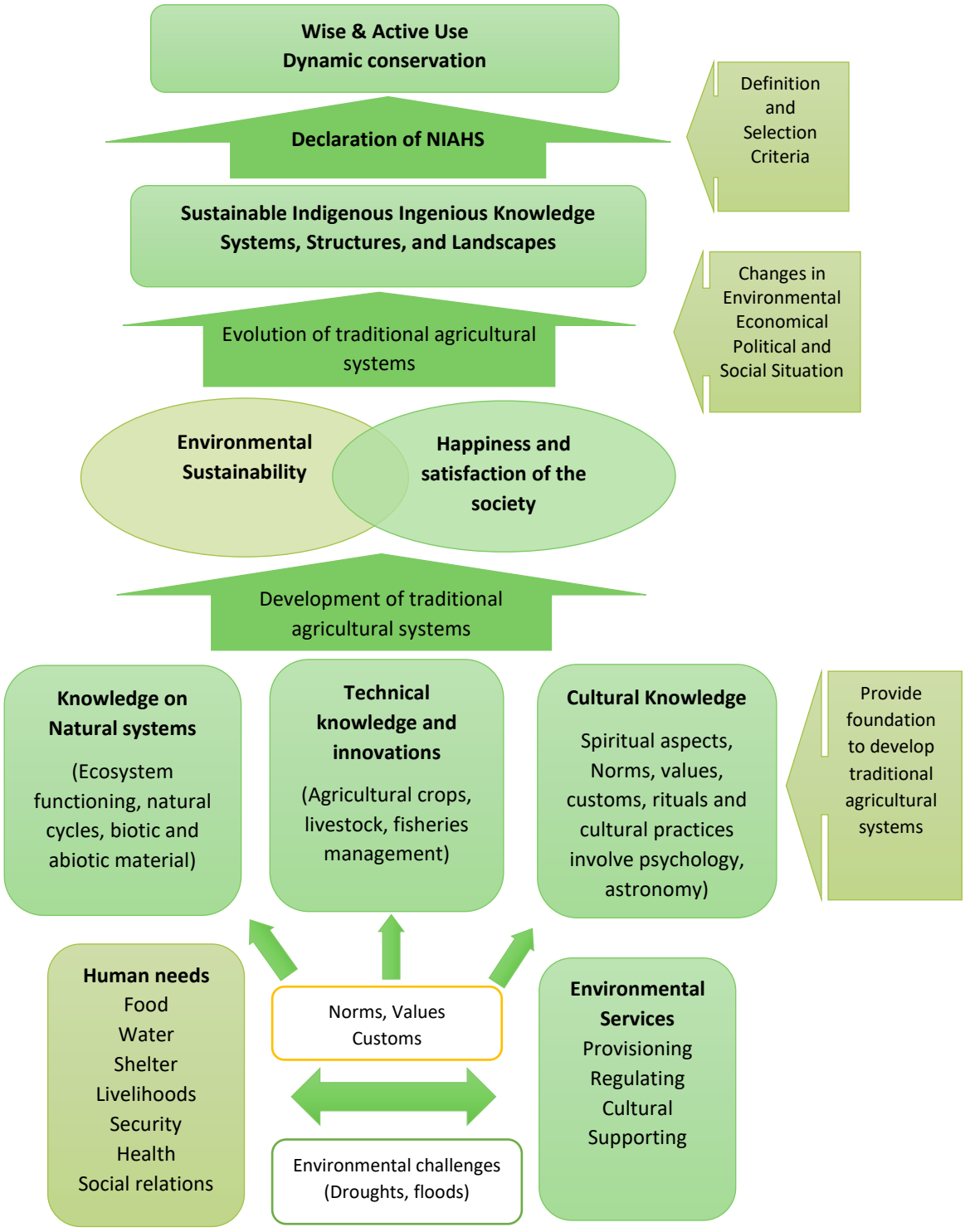
1. **Knowledge on natural systems**
   This is the knowledge that farmers possess with respect to the ecosystem functioning, natural cycles such as water cycle and nutrient cycles, knowledge on biotic material such as knowledge of plants and animals and their life cycles and knowledge on abiotic material such as soil and geology.

2. **Technical knowledge and innovations**
   This is the knowledge developed by farmers over the time through the experience they received on crop management, plant breeding, irrigation and water management, soil nutrient management, pest and disease management, weather forecasting, livestock management and fisheries. This knowledge helped them for varietal development, development of special structures and equipment, to change the landscapes and land use systems in a more sustainable manner even better than the way it originally existed. Construction of village tanks and components of village tank complex are excellent examples for this. Due to the knowledge they possessed on the natural systems, these human constructed systems are in harmony with the natural system.

   Some archaeologist argues that the peasants who lived in this country very much prior to the Buddhism were fully aware and experimented with the secret of negotiating terms with the nature. Anyhow, how the ancient people discovered the secret of the principles of natural governance to produce such a comprehensive eco systems with unbelievable lifetime is still unknown.

3. **Cultural knowledge**
   Cultural knowledge mainly consisted of spirituality, norms, values and customs which play a huge role in construction of the governance system. Apart from this, knowledge and rituals have also been developed on invisible forces such as deities, demigods, and spirits. When people are unable to take physical remedial actions, they search for the protection of these spirits. Astronomy and knowledge on the electromagnetic spectrum of the sun also belong to this category (Kandegama, 2016).

In addition, folklores and songs associated with farming are also a part of this knowledge where they do not merely have an aesthetic value but also information on rural lifestyles and agricultural management (Karunaratne (2004).



Source: Conceptualized by the Authors

Figure 5.5: An Illustration of How a Sustainable Indigenous, Ingenious System is Formed.

Knowledge on these three factors act as the base to develop agro-ecosystems which are environmentally sustainable and people lived happily by being satisfied with the available resources. One of the key factors for their happiness and satisfaction was the value system of the farming community. Especially their ability to accept both profit and loss with equanimity and nature of let go are key factors for this.

Finally, by evolving these systems over various environmental, economic, political, cultural, and social changes, they have developed into sustainable, indigenous and ingenious knowledge systems, structures and landscapes and waterscapes.

5.7 Proposed Selection Criteria for NIAHS

Based on the above discussed analysis, and base factors, selection criteria for NIAHS have been developed. It consists of two major types of criteria as:
1) Common criteria; and
2) Specific criteria

5.7.1 Common Criteria

Common criteria provide a basic guidance to select a potential NIAHS. If the potential agricultural heritage system meets the common criteria, then the process can continue with more specific criteria explained in the section 5.7.

5.7.1.1 Historical and Contemporary Relevance on Agriculture Base

This criteria implies that the NIAHS might have been practiced in the past, but there should be evidence that it is being practiced at present as well. Agricultural heritage includes all tangible (historical constructions, equipment), natural (landscapes, waterways, ecosystems, plants and animals) and intangible (cultural activities including customs, traditions, norms, values and beliefs) heritage. However, this criterion indicates that selected NIAHS should not be merely an artefacts but should have a contemporary relevance.

5.7.1.2 Unique

The selected NIAHS should be unique in terms of its type, characteristic or function. For example, uniqueness of the system is based on the location, physical attributes or behaviour and functions.

5.7.1.3 Location Specific

NIAHS in general can be specific to a particular location. This indicates that these systems have developed and evolved based on the environmental, geographical, economic, political, social and cultural situation in that specific locality. Therefore, the particular system cannot be found commonly in the entire country.

5.7.1.4 Sustainability and Time Tested

Potential NIAHS should have developed, evolved, and thrived over generations until up to now successfully adapting to climatic, economic, political, social and cultural changes over time and should have contributed to ensure the food and livelihood security and the wellbeing of farming communities while elevating and conserving the associated ecosystem for present and future generations.

5.7.1.5 System Approach Based On Functionality

A system can be described as a group of units working together to perform a particular function. Since a system can operate at micro, meso, and macro levels, the NIAHS should be a system defined based on its function that it is intended to perform.

System approach identified for the selection of NIHAS consists of mainly two segments, namely, social systems and ecological systems. Every system has two types of functions that can be known as internalities and externalities. Internalities are always under the control of system users and externalities are beyond the control of system users. NIAHS is a balance and time tested product of ingenious interaction between social and ecological systems in agriculture sector.

Under the NIAHS concept, major internalities of a social system consist of knowledge, society, organizations, values, technology etc. and ecological system consist of air, soil, water, crop, plants, animals, micro-organism, people etc. Policy, weather and climate, market etc. are identified as externalities of both systems under consideration.

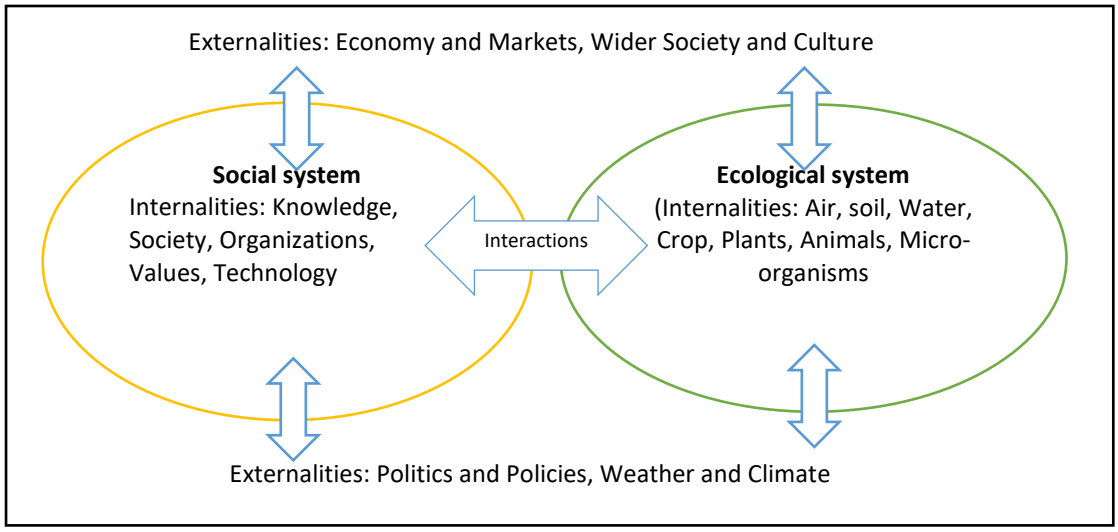


Figure 5.6: An Illustration of a Model NIAHS of Sri Lanka

Therefore, unique, sustainable and time tested agricultural heritage systems, which are of both historically and contemporary relevant, and have designed to perform a

particular function, developed and evolved based on the characteristics of the specific location that it has originated, have the potential to be selected as a NIAHS.

5.7.2 Specific Criteria

Specific criteria illustrate more detailed and specific characteristics that can be observed in a NIAHS.

5.7.2.1 Operational Structure and Functions

1. **Multifunctional systems**

Multifunctional agricultural systems can be described as location specific systems that sustainably provide multiple goods and services including food and livelihood security for humankind by integrated management of natural and manmade resources in agriculture. However, these systems not only aim at fulfilling the needs of people. Rather they focus on providing multifaceted functions to the entire ecosystem. For example, the village tanks fulfil irrigation and domestic water needs of people, food and water needs of wild animals, contribute to temperature regulation, and flood and drought regulation.

2. **Circular systems**

These systems are mostly self-sustained systems. It hardly takes resources from the outside and hardly send resources out from the system. All the agricultural inputs are produced within the system and rather than removing wastage, reuse and recycling concepts were much used. For example, fertilizer requirement was fulfilled within the system using available raw materials such as green manure and livestock waste. Once the crop is harvested crop residue was again fed to the livestock as animal feed.

3. **Efficient use of landscapes and waterscapes**

Our ancestors had a clear understanding about the topography, and soil types of the area that they are living. This is well evident when looking at the land use pattern of dry, wet and hilly areas. This has helped them to utilize landscapes and waterscapes efficiently to face climatic and other environment related challenges. Examples are construction of village tanks in the dry zone of Sri Lanka and paddy terraces in the hilly areas.

4. **Resilience and Coping power**

Resilience implies the ability of a system to return to its original sate after a shock. Ability of a system to absorb and withstand an external shock is known as coping power. The traditional agricultural systems had both the above abilities. One of the best examples is the dry zone village tank system. Dry zone village tank systems survived over centuries even without active interaction with humans during certain eras. This implies that the resilience and the coping power of dry zone village tank systems are high. The major reason for this is, since the systems has been designed

according to the environmental conditions (topography, climate, geology) of the area the nature has taken the system as a part of its own.

5. **System efficiency and effectiveness**

Efficiency can be explained as achieving maximum productivity with minimum wasted effort or expense. Effectiveness can be explained as the degree to which something is successful in producing a desired result. As discussed earlier, Even though the productivity of traditional systems is relatively low compared to modern agricultural systems, the **input usage of the system is also low**. Therefore, in case of a crop failure, the **loss to the farmer is minimal which make the system efficient**. Further to that as explained above these systems being multifunctional, system out puts and outcomes also serve multipurpose. Therefore, the systems are very effective in resource use.

Ecosystem and biodiversity

1. **High level of biodiversity**

Biodiversity can be defined as "*the diversity of all living forms at different levels of complexity including genes, species, ecosystems and even landscapes and seascapes*" (UNESCO, 2011). Traditional village tank systems maintained a very high level of biodiversity within the entire agro-ecological system. Since the addition of external inputs which are hazardous to living beings was minimal, the faunal diversity of the system was maintained. Use of mixed cropping patterns, indigenous plant breeding systems, integrated pest and weed management techniques, maintenance of floral and faunal diversity and the genetic diversity have resulted in high level of biodiversity in the landscapes, waterscapes and the entire ecosystem.

2. **Balanced systems**

High level of biodiversity and maintenance of natural cycles within the system have made the systems well balanced.

3. **Operating within the green stripe/belt**

These systems are operating within the green stripe of the earth. It does not go below it thus, the use of non-renewable resources such as fossil fuel is minimal. Therefore, the pollutants discarded into the nature are minimal.

4. **Bio remediation**

Since these systems are well planned and adapted to the natural system, the system is looked after by the natural system itself even though they are not maintained by humans. Village tank systems of the dry zone of Sri Lanka can be taken as an example.

Number of biological remedies through ecological components have successfully adapted to maintain the water quality as well as to improve the water use efficiency while augmenting the lifetime of the irrigation system, under village tanks in the dry zone.

5. Autonomous cycle

This implies that since these systems are well designed to fit into the natural environment, with time, the nature accepts these systems as a part of the natural system. Therefore, the concept of autonomous cycle is above and beyond the concept of eco-friendliness. Hence, the system will be included into the autonomous cycle of the nature to protect it. This knowledge was there with our ancestors. For example, our ancestors did not construct tanks wherever possible. For example, our ancestors did not construct tanks where ever possible. They have followed certain rules when selecting places to construct tanks such as soil types and geology of the area. One of the best example for the autonomous cycle is the village tank cascade system that enables return flow and reuse water without pollution to improve the water productivity and minimize natural disaster like floods and droughts in a very scientific manner.

6. Integrated Natural Resource Management (INRM)

The resources management with in the system was maintained as a package and not as individual components or elements. For example soil, water, crops, pest and diseases, home gardens, animal husbandry and forest were considered as a whole and not as separate components. Privilege of utilizing water is considered as an inbuilt part of land ownership to facilitate integrated land and water management one of the reasons behind the long term sustainability of agricultural systems in Sri Lanka.

5.7.2.2 Social Value System

1. High level of equity

High level of equity could be observed with regards to resource utilization, gender, and decision making. Land use methods such as *Bethma* cultivation, land entitlements where women get equal rights to declare ownership, alienation of land ownership under *purana wela* that was the command area under the tank at the very beginning, in a village tank system, collective decision-making opportunities can be taken as examples.

Water distribution in the command area under a village tank commences from the tail end to assurer the irrigation water for tail-enders to maintain the high degree of productivity and equity among the farming community. In most of the traditional agricultural systems, equity was integrated with productivity to achieve the sustainability, in the long run.

2. Social cohesion

High level of social cohesion could be observed in village tank systems. Starting from land preparation until harvesting sharing of labour and collective activities could be observed.

3. Respect to life

Respect to the right to live for all beings was a prominent character in traditional agricultural systems such as village tank systems. The entire system has designed to fulfil food, water and habitat needs of both humans and animals.

5.7.2.3 Governance System

1. Customary laws, traditions and its philosophical base

Traditional agricultural activities are necessarily accompanied with customs and traditions. Even though these customs and traditions resemble a set of ritual practices along with agricultural activities, there is a deep philosophical base embedded behind them. For example, in traditional agriculture there were concepts found as follows (Kariyawasam, 2011).

i. *Thriwida Dakma* (Three dimensional view)
ii. *Panchawidha Sankalpa* (Five concepts)
iii. *Sathwidha Urumayan* (Seven types of heritage)
iv. *Dasawidha Ana Widhanayan* (Ten commandments)

They resemble several rituals to follow before and during cultivation and after harvesting. However, in reality these concepts include a very rich and unique knowledge needed to get an optimum harvest whilst minimizing crop damages. Therefore, customs, traditions and their philosophical bases can be treated as equally important criteria.

2. Shared responsibility, accountability, and ownership

Activities such as maintenance of public goods (forest lands, waterways, grazing lands) and communal goods (tank, and irrigation channels) were taken place through a collective approach. Responsibility of maintaining public and communal goods are assigned to both farmers and community in a rational manner based on the landholding size. This has given the resource users a sense of accountability, which will ultimately lead to a sense of ownership. While this has helped reduce the cost of maintenance it has also help increase the productivity and longevity of the resource (Siriweera, 1993; Dalupotha, 2011).

3. Monitoring and sanctions

Literature suggests that there were certain set of rules to maintain village agro ecosystems. For example, it was prohibited to cut trees which are grown in tank bund, it was prohibited to drive cattle along the tank bund. These rules were maintained to protect these structures. Otherwise there were ways to penalize them.

5.7.2.4 Cosmo Spiritual Dimension

1. Spirituality, contentment and happiness

One of the key base principles of traditional cultivation practices was based on the spirituality which is mainly originated from Buddhist principles. This is accompanied with satisfaction on available resources, quality of letting go, contentment and happiness with the limited resources available.

2. Compassion, empathetic joy, equanimity and quality of letting go

Key Buddhist principles of compassion, empathetic joy, equanimity and quality of letting go characteristics were also very common among the society.

3. Spirits and gods

Ancestors had three major strategies for crop and livestock management. First two include natural strategies and human made strategies such as technologies. If they realize the issue cannot be addressed by any of them, then they search for the support from spirits and gods. There are many number of rituals attached to this component.

4. Folklore and folk songs

These folklore and folk songs are not just stories and songs that is coming from word of mouth from generation to generation. It encompasses vital knowledge about farming systems, techniques, practices and rituals. Apart from that, they have an esthetical value, which depicts the creativity of traditional farmers and they have helped during hardships giving farmers a psychological ease (Karunarathne, 2004).

5. Kem

Kem techniques are also widely used with other techniques during crop and livestock management. It is a technique or custom which follows to obtain certain favourable effects, relief or during an illness (Dalupotha, 2011).

6. Yantra and Mantra

This includes drawings which are desired by certain spirits. They are kept in a specific place expecting a blessing of an unseen power. *Mantras* are certain types of chanting with a specific sounds repeated for a specific number of times which makes vibrations in the environment. This again expects to bring about desired effects (Dharmasena, 2010).

7. Astrology and biodynamic farming

Astrology and biodynamic farming involve timely cultivation to get desired frequencies of electromagnetic spectrum received from the sun during a specific time of the year to induce crop growth and productivity (Kandegama, 2016).

5.7.2.5 Food security and alternative markets

1. **Food security of subsistence farmers**

These traditional systems had the ability to ensure food security of agrarian communities for over generations for centuries. While paddy ensures the energy security, vegetables coming from chena cultivations ensure nutritional needs of people. Fish in the tanks ensured protein needs of agrarian communities. Since the crops are well adapted to harsh environmental conditions and due to governing principles which allow fair sharing of limited available resources such as water, throughout the year food and nutrition security were maintained.

2. **Opportunities for participatory management, alternative markets and economic implications**

Due to cultural and aesthetic value of NIAHSs, they can be used to create alternative income sources. For example: to promote agro/ tourism in Sri Lanka. Since tourism is one of the key national income sources this will allow country to earn foreign remittances while enhancing living standards of agrarian communities and contributing to rural development. Certain agricultural heritage systems would possess a high potential for this which is a positive factor to become a NIAHS.

5.7.2.6 Historical Dimension and Conservation Needs

1. **Historical evidence**

In Sri Lankan agricultural development, historical dimension includes two key milestones which could be observed before colonization and after colonization which has initiated in 1505 BC. Most of the traditional agricultural systems which are much discussed, belonged to pre colonization period.

The coastal areas of Sri Lanka came under the rule of Portuguese during 1505 - 1658, Dutch during 1658 - 1796. Finally, the whole country came under the British rule from 1815 to 1948. Therefore, a significant impact on country's agriculture was made after British colonization since diverse plantation crops such as tea, rubber, coconut were introduced to the country. Therefore, the study defines agricultural systems which have originated in Sri Lanka before 1815 as agricultural heritage systems of Sri Lanka.

1. **Endangeredness**

The endangeredness may vary for different agricultural heritage systems. One of the key factors for conservation needs is the endangeredness of these systems. Therefore, endangeredness can be identified as one of the selection criteria.

5.8 Developing a definition for NIAHS

5.8.1 Related definitions for NIAHS

Food and Agriculture Organization of the United Nations (FAO) has defined Globally Important Agricultural Heritage Systems (GIAHS) as *"remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development"* (Food and Agriculture Organization of the United Nations, n.d.).

Singh and Rana (2019) in the process of identifying the need for characterization and scientific validation of nationally important agricultural heritage systems for India defined Agricultural heritage systems in general as "*remarkable unique land use systems and landscapes, evolved by local communities with coadaptation of biological diversity and the surrounding environment in a profitable manner, meeting the livelihood requirements, needs and aspirations of locals for sustainable development of the region*." (Singh and Rana 2019, p. 229).

5.8.2 Definition for NIAHS of Sri Lanka

5.8.2.1 Steps to follow developing a definition

A definition is "a statement of the meaning of a word or word group or symbol". It explains by clarification and further explanation the term or the symbol with one or few short words (Unified Compliance Framework, 2021). A definition can be break down in to two parts as follows Compliance Framework, 2021).

1) Category of Concept
2) Differentiating characteristics.

Category includes the category or the class that the concept falls into. Thus the reader will understand the broader category the term belongs to (Unified Compliance Framework, 2021).

Differentiating characteristics implies specific characteristics that distinguish the term or the symbol from others within the same category. Generally, in a definition firstly the category of the concept is mentioned which is followed by the differentiating characteristics (Unified Compliance Framework, 2021).

There are seven major types of definitions as shown in the table 6.1. Based on the above explanation and based on the definition of GIAHSs' and other NIAHSs' definitions developed by other countries, best category to use to develop NIAHS definition for Sri Lanka is the Encyclopaedic Definition type.

Table 5.1 Types of Definitions

		Description
1	Intensional definitions	Begins with the category and continues with what makes the concept different from the rest in the same category
2	Extensional definitions	Lists objects, properties or features as required as possible which represents the concept and explains how the objects fit into more generalized category.
3	Lexical definitions	Begins with the setting explaining how the term is used in the document and place the setting in to the category.
4.	Partitive definitions	Starts by explaining the particular concept as a fragment of grater whole and continue with the category which the grater whole fits into. Then includes how the concept become different than the other parts of the greater whole.
5.	Functional definitions	Begins with explaining what the concept does and continue to explain the role of how it fits in to a larger category with properties and other functions
6.	Encyclopaedic definitions	Begins with the category, properties or features shared by other concepts and continues to explain what makes the concept different from other members of the same category and illustrates extra classification, history and etc. about the concept to further explain the purpose.
7.	Theoretical definitions	Begins with the category, properties or features shared by other concepts and continues to explain what makes the concept different from other members of the same category and continue to further explain the theory of why the concept fits in to the category and why differentiators are important.

Source: Unified Compliance Framework, (2021)

5.8.2.2 Factors Considered during Developing a Definition for NIAHS of Sri Lanka

Two factors were considered while developing NIAHS of Sri Lanka as follows.

1. **The object of the study:**
   To systematically identify nationally important agricultural heritage systems of Sri Lanka and to recognize their applicability and conservation needs

2. **The main purpose of systematic identification of NIAHS:**
   To recognize and conserve proudest and time-tested, outstanding traditions of human ingenuity in harnessing precious resources to provide safe food, and livelihoods and protect unique ecosystems and to maintain the balance between conservation, sustainable adaptation and socio-economic development through multi stakeholder support.

5.8.2.3 Proposed Definitions NIAHS

Many definitions were proposed for NIAHS during key informant discussions, panel discussions and the validation workshop which are illustrated below.

Definition 1:
Sustainable agricultural knowledge systems, structures and landscapes which have evolved and thrived till to date which can be wisely utilized at present scenario and worth preserve for future generations for their active use".

Definition 2:
Sustainable agricultural knowledge systems, structures and landscapes which have evolved and thrived over generations, successfully adapting to diverse environmental, climatic, social, cultural, political and economic variations while ensuring food and nutritional security of subsistence farmers and providing the ecosystems services

Definition 3:
A combination of series of locally adapted, time tested ingenious techniques to assure social, cultural, ecological, spiritual and economic goods and services to mankind.

Definition 4:
Outstanding landscape of aesthetic beauty that combine agricultural bio diversity, resilient eco systems and a valuable cultural heritage.

Definition 5:
An evolution of remarkable processes of interaction of humankind and nature representing accumulated knowledge, beliefs and experiences of rural people in agriculture.

Definition 6:
Long term cultural and biological interactions.

Definition 7:
A geopolitically bounded land parcel with the national governing system, experiencing hydrologically interconnected geographical area operating under sustainable agricultural knowledge systems, with structural and non-structural surface and subsurface water governing systems, supporting all categories of ecosystems to enhance not only livelihoods of all stakeholders, but also to improve ecosystem services, manage resilience and to conserve its own landscapes which have evolved and thrived till to date, could be wisely utilize at present scenario and worth preserve for future generations for their active use.

Definition 8:
Knowledge systems including related structures which are based on the concept of till sun and moon exist, which is nurtured with the *Dhamma* or our spiritual values and not limited for human beings and present generations, but all living beings including flora and fauna.

5.8.2.4 Definition of NIAHS

Considering all above factors the final proposed definition for NIAHS is

"Outstanding and unique landscapes, waterscapes, knowledge systems, and structures, which are locally adapted, time tested, and ensure social, cultural, ecological, spiritual and economic goods and services to humankind whilst preserving the associated ecosystem".

CHAPTER SIX

Way Forward for Policy Guidance to Develop a National Policy towards Conservation and Management of Agricultural Heritage Systems of Sri Lanka

6.1 Policy Framework Towards Conservation and Management of NIAHSs of Sri Lanka

6.1.1 NIAHSs Conservation Policy Focus

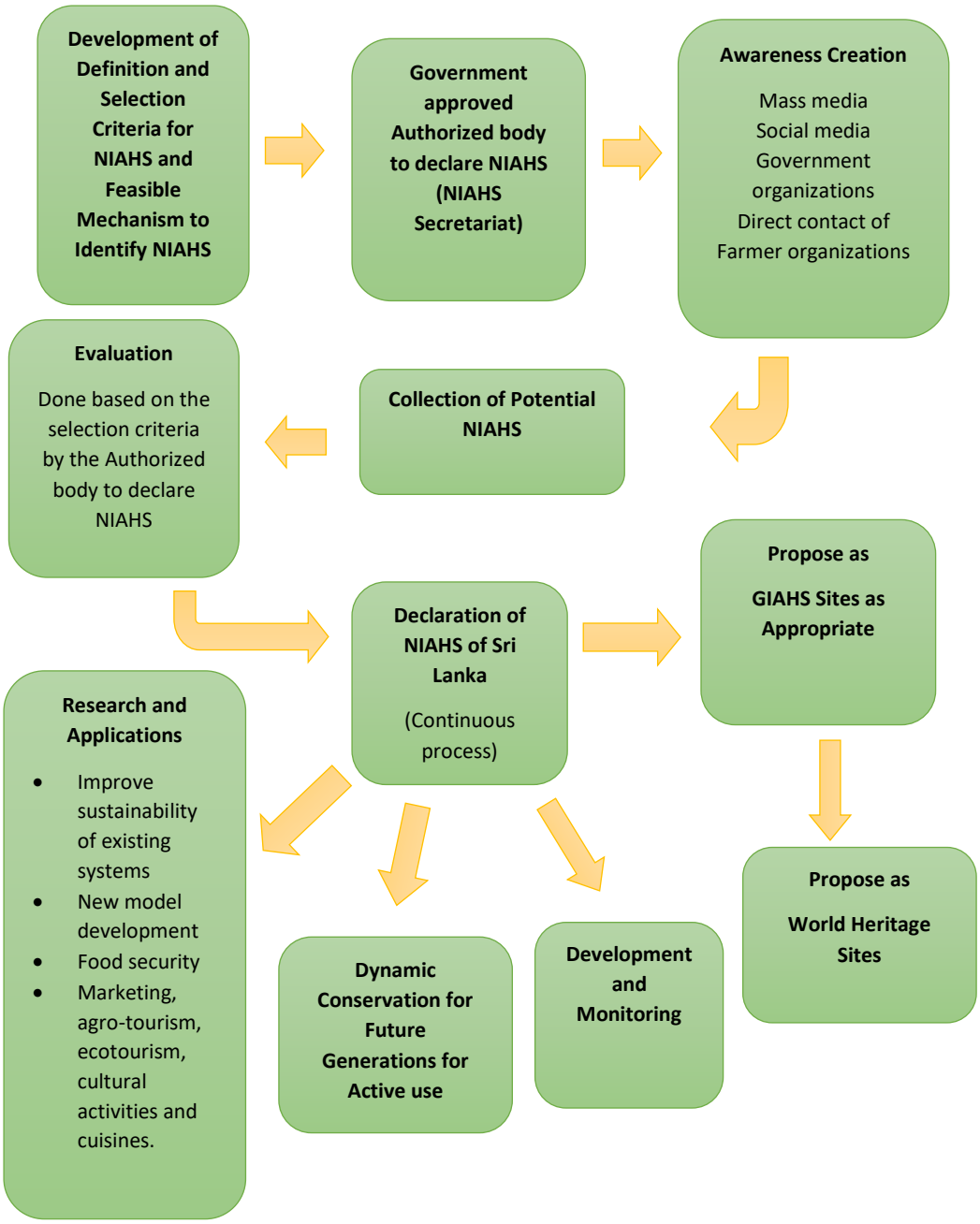
Based on the objectives, expected study outcomes, literature review, key informant discussion and panel discussions, the study suggests that NIAHS conservation and management policy of Sri Lanka should focus on restoration, wise use, and dynamic conservation for active usage for future generations.

6.1.2 NIAHSs Conservation and Management Policy Framework

Conservation and management policy should be realistic, comprehensive and long term. Based on the policy focus study proposes a conservation policy framework as depicted in the figure 6.1.

Once the definition and selection criteria are finalized it is recommended to establish a government appointed body to collect, identify and declare NIAHSs of Sri Lanka. The authorized body should consist of subject experts, practitioners and stakeholder institutes and organizations who would implement decisions taken by the authorized body at the field level. Also the authorized body should liaise with FAO where GIAHSs are declared and with the UNESCO where World Heritage sites are declared.

Once the authorized body is formed, a mechanism should be established to collect existing agricultural heritage systems scattered around Sri Lanka. For that, awareness should be created among the general public about the concept, activities and eligibility procedures related to NIAHS using mass media, social media, relevant government institutes such as Department of Agriculture, Department of Agrarian Development, Divisional Secretariats etc., and by directly contacting farmer organizations and individual farmers. An application procedure should be established to propose a certain system as a NIAHS.



Source: Conceptualized by the Authors

Figure 6.1: Proposed Conservation and Management Framework for NIAHSs of Sri Lanka

Once a system is proposed as a NIAHS the authorised body should carry out a detail study to examine the system, based on the definition and selection criteria. Once it fulfils the requirements, the system can be declared as a NIAHS of Sri Lanka. The process should be on going.

Once a system is declared as a NIAHS three major procedures should be followed.

1. Wise use at present context

The term wise-use is defined as "*the maintenance of their ecological characters, achieved through the implementation of ecological approaches, with in the context of sustainable development*" (Ramsar Convention, 2005, p.6).

1) There should be an ongoing process to analyse these systems to identify potential to use them to increase the sustainability of modern agricultural systems and develop new modern agricultural systems. This should be followed by application of the findings at field level.
2) There should be a mechanism to keep farmers practicing and maintaining these systems continuously.
3) There should be a process to restore these systems if they are endangered, and monitor the progress.
4) There should be a mechanism to identify possibility of developing these systems for agro-tourism and ecotourism. Promotion of these economic activities should contribute to increase the income and living standards of practitioners. However, commercialization of these systems should not impact on the ingenuity and purity of the natural and human system.

2. Dynamic conservation

1) A mechanism should be established to dynamically conserve these systems not as an artefact but allowing future generations to actively use them. Dynamic conservation includes conservation, management and monitoring.

3. Global potential

1) While preserving these systems locally, a procedure should be established to get declared these systems as GIAHS sites and finally as World Heritage Sites where appropriate. This will give a world recognition to our agricultural heritage systems. Having the country's agricultural heritage a global recognition would be helpful in diverse ways. 1) It would help conserve these systems further. 2) It would help brand our country at global level and promote tourism industry which will increase national income. 3) It would increase the income and living standards of rural communities.

CHAPTER SEVEN

Conclusions and Recommendations

7.1 Conclusions

1. The study intended to systematically identify nationally important agricultural heritage systems of Sri Lanka by developing a definition and appropriate selection criteria, and to provide policy guidance to develop a national policy towards identifying, collecting, storing and conserving agricultural heritage systems in Sri Lanka.

2. Literature review, key informant discussions with practitioners, panel discussions with subject experts and a validation workshop were conducted to develop and validate the definition, selection criteria and policy guidance framework.

3. Selection criteria and the definition were developed based on four major factors namely, 1) Identification of operational structure, functions, and governing principles of NIAHS; 2) Identification of economic implications of NIAHS; 3) Identification of food security implications of NIAHS; 4) Sustainable agriculture systems concept.

4. Selection criteria developed include five common criteria, seven major specific criteria and 28 sub specific criteria.

No	Major Criteria	Sub criteria
Common criteria		*1.* Historical and contemporary relevance on agriculture base 2. Unique 3. Location specific 4. Sustainability and time-tested 5. System approach based on functionality
Specific criteria	1) Operational Structure and Functions	1. Multifunctional systems 2. Circular systems 3. Efficient use of Landscapes and Waterscapes 4. Resilience and Coping power 5. System efficiency and effectiveness
	2) Ecosystem and Biodiversity	1. High level of biodiversity 2. Balanced systems 3. Operating within the green strip/belt 4. Bio remediation 5. Autonomous cycle 6. Integrated Natural Resource Management
	3) Social Value	1. High level of equity

	System	2. Social cohesion 3. Respect to life
	4) Governance System	1. Customary laws, traditions and its philosophical base 2. Shared responsibility, accountability, and ownership 3. Monitoring and sanctions
	5) Cosmo Spiritual Dimension	1. Spirituality, contentment and happiness 2. Compassion, empathetic joy, equanimity and quality of letting go 3. Spirits and gods 4. Folklore and folk songs 5. Kem 6. Yantra and Mantra 7. Astrology and biodynamic farming
	6) Food Security Alternative Markets	1. Food security of subsistence farmers 2. Opportunities for participatory management, alternative markets and economic implications
	7) Historical Dimension and Conservation Needs	1. Historical evidence 2. Endangeredness

6. Final definition of NIAHS would be “Outstanding landscapes, waterscapes, knowledge systems, and structures, which are locally adapted, time tested, and ensure social, cultural, ecological, spiritual and economic goods and services to humankind whilst preserving the associated ecosystem”.

7.2 Recommendations

1. It is recommended to focus NIAHS conservation and management policy of Sri Lanka towards identification, recognition, restoration, wise use, and dynamic conservation for active usage for future generations.
2. It is recommended to develop a realistic, comprehensive and time bound (Short, medium and long term) conservation and management plan for NIAHSs of Sri Lanka.

3. It is recommended to construct NIAHS conservation and management policy framework as follows.
    a. Development of Definition and Selection Criteria for NIAHS
    b. Government Appointed Authorized Body to Declare NIAHS
    c. Awareness Creation
    d. Collection of Information on Potential NIAHS sites

e. Evaluation conducted based on the selection criteria by the Authorized body to declare NIAHSs
f. Declaration of NIAHS of Sri Lanka
    i. Research and applications
    ii. Dynamic conservation for future generations for active use
    iii. Development and monitoring
    iv. Propose as GIAHS sites
    v. Propose as World Heritage sites

g. Popularize and introduce application and wise-use of NIAHS in Sri Lanka including education at different levels.

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Hector Kobbekaduwa Agrarian Research and Training Institute,
PO Box 1522,
Colombo,
Sri Lanka.

Tel. +94 11 2 6969 81
+94 11 2 6964 37
Fax. +94 11 2 6924 23
e-mail director@harti.gov.lk
Web www.harti.gov.lk

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