Food and Agriculture Organization of the United Nations

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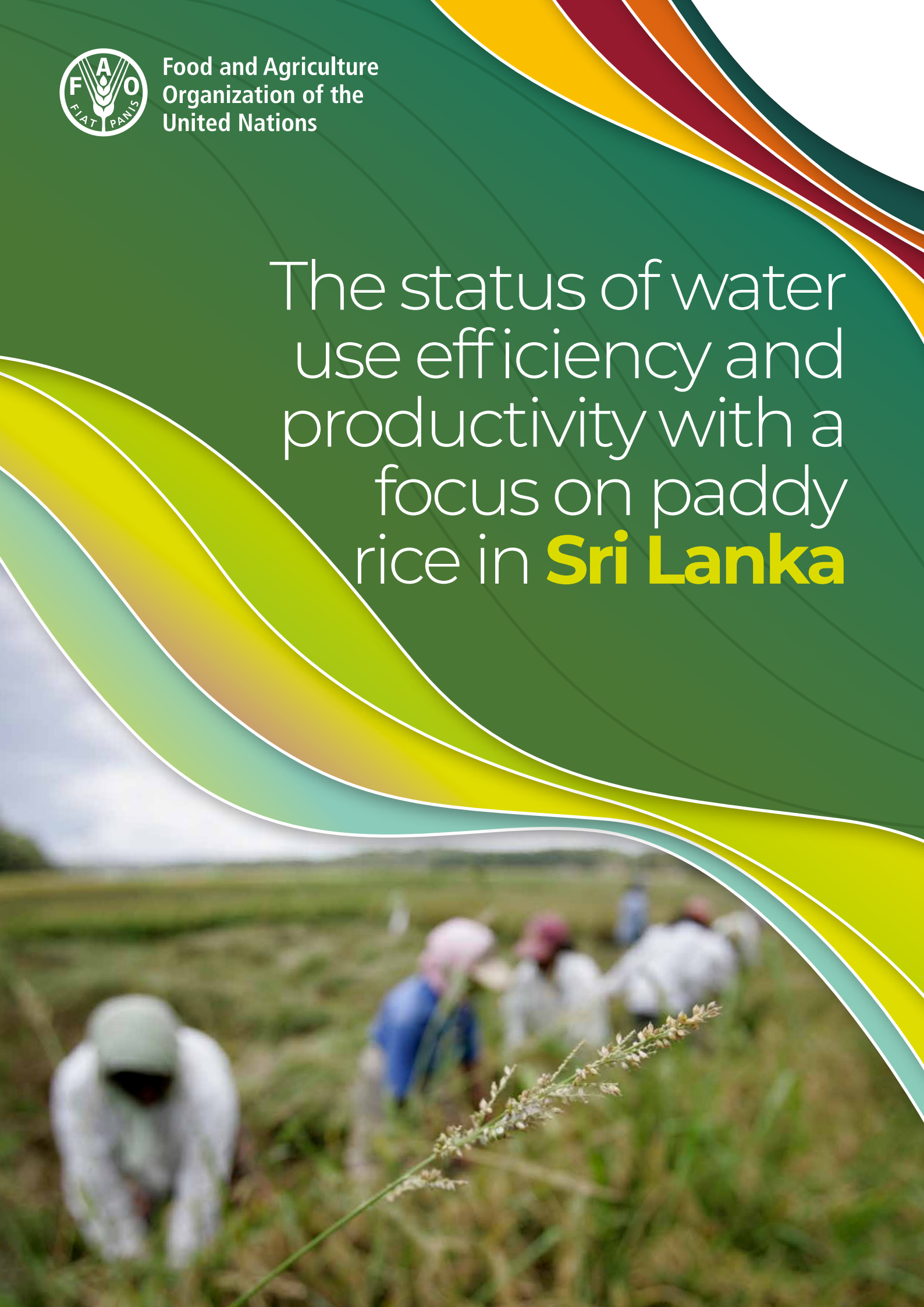

The status of water use efficiency and productivity with a focus on paddy rice in **Sri Lanka**

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Foreword

In Sri Lanka, about 80 percent of the national food requirements are produced locally, with the remaining 20 percent coming from imports. Sri Lanka is self-sufficient in rice production which is the national staple food. However, the cultivation of rice is becoming less profitable for producers, while the vulnerability of the agriculture ecosystems to climate change and natural disasters is increasing the risks of failed harvests and household food insecurity. Sri Lanka's population is expected to grow by 2.4 million by 2050. A gradual increase in per capita income and changes in lifestyle are leading to increased consumption of food, water, and energy, making sustainable management of natural resources and fragile ecosystems a challenge. More than 80 percent of Sri Lanka's rice farmers are smallholders and 60 percent of rice production comes from the dry zone, leaving a large number of farmers and much of the rice production at risk.

In order to adapt to climate change and sustainably use natural resources in Sri Lanka, it is crucial to identify best practices and policies in paddy rice cultivation that will enable the country to maintain sustainable production levels. The "Efficient Agricultural Water Use and Management Enhancement in Paddy Fields" project, funded by the Japanese Ministry of Agriculture, Forestry and Fisheries, aims to improve understanding of the status of water use efficiency and water productivity in Sri Lanka and identify both limitations and potentials at the national level.

The project “Efficient Agricultural Water Use and Management Enhancement in Paddy Fields”, funded by the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF), is designed to increase the understanding of the current status of water use efficiency and water productivity in Zambia and Sri Lanka, identifying both limits and potentials at national level.

This report focuses on the technical and policy measures to address existing challenges, and outline gaps in the implementation of policies to improve agricultural water use efficiency and enhance management in paddy fields in Sri Lanka. It promotes the formulation and deployment of an effective system for the development of the untapped potential for agricultural water use efficiency and management in paddy fields. The report addresses all stakeholders, including policy makers, researchers, and extension agents, who will directly and indirectly benefit from its recommendations.

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Abbreviations and acronyms

AER	Agroecological region
AWD	Alternate wetting and drying
FAO	Food and Agriculture Organization of the United Nations
GA	Government agent
RRDI	Rice Research Development Institute
SRI	System of rice intensification

Executive summary

Global water demand is likely to grow in the next 20 to 30 years due to agriculture intensification, population growth, urbanization, and climate change. In water stress regions, future demand will require reallocation of 25 to 40 percent of water from lower to higher productivity and employment-oriented activities. These reallocations are likely to come from agriculture sector due to its high share of current water use. To deal with the projected rise in water demand, appropriate actions that increase water use efficiency, especially in irrigation, are crucial to sustainably enhance agricultural production and productivity.

In Sri Lanka, one-third of the rural population depends on agriculture. Rice is the national staple food which is cultivated twice a year on more than half a million hectares of land under a range of physical and environmental conditions. Currently, about 80 percent of paddy production comes from irrigated agriculture, while 20 percent is by rainfed areas. Paddy cultivation is water demanding as it needs continues inundation of the field during most of the growing season. Despite being self-sufficient in rice production, Sri Lanka has low levels of water productivity and water use efficiency in paddies. Furthermore, its water and food security is extremely vulnerable to climate change.

The Food and Agriculture Organization of the United Nations (FAO) has been active to increase the understanding of the status of water use efficiency and water productivity in Sri Lanka through the project "Efficient Agricultural Water Use and Management Enhancement in Paddy Fields", funded by the Japan Ministry of Agriculture, Forestry and Fisheries (MAFF).

The project objective is to identify limits and potentials of paddy rice production at national level. The project findings presented in this report is a basis for assisting the country with the evaluation of the status of water use efficiency and water productivity of paddy fields, providing technical and policy support to enhance water resources management in Sri Lanka.

This report will help increasing the knowledge and building capacities of technical experts in relevant institutions, ministries, and universities in Sri Lanka. The analysis of best practices will assist in determining the needs and existing gaps and will explore options to fill these gaps. Furthermore, the analysis of water governance and policy instruments will support the future water resources development plans in the country.

The report exclusively covers literature published on the above topics during 2000 to 2020, which covers the following aspects:

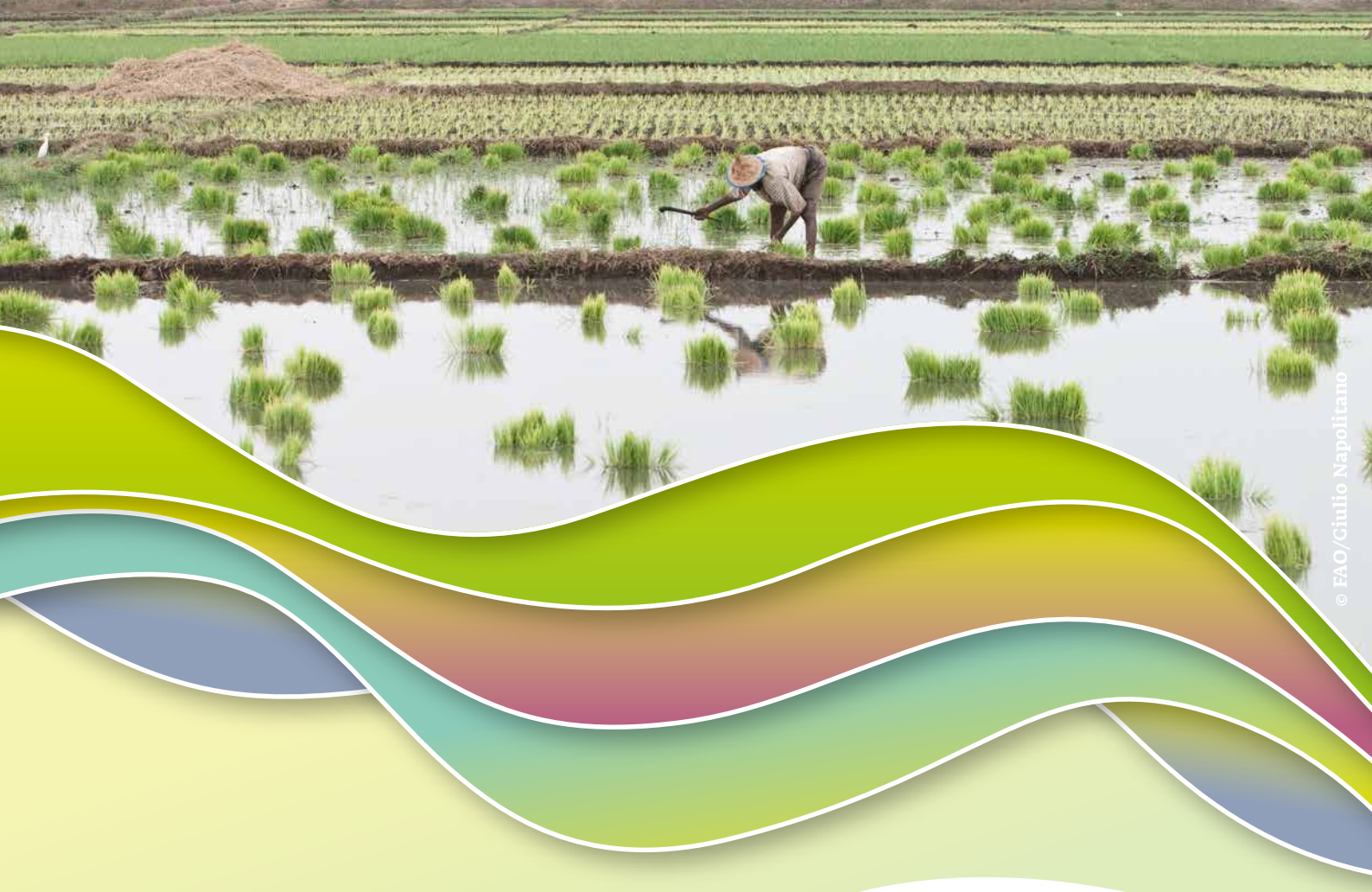
Section 1 introduces the country profile focusing on the status of economy, agroecological regions, water resources of Sri Lanka, water use in paddies and the importance of rice cultivation in food security of Sri Lanka.

Section 2 describes the methodology used for the review of literature and mapping of water governance structure in Sri Lanka. Systematic literature review, which is central in this report, is applied to review the status of paddy rice production, and the FAO tool for institutional and policy evidence–based analysis in the context of agriculture water management (AgWA) is used for the mapping of water governance structure in Sri Lanka. The section focuses on the conceptual framework, the formulation of the primary interrogation points and the methodology for gap analysis.

Section 3 describes the review result in the context of the primary interrogation points. It elaborates on the role of paddy rice in food security and the opportunity and constraints in paddy rice production. The section outlines the prospects of enhancing rice production and ensuring food security. Finally, the section discusses the potential of several technological interventions that could play a significant role in achieving high water productivity.

Section 4 focuses on the mapping of water governance in Sri Lanka. Water institutions, legislations, and policies and strategies makes the basic units of water governance structure. Each of these building units is synthesized and mapped step-by-step.

Section 5 highlights the gaps in policies, presents the gap analysis matrix and provides recommendations to strengthen the management of water resources in the country.



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1. Country profile

1.1 BACKGROUND

Sri Lanka's economy is dominated by agriculture, with 25 percent of the rural population directly employed in various agricultural activities. Despite its large share in employment and in the use of natural resources, the sector contributes only nine percent to the national gross domestic product due to low production levels. Rice is the national staple food and the main crop grown on more than 500 000 hectares nationwide, producing an average of 3.71 million tonnes of paddy. It accounts for 40 percent of total agricultural production and plays an important role in food security for smallholder farmers, as almost all rice produced in the country is consumed locally. Rice is mainly grown in two cropping seasons, Maha and Yala. The main growing season is Maha, which starts in September and ends in March of the next year. This season is fed by the inter-monsoon rains and the well-distributed northeast monsoon. The secondary cropping season, Yala, spans from April to September, this season brings rains mainly in the southwestern region of the country.

Paddy rice is grown in different agroecological regions of Sri Lanka which requires 3 000 to 5 000 litres of water to produce one kilogram of rice. Annual rainfall variability and climate

change have a significant impact on the crop production levels and food security of farmers. In 2016–2017, the country was hit by a severe drought that resulted in a loss of about 20 percent of rice production amounting to more than 700 000 tonnes. This has proved the importance of water and the vulnerability of the paddy rice farming system to climate change. With increasing demand for food and competition for water resources between different sectors in the future, it is important to increase sustainable food production by increasing water use efficiency and water productivity of irrigated agriculture.

In Sri Lanka, the average water use for paddy cultivation is almost twice that of other rice–growing countries. Some of the main reasons for the low water use efficiency and water productivity are the lack of on-farm water management, inefficient irrigation methods, un-levelled paddy fields and poor soil management practices. This report aims to improve the understanding of the current status of water use efficiency and water productivity in rice production in Sri Lanka, identify productivity constraints and potentials at the national level, and analyse the policy framework to support and improve water resource management for rice production.

1.2 AGROECOLOGICAL REGIONS

Sri Lanka has a diverse climate with high rainfall variability. Based on the total annual rainfall, it can broadly be divided into three climatic zones: the dry zone (DZ) with rainfall below 1 750 mm, the intermediate zone (IZ) with rainfall between 1 750 and 2 500 mm, and the wet zone (WZ) with rainfall above 2 500 mm. In addition to the climatic zones, the country is also divided into three elevation zones: lowlands with an elevation between mean sea level and 300 m above mean sea level, midlands with an elevation between 300 and 800 m above mean sea level and uplands with an elevation above 800 m above mean sea level. Taking into account the climatic and elevation zones, soil types, surface terrain and land use, there are 46 agroecological regions (AER) in Sri Lanka, which are listed in Appendix.

In 31 of the 46 AERs, rice is grown on an average of more than 500 000 ha throughout the country in a season. In wet climatic zone, rice cultivation is practiced in all mid and lowland AERs, with the exception of wet zone midland 1a and 1b (WM1a and WM1b, respectively), which have humid climates due to their adjacent location to the wet uplands. The wet climatic zone contributes 18 percent of total rice production and is considered as a minor rice production zone. Similarly, in the intermediate climatic zone, rice is grown in all mid and lowlands AERs except intermediate midland 1c, 2a and 3c (IM1c, IM 2a and IM3c, respectively). In addition, two upland AERs, e.g. intermediate upland 3c and 3e (IU3c and IU3e, respectively), are also suitable for rice cultivation in the intermediate climatic zone. The intermediate climate zone receives moderate rainfall from the southwest monsoon and contributes 22 percent to the national rice basket. In the dry climatic zone, rice is mainly grown under irrigated condition. The dry climatic zone occupies the entire lowlands in the central, northern, eastern, and southeastern AERs. All lowland AERs in the dry zone are well suited to rice production, except dry zone lowland 3 (DL3), which covers the northeastern and northwestern coastal belts and is well suited to nut and spice production. The dry zone is the largest contributor to rice production, accounting for 60 percent of the total production.

1.3 WATER RESOURCES OF SRI LANKA

The total renewable water resources of Sri Lanka are 52.8 billion m^3/year, received by 103 river basins feeding a total length of about 4 500 km of river systems. The area of the river basins varies from 10 km^2 to over 10 000 km^2 and only 17 of the 103 basins are larger than 1 000 km^2. Out of the 103 rivers, only 16 are longer than 100 kilometres, 12 of which carry about 75 percent of the mean runoff of the entire country. The major rivers in the wet zone of the southwest monsoon are the Kelani, the Kalu, the Bentara, the Gin, the Niwala, the Maha and the Attanagalu Oya, which together carry about half of the country's runoff. The water resources of these river systems are used for irrigation development, water supply, hydropower, industrial use and other economic activities. There are 26 rivers in the northeast monsoon area, covering a considerable spatial extent of the country. These rivers are located in the arid region where the construction and rehabilitation of irrigation reservoirs is necessary to divert water to irrigation systems. The river systems of Sri Lanka mostly originate in the central uplands and flow radially in all four directions to the coasts. An exception to this radial pattern is the 335 km long Mahaweli River with a catchment area of 10 448 km^2. Sri Lanka has a sparse network of river gaging stations and discharge data is only available for the Mahaweli Ganga. The Mahaweli catchment receives an annual rainfall of 28 billion m^3. The mean annual discharge of the Mahaweli Ganga is 8.8 billion m^3 and it contributes to one seventh of the total discharge of all rivers in Sri Lanka. The headwaters of the Mahaweli Ganga are located in the western part of the central uplands, where total annual precipitation reaches 60 000 m^3/ha. The mean annual rainfall for the lower reaches varies between 1 600 and 19 000 m^3/ha.

Sri Lanka has a unique network of more than 10 000 ancient reservoirs, known locally as 'wewa' or 'tanks'. Some of the reservoirs are particularly large and many of them are thousands of years old, while almost all of them display a high degree of sophistication in their construction and design. The network of village tanks plays a multifunctional role in supporting irrigation and several livelihood activities. Thousands of hectares of paddy fields are supplied with irrigation water from these tanks through hundreds of kilometres of irrigation canals. The country also has 7.8 billion m^3 of groundwater resources, but almost 90 percent of the groundwater feeds the river system and is accounted for as surface water.

1.4 WATER USE FOR PADDIES

Total freshwater withdrawal in Sri Lanka is estimated at 12.95 billion m^3 and about 82 percent of the total withdrawal is used only for paddy irrigation. A little over five percent of freshwater is used to irrigate other crops, about six percent is used for municipal purposes and seven percent is used in industry. Traditionally, paddies require more water than any other crop, apart from its critical functions in plant physiology, water plays an important role in carrying out various management practises in rice cultivation, such as nursery preparation, transplanting, weeding, fertilizer application and pest and disease control. Water requirements for rice cultivation can be divided into different phases of crop production (Table 1).

Table 1. Water requirements during different phases of paddy production

Crop growth stage	Water requirement (mm)	Water requirement (%)
Nursery	40	3
Main field preparation	200	16
Transplanting to panicle initiation	460	37
Panicle initiation to flowering	417	34
Flowering to maturity	123	10
Total	**1240**	**100**

Source: Expert System for Paddy. 2022. Water management. In: Expert System for Paddy. Coimbatore, India. Cited 25 October 2022. http://www.agritech.tnau.ac.in/expert_system/paddy/cultivationpractices3.html

1.5 RICE CULTIVATION IN SRI LANKA

Rice is cultivated during two cropping seasons in Sri Lanka, Maha (September to March) is the main rice growing season throughout the country while Yala (April to September) is the secondary growing season. Sri Lanka produces an average of 3.71 million tonnes of paddy rice with a yield of 4.23 tonnes/ha. Rice is the national staple food of 21.8 million people and nearly all of the production is consumed domestically. Paddy farming is an important socioeconomic activity which employs 72 percent of the rural population in its farming. Every year, rice is grown on more than 500 000 ha throughout the country. Two-thirds of this area is in the dry zone, where rice is grown as an irrigated crop, and the remaining third of the rice area is in the wet zone, where it is grown as a rainfed crop. Due to continues land fragmentation, more than 50 percent of total rice production comes from smallholders who cultivate less than 0.4 ha per household. About 25 percent of the total production comes from landholding of 0.4 to 0.8 ha per household. Commercial rice farming is limited only to the eastern province where paddy fields of more than 2 ha are common which contribute less than 25 percent of the total production. Nearly 83 percent of the area sown in 2019–2020 Maha season fell under the single owned category. Eight percent fell under the Ande (sharecropping) and 5 percent under the joint ownership category. Although, small scale rice farming is economically not lucrative, but it provides local jobs and food security to a large number of smallholders. Most of these smallholders are settled in the dry zone where they practice irrigated rice farming. Sri Lanka seldom exports rice to the international market and is considered as self-sufficient in the national food security.

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2. Approach

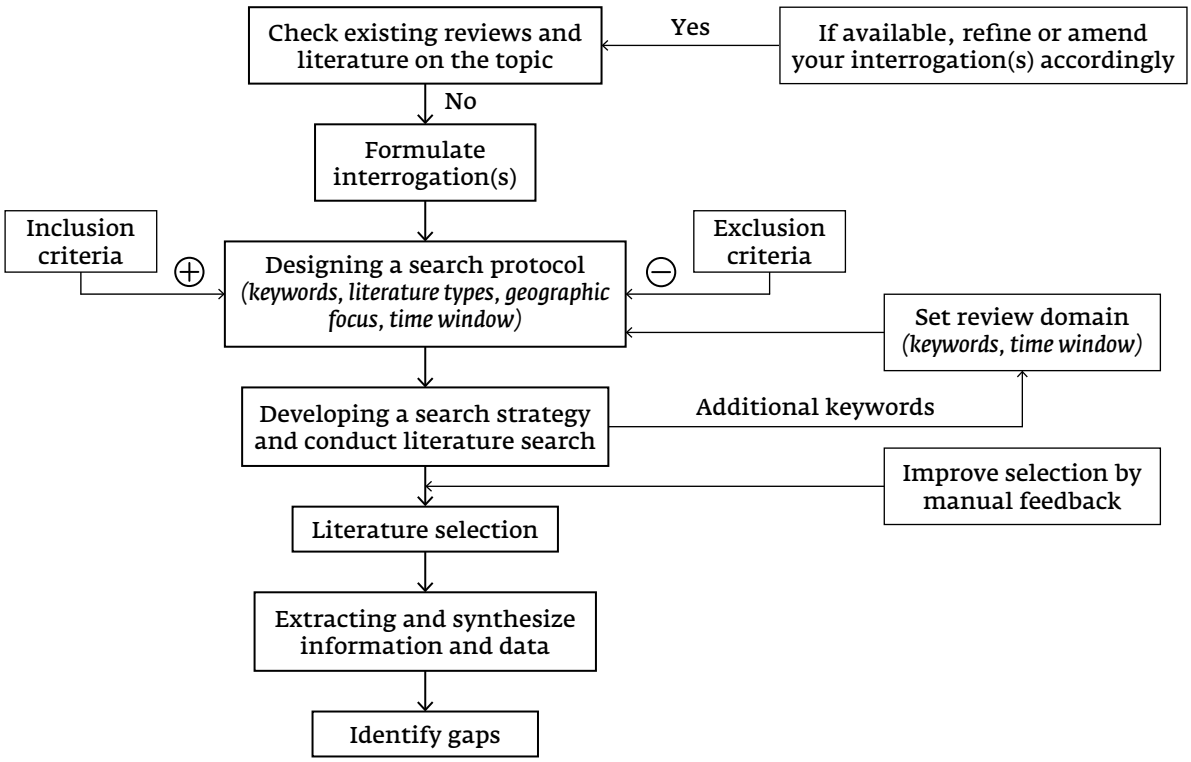
2.1 CONCEPTUAL FRAMEWORK FOR SYSTEMATIC REVIEW

The concept of systematic literature review has been used in this assessment to identify, select, and appraise the relevant literature in order to answer a set of clearly formulated questions. The systematic literature review conceptual framework describes a comprehensive understanding of the available literature within the scope of investigation, develops a protocol for formulating the primary interrogation points, and sets synthesis pathway for screening and appraising the available literature to identify gaps. Figure 1 shows a graphical representation of the conceptual framework used in the assessment.

2.1.1 Primary interrogation points

Addressing the major areas of the assessment, i.e. constraints and challenges in paddy rice production, the role of natural resource for paddy rice production, potential best practices and policy support for rice production, requires setting the primary interrogation points to examine the status of agriculture water use for paddy rice production in the country.

Figure 1. Conceptual framework of the systematic literature review



Source: elaborated from Moher, D., Liberati, A., Tetzlaff, J. Altman, D.G. 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLOS Med., 6(7): e1000097. https://doi.org/10.1371/journal.pmed.1000097

These concluded to be:

1. What are the constraints, challenges, and opportunities for improvement in paddy rice production in Sri Lanka?

2. Which factors could be considered as the driving force for the enhancement of paddy rice production and water use efficiency of paddy rice in Sri Lanka?

3. What are the potential best practices and improved rice production methods for improving water productivity in Sri Lanka?

4. How the national policies and plans support paddy rice production in Sri Lanka?

2.1.2 Designing a search protocol

The focus of designing a search protocol is to refine the review domain by identifying paddy rice as the target crop and related keywords for extended search according to the defined scope of the assessment. Additional filters are applied to define Sri Lanka as the geographical focus and the year 2000–2020 as the literature search time window in order to screen the large number of potential publications for the most appropriate and relatively recent knowledge and gaps. Moreover, the analysis includes only those publications that had an established relationship between improvement in water productivity or water use efficiency and at least one positive environmental impact.

Finally, the characteristics and type of publications have also been considered to include only those publications in the analysis which are based on established scientific methods with certain rigour such as experimental or quasi experimental methods, having well defined geographical identity, e.g. public irrigation scheme or part of national strategy or programme.

2.1.3 Developing the search strategy

In reference to the developed criteria, the search strategy comprised the following three steps to systematically narrow down the search to the target domain:

1. Firstly, a limited search of the Web of Science, Google Scholar, Science Direct, Wiley Online Library, and online repositories of relevant international, regional, and national organizations (e.g. FAO, the World Bank, the International Rice Research Institute, the International Water Management Institute, the Rice Research and Development Institute and the Department of Densus and Statistics in Sri Lanka) was conducted. The keywords "paddy", "paddy irrigation", "water management", "rice production", "rice productivity", "water productivity" and "rice yield" were employed to identify relevant literature containing the given keywords in the title, abstract and subject descriptors.

2. Once key terms and eventual synonyms were identified, an extensive search of the literature was performed on these platforms.

3. Finally, the reference lists and bibliographies of the articles collected from those identified in stage two above were further searched for relevant literature.

Articles published over the last 20 years (2000 to 2020) were searched. Full copies of articles identified by the search, and meeting the inclusion criteria based on their title, abstracts and subject descriptors, were screened for data collection. Articles identified through reference list and bibliographic searches were also considered for data collection based on their titles and abstracts.

2.1.4 Literature assessment and selection

The literature and studies that met the search protocol were grouped as: a) quantitative studies (i.e. experimental studies, cohort studies and case studies), b) qualitative studies (i.e. review and interpretive studies and policy document, etc.), and c) textual or opinion papers. Before the final selection, the methodological validity of these studies was assessed using the comprehensive selection checklist for each type of study.

2.1.5 Data collection and synthesis

Following the assessment of methodological quality and rigour of the publications, about 5 reports, 25 research articles and 15 websites were finally selected for data collection. Quantitative and qualitative data were extracted. Collection of quantitative data was made possible by reported tabular data sets and numerical values in the publications, while descriptive information about rice production in the literature was extracted as qualitative data.

The extracted information was synthesized in the context of the developed framework to answer the given interrogation points on the constraints and opportunities in paddy rice production, resource use in rice paddies, and technological adoption for enhanced water productivity and policy support for paddy rice production.

2.2 METHODOLOGY FOR MAPPING OF WATER GOVERNANCE

The mapping of water governance structure in Sri Lanka is based on the methodology developed by FAO in 2014 within the context of the agricultural water management (AgWA) partnership. The mapping allows the identification of:

- institutions
- laws and regulations
- policies

2.2.1 Institutional mapping

Institutions and actors are involved in the elaboration and are responsible for the implementation of regulations and laws of a predefined sector of the economy, i.e. natural resources management. They are identified at national, provincial, and local levels and their respective mandates and coverage are mapped using the following dimensions:

- geographical level: presence and influence at the national, regional, provincial, district or village level;
- nature of the institutions: public or private, for or not-for-profit, formal or informal;
- mandate: brief description of the key authorizations entrusted into the institution by law to perform certain duties in order to manage the state resources for the benefit of its public. A mission statement is also a good description of the institution's mandate; and
- functional objectives: key tasks conducted by the institution to fulfil its mandate.

2.2.2 Regulatory and legal mapping

Laws and regulations in the agriculture and water management sectors are identified through a literature review and described using the following dimensions:

- Specific targets: each of the specific objectives that the law or regulation aims at attaining, e.g. promote renewable energy sources or increase transparency in budget management.
- Measures implemented to attain defined targets: these measures may include setting up institutions, mandating participation, devolving, or centralizing responsibilities, etc.

2.2.3 Policy mapping

The policy environment in the agriculture and water sectors of the economy were mapped by identifying all relevant policies (eventually also beyond the single sector to highlight complementarities or overlaps) and describing each of them through the following aspects:

- Specific objectives: each of the specific objectives that the policy or regulation aims at attaining, e.g. economic allocation of water resources or provide sufficient water of good quality to all citizens.

- Measures implemented to attain defined objectives: these can be management, administrative, budgetary, capacity building, and accountability measures.

2.2.4 Gap analysis

The analysis of gaps in the policies and strategies in the agriculture and water sectors were guided by the OECD multi-level governance framework tool. This was used to identify the main multilevel governance challenges in the water sector and the policy instruments that governments use to overcome them. The framework is structured around seven types of gaps, as indicated in Table 2.

Table 2. OECD multi-level governance framework

Gap	Questions/Problems	Proposed action/ Recommendations
Administrative gap	Geographical "mismatch" between hydrological and administrative boundaries. This can be at the origin of resource and supply gaps.	Need for instruments to reach effective size and appropriate scale.
Information gap	Asymmetries of information (quantity, quality, type) between different stakeholders involved in water policy, either voluntary or not.	Need for instruments for revealing and sharing information.
Legal and policy gap	Sectoral fragmentation of water–related tasks across ministries and agencies and/or lack of appropriate regulation.	Need for mechanisms to create multidimensional/ systemic approaches, and to exercise political leadership and commitment.
Capacity gap	Insufficient scientific, technical, infrastructural capacity of local actors to design and implement water policies (size and quality of infrastructure, etc.) as well as relevant strategies.	Need for instruments to build local capacity.

(Cont.)

Table 2. OECD multi-level governance framework *(cont.)*

Gap	Questions/Problems	Proposed action/ Recommendations
Funding gap	Unstable or insufficient revenues undermining effective implementation of water responsibilities at sub-national level, cross sectoral policies, and investments requested.	Need for shared financing mechanisms.
Objective gap	Different rationales creating obstacles for adopting convergent targets, especially in case of motivational gap (referring to the problems reducing the political will to engage substantially in organizing the water sector).	Need for instruments to align objectives.
Accountability gap	Difficulty ensuring the transparency of practices across the different constituencies, mainly due to insufficient users' commitment' lack of concern, awareness and participation.	Need for institutional quality instruments.
Coordination/ Cooperation gap	Lack of cooperation/coordination among various stakeholders for effective implementation of the policy.	Strengthening cooperation among various stakeholders.

Source: Charbit, C. 2011. Governance of Public Policies in Decentralised Contexts. The Multi-level Approach. OECD Regional Development Working Papers No. 2011/04. https://doi.org/10.1787/5kg883pkxkhc-en

A gap is identified when there is a policy need not matched by an appropriate and effective governance response. The gap could take the form, for instance, of partial implementation of existing strategies, lack of law or regulatory provisions, poor coordination among various levels of governance, lack of governmental commitment to a specific action (deemed as necessary by stakeholders). The identification of gaps was carried out through an iterative process that involved desk research, consultation with key sector experts and wider stakeholders' engagement.

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3. Review of paddy rice production in Sri Lanka

3.1 OPPORTUNITIES AND CONSTRAINTS IN PADDY RICE PRODUCTION

Due to a favourable climate, rice is cultivated twice a year on an average of 500 000 ha in 31 agroecological zones of Sri Lanka. Paddy farming is a major socioeconomic activity which directly employs 72 percent of rural population. Rice is the national staple food and the main agricultural product which accounts for 40 percent of all agricultural outputs. The total area under rice cultivation has gradually increased from about 400 000 ha to over 600 000 ha during the last two decades. Despite this increase, the average landholding of rice farmers is less than one hectare which account for more than 50 percent of rice production. Economically, small-scale rice farming is not a lucrative business, but it plays an important role in poverty alleviation, local employment generation and ensuring household food security of smallholders. Although average rice production in the country amounts to 3.71 million tonnes a year, low yields and low resource use efficiency as compared to other rice producing countries in the region are still a challenge.

Sri Lanka has almost exhausted its irrigation potential and the prospects of developing additional land and water resources for irrigation are limited – there is little or no choice but to increase yields to meet its growing food demand. Some of the reasons of low paddy yield are decreasing farm size due to inheritance, inefficient resource use efficiency, low adoption of mechanized farming, high cost of quality seeds and crop inputs, shortage of labour, and marketing difficulties. Besides this, extreme weather conditions and climate change are increasing the risks of failed harvests and household food insecurity. In these circumstances, some progressive farmers are adopting innovative rice farming approaches to overcome the constraints in customary paddy cultivation. Some of the adopted innovations are the high yielding organic rice farming and parachute planting method promoted with the support of Sri Lankan cooperatives and the system of rice intensification (SRI) with the support of government, national and international NGOs. Sri Lanka has 30 percent potential to increase production efficiency by improving resource accessibility, capacity building of farmers, and retaining experienced farmers in the field by offering them incentives.

3.2 CLIMATE CHANGE – A CHALLENGE TO RICE PRODUCTION

Climate change has severely affected rice production in Sri Lanka. In 2016–2017, more than 82 000 hectares of paddy area was hit by a severe drought, resulting in a loss of more than 700 000 tonnes of rice. Nearly 72 percent of paddy is grown during the Maha season in dry areas where water resources are already stressed. According to the projections of the National Adaptation Plan for Climate Change Impacts in Sri Lanka 2016–2025, water demand during the Maha season will increase by 13–23 percent by 2050 as average rainfall will decrease, potential evapotranspiration increase, and the rainfall pattern will shift. The demand for irrigation water requirement in the dry and intermediate zones during the Yala season will also increase significantly. The projected changes in rainfall amount and the shift in rainfall pattern in the central highlands is likely to lead to conflicts between water supply for irrigation and hydropower generation from the Mahaweli multi-purpose project, which supplies 23 percent of irrigation water to the major schemes and meets 29 percent of national electricity demand.

3.3 PROSPECTS OF ENHANCING RICE YIELD AND PRODUCTION

3.3.1 Crop water productivity of paddies

Water productivity per crop is termed as crop water productivity, and it is defined as the agricultural production per unit of water. Crop water productivity can be influenced by several external factors since agriculture production is the result of selected crop variety, cropping season and crop management practices. Similarly, the volume of water supplied also depends on the evaporative demand, performance of irrigation system, mineral fertilization, planting density and date of sowing, and crop protection measures. All of these are important factors for optimizing crop water productivity.

In Sri Lanka, about 82 percent of the diverted freshwater is used for paddy irrigation but average rice yield and water productivity is just over 4.2 tonnes/ha and 0.7 kg/m^3, respectively. Water consumption for rice cultivation in Sri Lanka is estimated at 1 200 to 1 800 mm – almost double that of other rice growing countries. Comprehensive and relatively recent studies on water productivity of rice in Sri Lanka are limited. Table 3 shows the comparison of water productivity in three irrigation schemes during the two cropping seasons. Low water productivity is due to frequent irrigation, un-levelled paddy fields, rice cultivation in highly drainable soil and continues flooding of paddy fields.

Table 3. Water productivity of three major irrigation systems

Irrigation system	Water productivity (kg/m^3)	
	Yala	Maha
Batalagoda	0.72	1.03
Hakwatuna Oya	0.86	0.98
Kimbulwana Oya	0.50	0.31

Source: Lakmali, W.A.S., Gunawardena, E.R.N. & Dayawansa, N.D.K. 2015. Comparative performance assessment of major irrigation systems in Upper Deduru Oya Basin. Tropical agricultural research, 26(2): 343-354. http://doi.org/10.4038/tar.v26i2.8097

Water productivity of rice can be improved by reducing large amounts of unproductive water outflows during crop growth and using green water more efficiently. Instead of constantly flooding the rice field with 5–10 cm of water, the depth of flooding can be reduced by levelling the fields, the soil can be kept near saturation or alternate wetting and drying regimes can be introduced to increase yields and water productivity.

3.3.2 Water use efficiency of paddies

Water use efficiency is the ratio between the volume of water used to irrigate the crop effectively to the volume of water diverted to the irrigation system. It indicates the amount of diverted water that does not reach the crop root zone, and lost through evaporation, seepage of irrigation canals, overtopping, leakage, non-beneficial uses by weeds and bushes, and deteriorated irrigation infrastructure. In Sri Lanka, water use efficiency of paddy fields is estimated at 30 percent, which shows large amount of water losses in the system. Low standard of irrigation technology, lack of agricultural water management practices, inadequate allocation of funds for repair and maintenance, improper operation of irrigation system and uncoordinated approach to rehabilitation and maintenance of irrigation infrastructure are some of the known reasons for low water use efficiency. Several interventions in the irrigation sector such as the Mahaweli development project and participatory irrigation management have been implemented with the aim of improving the performance of irrigated agriculture, but the overall performance and water use efficiency remained far below its potential. It is estimated that increasing the overall irrigation efficiency to a level of 55 percent could lead to 35 percent reduction in water demand – equivalent to more than 3.9 billion m^3. The major irrigated areas have the potential to contribute to 78 percent reduction in demand if water use efficiency is increased to the potential level. Much of the blue water is lost during the continues flooding of paddy fields.

Sequential flooding of irrigation basins in the field result in significant water loss compared to direct application of water to each basin from a field channel. Farmers prefer sequential flooding as this method is less labour intensive and it facilitates field operations by reducing the number of field channels for direct application of water. Improper levelling of fields and failure to take into account the topographic slope and soil type also cause significant water loss.

The identified problems and the estimates of increase in irrigation efficiency show that if the currently developed water resources are used efficiently, only a fraction of this will be sufficient to meet future irrigation needs. In addition, the lack of an adequate water monitoring network, water pricing mechanism, and reliance on manual demand estimates result in excessive over-allocation and misuse of water in the Maha and Yala seasons, amounting to 63 and 52 percent respectively. Adjusting water allocation plans to take into account the contribution of green water could lead to a further reduction of blue water allocation in Maha and Yala by 35 and 8 percent respectively. Effective collection of water fees could be implemented with the aim of reducing water consumption and improving water use efficiency. However, the decision of tariff introduction and its impact on water use efficiency could be based on comprehensive socioeconomic and technical studies in pilot projects.

3.3.3 System of rice intensification (SRI)

The system of rice intensification is a climate smart low-cost farming methodology aimed at sustainably increasing rice yield with modified management of plant, soil, nutrients, and water. SRI is a system of production rather than a package of technical best practices. The basic principles of SRI involve early crop establishment, reduced plant density, improvement of biochemical properties of soil by incorporating organic matter, and conserve water by intermittent irrigation rather than continues flooding. It is a labour-intensive method of rice production, and its adoption is particularly favoured by farmers who rely on family labour. In several countries, including Sri Lanka, SRI trials have shown that the cost of production is half of the conventional system with significantly higher yields. A systematic investigation of production potential of SRI in dry zone of Sri Lanka has shown 7.6 tonne/ha yield against 6.3 tonne/ha (20.6 percent increase) under conventional broadcasting. The investigation also showed improved performance of SRI in terms of number of grains per panicle, plant height, weight of dry matter and leaf area index. Most importantly the amount of irrigation water under SRI system is reduced to about half and the crop has better resistance to diseases and pest without the application of pesticides and agrochemicals. In Sri Lanka the poor and rich farmers are equally inclined to the adoption of SRI system – the poor need to urgently raise their production and the rich are in a better position to experiment new techniques. SRI has shown promising results in trial and pilot studies, but substantial increase in production and water saving could only come from its large-scale adoption and uptake by the ordinary farmers. However, there are certain common issues such as mechanized transplanting and weeding, alternate soil fertility management methods and reliability of irrigation service that need to be addressed to make this system highly feasible for rice farmers.

3.4 BEST PRACTICES FOR INCREASING IRRIGATION EFFICIENCY AND WATER PRODUCTIVITY OF RICE

3.4.1 Optimal utilization of green and blue water

Water use efficiency in rice cultivation is influenced by the optimal utilization of green and blue water, which is widely practiced in Sri Lanka. In the Maha season, the decision to start cultivation is based on the predicted onset and expected amount of seasonal rainfall in the lowlands. As the Yala crop is harvested in late August or early September, cultivation of the Maha crop starts as early as possible (September and October) to take maximum advantage of the inter-monsoon rainfall. Under these conditions, dry-seeded rice technology offers a significant opportunity for early crop establishment and more efficient use of rainwater. Delayed sowing in Maha reduces the water use efficiency of green water, which also affects yield and production due to the resulting shortened age of the crop. Farmers are encouraged to follow a uniform cropping calendar without overlapping different growing stages in a particular region to integrate crop management practises at the regional level and reduce the time required to maintain individual crops. Supplementary irrigation during the Maha season with blue water from storage tanks is done only when crop water demand is high, or rainfall is insufficient.

In contrast, during the Yala season, most areas of the country, including the lowlands, do not receive sufficient rainfall and irrigation is the main source of supplementing soil moisture. The decisions on the extent of cultivated areas are based primarily on the amount of irrigation water available in the storage tanks. Water use efficiency in irrigation is one of the lowest in Sri Lanka. Water losses occur in storage, conveyance and distribution system. Conveyance and distribution losses could be reduced through optimal design of canal geometry and continuous operation of the irrigation network so that water losses are avoided during initial infiltration when the canal is turned on each time. Rotation of water delivery at field level should be encouraged to ensure equitable distribution of water among farmers. On farm water management practises and diversion of irrigation water to individual fields instead of continuous flooding of fields should be practised. During the Yala season, farmers and officials from the department of agriculture, the department of agrarian development, the department of irrigation and Mahaweli authority make important decisions about the extent of cultivated land and the type of crops for optimal use of available water, such as: i) whether to grow rice or other crops, ii) the proportion of lowland that can be cultivated with rice using the available water in the reservoirs, iii) the type and extent of other crops that require less water and can be grown to maximize agricultural production, water productivity and total cultivated area.

3.4.2 Adoption of on-farm water management practices

Water productivity of rice can be increased by reducing unproductive water use in rice fields through on-farm water management practises such as precision land levelling, high efficiency irrigation, deficit irrigation and alternate wetting and drying (AWD). Land levelling ensures even distribution of water and agronomic inputs, increases crop yield, and reduces post-harvest losses.

Studies have shown that land and water productivity of rice is significantly increased by uniform application of nitrogen fertilizer. Land levelling in irrigation schemes with a shallow water table becomes more significant as optimal nitrogen management is as important as water conservation to control environmental impacts and increase water productivity, respectively.

High efficiency irrigation systems allow frequent application of water and plant nutrients in small doses to create favourable conditions for plant growth, thus increasing water productivity. Recent trials of a high-tech rice irrigation system in the region have shown that it uses up to 76 percent less water compared to continuously flooded fields, resulting in water productivity of more than 0.30 kg/m^3 compared to 0.089 kg/m^3 for flooded fields. Deficit irrigation and AWD are water-saving technologies widely tested and commonly used in rice production to reduce irrigation water consumption without reducing yields. There are several variants of AWD, which can be combined with different cultivation methods depending on the agroecological region. In AWD, rice fields are flooded days after the water recedes below the soil surface. The number of days the soil is kept dry varies from 1 to more than 10 days, depending on soil type, weather conditions and crop growth stage. AWD helps reduce the number of irrigations by 2 to 5 without sacrificing yield, and excessive root growth allows for higher water and nutrient uptake, which helps increase land and water productivity. Alternate wetting and drying technology has been introduced in irrigated rice cultivation with water productivity ranging from 0.6 to 0.7 kg/m^3. But due to the lack of awareness among farmers and their capacity, AWD has not been widely adopted in Sri Lanka. As a result, scarce water is wasted in the large irrigation schemes and, on the other hand, crops in the smaller irrigation schemes suffer from water stress.

3.4.3 Intercropping and crop rotation to reduce water use

Intercropping and crop rotation are agricultural practices that enhance resource use efficiency, increase productivity, optimize soil nutrients, and improve soil health. Crop rotation is practiced in the lowlands during Yala season to maintain high cropping intensity and overall agricultural production, as irrigation water is insufficient to cover rice crop in the entire lowland. Most commonly, maize is intercropped with mung beans in the lowland rice belt to address water scarcity, and in the rainfed uplands with low productivity. In addition to intercropping with maize, the department of agriculture has recently recommended the cultivation of mung bean as a third season crop in selected rice-growing areas between the Yala and Maha seasons. In some areas, maize is also intercropped with soybean for increasing land and water productivity, increase in productivity of soybean-maize intercropping compared to rice alone is attributed to better utilization of solar radiation and water. The productivity of rice-chilli crop rotation was studied in the tank irrigation systems of Ambalegoda village in Sri Lanka in terms of land, water, and capital and material costs. The rice-chilli crop rotation was preferred by almost a quarter of the farmers because of the high return on investment and the low irrigation requirement of the chilli crop.

3.4.4 Introduction of water tariff

Water tariff could be introduced in Sri Lanka to economize water consumption and encourage efficient use of water for irrigation. However, there is no sound experience at the regional level to show the effect of irrigation tariffs on consumption. The introduction of irrigation water tariff in Sri Lanka would require considerable social and technical evaluation on pilot scale but currently this option is not under consideration by the policy makers.

3.4.5 Improved rice cultivars

Pest, diseases, salinity and iron toxicity are major constraints to rice production and the development of resistant rice varieties to these hazards is a strategy to improve rice yield. Traditional rice varieties (such as pokuru samba, suwadel, suduheenati, kahawanu and kuruluthuda) do not resist these hazards and produce more biomass than rice grain that result in lower water productivity in terms of grain yield per unit of water. Water productivity is also impacted by the duration of rice crop due to higher number of irrigations. The Rice Research Development Institute (RRDI) emphasized the cultivation of location specific short- and medium-duration rice varieties (2.5 to 4 months age) to optimize yield and resource use efficiency. Although this practice is still in the research phase at the RRDI, preliminary results indicate that there is no significant difference between the yields of medium and long duration varieties. Therefore, in water-scarce areas, it is recommended to increase the acreage of short-duration varieties through intensive management. The socioeconomic and planning centre at the department of agriculture has recommended 53 rice varieties of different crop ages, which are listed in Table A2. Farmers lose an estimated 37 percent of their rice crop to pests and diseases each year. The use of pure and healthy rice seeds is important to maximize yield and maintain plant's resistance against pests, disease and water stress. Over the last 4 to 5 decades, the RRDI has embarked on an extensive programme and has so far developed 87 rice varieties that are resistant or moderately resistant to various pests and diseases. The government supplies these varieties through mini kits of seeds to farmers for multiplication and encourages them to cultivate good quality seed. The private sector in Sri Lanka also plays an important role in the provision of good quality seed to farmers.

3.4.6 Transplanting of nursery

Transplanting the nursery from seedbeds to paddy fields has a significant impact on water productivity. It reduces water use during land preparation, germination and early stages of plant growth, shortens the duration of crop growth in the field, and makes it easier for farmers to harvest intercrops and continue land preparation while the nursery is still in the seedbeds. Although transplanting is a water-saving method, this practice is increasingly being replaced by direct seeding. The RRDI estimates that direct seeding is currently practiced on more than 90 percent of the rice area, and this trend is likely to continue in the future if large-scale mechanized transplanting is not encouraged. The driving force behind the shift from transplanting to direct seeding is the increased demand for labour due to economic growth, which has increased wages or reduced the availability of labour for various agricultural activities. This has led farmers to switch from transplanting, which requires 30–35 man-days/hectare, to direct seeding, which requires only about 5 man-days/hectare.

3.4.7 Soil fertility improvement and application of organic manure

Due to the increased cropping intensity and high temperature, the organic matter content in rice fields in the dry and intermediate zones of Sri Lanka has declined to less than one percent. In addition, the use of improper implements for land preparation has led to the development of a shallow hardpan resulting in poor root development and grain yield. The addition of organic matter, especially rice straw, farmyard manure and occasionally ploughing to a depth of about 20 to 25 cm, is considered advantageous in most of the rice cultivation zones. Macro and micronutrients – based on soil test – can be added to improve soil fertility and increase crop production. Organic fertilizers and farmyard manures help create a healthier soil environment for plant growth. They are commonly used in home gardens and organic farming to increase crop yields, but now agricultural practitioners are also recognizing their water-saving properties. Organic fertilizers increase microbiological activity in the soil, which improves soil structure and organic matter content. Better soil structure reduces surface runoff, improves infiltration and the water-holding capacity of the soil so that water can be stored for longer duration in the root zone. Organic fertilizers can also contain a fungus called mycorrhiza, which grows in the root zone and forms hyphae. The hyphae can extend beyond the actual root structure and contribute to high water and nutrient uptake. Unlike synthetic fertilizers, organic fertilizers contain a low proportion of soluble salts. This means that less water is needed to dissolve the salts and make them available as plant nutrients. The nutrients in organic fertilizers and manure are loosely bound together and are converted into inorganic compounds that are released more slowly in the soil, matching the plant's natural rate of uptake, and thus regulating plant growth. This process reduces the need for large amounts of water required by synthetic fertilizers to dissolve the soluble inorganic salts all at once, thus increasing water productivity.

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4. Mapping of water governance structure in Sri Lanka

4.1 EXECUTIVE GOVERNANCE AND ADMINISTRATION

Sri Lanka is governed by the elected president and the parliament composed of 225 members elected through a proportional electoral law. Some of the key functions and responsibilities of the central government have been devolved to nine provincial councils, established in 1987 according to the 13th amendment to the constitution of Sri Lanka. The political head of the province – the chief minister – is elected by the members of the council. Members of provincial councils, municipal and urban councils and pradeshiya sabhas (third tier municipal councils) are locally elected. The provincial administration is headed by the chief secretary, and there are separate administrative units headed by secretaries of the provincial ministries. The municipal and urban councils and sabhas are administered by public administrators and officers seconded from the central government or recruited under the provincial council's act. Table 4 shows the three-tier political set up with their administrative arrangements in the country.

Table 4. Political and administrative set up in Sri Lanka

	National	Provincial	Local
Political	The president and the legislative body (parliament) are elected by public. The president and the parliament have executive powers. The parliament is headed by an appointed prime minister selected among the elected members of the parliament and supported by the majority of them.	Provincial council headed by an elected chief minister.	Municipal councils, urban councils and pradeshiya sabha, headed by elected mayors or chairpersons.
Administration	The administrative side at the national level is headed by the secretary of the president and secretaries to various ministries.	Provincial administrative set up is headed by the provincial chief secretary.	Local administration set up is headed by the council secretary.
	District administration is headed by district secretary, representing the national government at the district level.		
	Divisional administration is headed by divisional secretary.		
	Grama niladhari unit (village level) is headed by grama niladhari (village officer).		

Source: authors' own elaboration.

Districts are the second-level administrative units of the national government. There are 25 districts covering nine provinces. Each district is administered by a district secretary, appointed by the central government. The main tasks of the district secretariat involve coordinating communications and activities of the central and divisional governance. The district secretariat is also responsible for implementing and monitoring development projects at the district level and assisting lower-level administrative units in their activities. The 25 districts are divided into

315 divisional secretariats. The area of a divisional secretariat is roughly equal to a pradeshiya sabha and sometime the spatial boundaries are the same for both units. The divisional secretariats are subdivided into 14 009 village units, each of which is administered by a government official locally called grama niladhari (village officer). The grama niladhari units are demarcated on the basis of an optimal number of households (around 250 families) that can be managed efficiently by the lowest level of government administration. This basic level administration collects and maintain various types of statistical and electoral data, issues local permits, maintains law and order by addressing local disputes and provides emergency response and relief to the communities when they are in distress. All the national, provincial, and local authorities and agencies remain financially accountable to the national government and the parliament, and all public entities at different levels are subject to the supervision of the auditor general.

4.2 MINISTERIAL INSTITUTIONS

A ministry is the first level of executive administration in Sri Lanka, a ministry manages one or more sectors of public administration and is headed by the cabinet minister. Several state ministries, branches, divisions, directorates, departments, authorities, councils and institutions are grouped under each cabinet ministry to perform specific functions of the sector such as providing technical support, administration and accounting, planning and development, research, implementation and operations and maintenance, etc. The ministry generally leads the formulation of policies with technical input from the line agencies, the policies are implemented with the help of subordinate institutions to achieve the objectives. In Sri Lanka, water resources are managed by several ministries in different capacities, which are mapped in Table 5.

Table 5. Mapping of water related institutions in Sri Lanka

Institution	Administration level	Mandate/ mission	Functions/objectives
Ministry of irrigation (including state ministry of Mahaweli development and state ministry of irrigation).	- National - Provincial - District	Providing wellbeing of community and environment by fulfilling multiple water users through water resources development and management.	- Formulation and execution of policies, programmes and projects related to the ministry. - Development of water resources and irrigation facilities. - River basins and irrigation systems management including operation and maintenance. - Conservation and protection of water sources and irrigation systems. - Bulk water allocation for multiple uses.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Ministry of irrigation *(cont.)*	- National - Provincial - District	Providing wellbeing of community and environment by fulfilling multiple water users through water resources development and management.	- Control of pollution of water sources and ensure quality of water. - Prevention of salt water intrusion to inland areas. - Drainage and flood protection. - Engineering consultancy services. - Institutional development and productivity enhancement of irrigation systems. - Development, monitoring and management of ground water. - Conversation of rainwater and promoting rainwater harvesting programme.
Irrigation management division	- Major irrigation schemes in Sri Lanka.	Implementation of integrated management of agriculture settlement in 54 major irrigation schemes.	- Strengthening project management committees and farmer organizations for management of common resources in irrigated areas. - Enhancing beneficiary contribution for irrigation water management. - Improving efficiency in irrigation sub-system operation and maintenance. - Capacity building of farming communities. - Popularizing cultivation of perennial and other field crops in irrigated schemes.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Irrigation management division *(cont.)*	- Major irrigation schemes in Sri Lanka.	Implementation of integrated management of agriculture settlement in 54 major irrigation schemes.	- Facilitating input supply and services for agriculture. - Facilitating and coordinating to enhance farmer family income.
Ministry of environment The ministry has the following divisions and units: - *Administration division* - *Accounts division* - *Air resources and national ozone unit* - *Biodiversity division* - *Climate change secretariat* - *Environment education training, promotion, and special projects division* - *Environment planning and economics division* - *Environment pollution control and chemical management division* - *Human resources development unit* - *International relations division* - *Investigation division* - *Internal audit division* - *Land resources division* - *Legal division* - *Policy planning and monitoring division*	- National	To provide leadership for sustainable environmental management by ensuring environmental protection through sustainable natural resource management.	- Acting as custodian of international commitments and treaties on environment and climate change. - Identification and analysing the problems in environment and natural resources sector through stakeholder consultation to enable policy formulation for sustainable development. - Ensuring notification and implementation of relevant stakeholders in the formulation of policies related to the conservation of the environment and natural resources. - Preparation of strategies and action plans and implementation of pilot projects to be able to implement policies that are in line with environmental and natural resources.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Ministry of environment *(cont.)*	- National	To provide leadership for sustainable environmental management by ensuring environmental protection through sustainable natural resource management.	- Ensure the implementation of multilateral environmental agreements signed by the Sri Lanka incompliance with the international commitments. - Development of monitoring mechanisms for environment and natural resource sector and develop strategies based on the data and information of monitoring. - Conduct research to identify impact of implementation of policies and analyse the research finding and disseminate among public and related agencies. - Creating a conducive environment for state and political sector's commitment towards sound environment management.
Central environment authority	- National	Integrating and ensuring environmental considerations in the development process of the country.	- Scheduled water management and environmental protection licencing. - Environmental impact assessment and initial environmental examination of development projects in the country. - Provision of laboratory services for water and air quality monitoring.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Ministry of water supply The ministry has the following divisions and units: - *Administration division* - *Technical division* - *Accounts division* - *Monitoring division* - *Procurement division* - *Land division* - *Development division* - *Internal audit division*	- National	Sustainable and affordable safe drinking water supply and safe sanitation facilities through environmentally friendly resource protection solutions.	- Management of human resources and assists to carryout duties assigned to the ministry of water supply. - Coordination with line institutions for the planning and implementation of large-scale water supply and sewerage projects. - Procurement for water supply and sewerage projects. - Effective, efficient and transparent management of public financial resources in accordance with the relevant laws, rules, regulations, procedures and guidelines in the country. - Review new project proposals submitted by line institutions. - Developing new initiatives in the field of water supply and sanitation and reviewing and reporting the progress of on-going projects of the institutions under the ministry. - Ensuring best value of money by monitoring the economy, efficiency and effectiveness of procurement activities.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Ministry of water supply *(cont.)*	- National	Sustainable and affordable safe drinking water supply and safe sanitation facilities through environmentally friendly resource protection solutions.	- Acquisition of land for water supply and sanitation project implemented by the national water supply and drainage board. - Ensuring that the government policies and priorities related to the water and sanitation sectors are implemented in conformity with the country's overall national development strategy.
National water supply and drainage board	- National - Regional - District	Serve the nation by providing sustainable water and sanitation solutions.	- Planning and design of water supply and sewerage projects. - Provide technical inputs to national policies on water and sanitation. - Ensuring water supply and sanitation services to the nation. - Provision of mechanical and electrical engineering solutions and consultancies to optimize operation of water supply and sewerage system. - Research and development for water supply and sanitation.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Department of national community water supply	- District - Community	Executing community water schemes and sanitation development.	- Community mobilization for water supply and sanitation schemes. - Empowering of community water organizations. - Promote water conservation. - Capacity building of communities on rainwater harvesting, health hygiene and sanitation and house hold pumping.
Ministry of agriculture	- National	To achieve globally competitive production, processing and marketing enterprises through socially acceptable, innovative and commercially-oriented agriculture, through sustainable management of natural resources of the country.	- Supportive agricultural policy for food and allied agricultural crops. - Established food and nutrition security. - Stable prices for agricultural products. - Efficiently coordinated paddy purchasing and marketing programme. - Timely implementation of projects. - Increase production in selected crops. - Efficient and effective implementation of accelerated food production programme. - Efficient and effective use of foreign funds. - Customer friendly and result oriented administrative system. - Results based management in entire government sector.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Department of agrarian development The department has the following divisions and units: - *Human resources development division* - *Development division* - *Corporate development division* - *Accounts division* - *Engineering division* - *Water management division* - *Internal audit division* - *Productivity and marketing division* - *Planning division* - *Legal division*	The department has the status of state ministry.	Formulation and timely maintenance of institutional, ancillary, legal and management services so as to ensure sustainable development of the agrarian society of Sri Lanka and making optimal productivity for all agricultural lands.	- Provision for the utilization of agricultural lands in compliance with the agricultural policies of the government. - Implementing provisions for the protection of cultivating rights of agricultural land owners, farmers owning agricultural lands and tenant farmers. - Making regulations in respect of registration and maintenance of farmers' organizations and ensuring the enforcement of such regulations. - Establishing agrarian development councils, and guidance and supervision for the execution of powers thereof. - Preparing, amending, revising and maintaining registers of agricultural lands containing information on agricultural lands relating to each agrarian development council area of the island. - Initiating action to solve problems of tenant cultivators in respect of agricultural lands and other disputes involving farmers.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Department of agrarian development *(cont.)*	The department has the status of state ministry.	Formulation and timely maintenance of institutional, ancillary, legal and management services so as to ensure sustainable development of the agrarian society of Sri Lanka and making optimal productivity for all agricultural lands.	- Enforcing provisions relating to the productivity, security, conservation and management of minor irrigation systems. - Constituting legal action against parties who violate the agrarian development act and agricultural policies of the government. - Providing institutional, legal, ancillary and management services required by other institutions in implementing agricultural and other development projects of the government.
Department of agriculture The department functions under the ministry of agriculture and it has 16 research centres and institutions.	- National - Provincial - District	Achieve an equitable and sustainable agriculture development, ensuring nations food and nutrition security through development and dissemination of improved agriculture technology and provide the relevant services to all stakeholders with more emphasis to the farmers.	- Promotion of agro technology. - Agricultural extension services. - Seed certification services. - Laboratory testing. - Agro-met advisory. - Regulatory services.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
Water User Associations	- District - Community	Water resources management and conflicts resolution.	- Maintenance of water storage tanks, irrigation canals, and help in implementation of decisions made at *kanna* meetings.
Mahaweli authority The authority has four divisions: - *Land use planning division* - *Water management secretariat* - *Business development division* - *Administrative division*	- Mahaweli authority has the status of state ministry which works at the regional and district level.	Implementation of the Mahaweli development programme to use innovative technologies in land and water management for enhanced agriculture productivity, sustainable energy production and environment.	- Preparing and implementing land and water development plans according to the project master plan. - Operation and maintenance of Mahaweli project infrastructure. - Resettlement of farmers in the newly developed irrigation schemes. - Rehabilitation and maintenance of irrigation network. - Irrigation water management and monitoring of water levels and discharge. - Enhancing agriculture production.
State ministry of tanks, reservoirs and irrigation development related to rural paddy fields	- Tank irrigation scheme - Rural level	Increasing agriculture production and water availability for environmental and domestic use by rehabilitation and modernization of rural irrigation systems.	- Increasing water retention capacities of existing tanks. - Clearing invasive water weeds, debris from water bodies and maintaining sustainably. - Rehabilitation of abandoned tanks to increase water availability. - Rehabilitation of irrigation networks and infrastructure to improve water use efficiency.

(Cont.)

Table 5. Mapping of water related institutions in Sri Lanka *(cont.)*

Institution	Administration level	Mandate/ mission	Functions/objectives
State ministry of tanks, reservoirs and irrigation development related to rural paddy fields *(cont.)*	- Tank irrigation scheme - Rural level	Increasing agriculture production and water availability for environmental and domestic use by rehabilitation and modernization of rural irrigation systems.	- Conservation of reservoirs catchment areas and riverine areas. - Capacity building of beneficiary organizations for sustainable maintenance and management. - Introduction of good water management practices based on cascade and basin level management.
Research and academia	- National	Develop knowledge and capacities through research and trainings.	- Facilitating the national institutions on research for development.
International and regional organizations	- National	Facilitating the national government in achieving sustainable development goals.	- Providing technical support, financial aid and capacity building initiatives for national development programmes.

Source: based on FAO. 2015. Tool for Institutional, Policy and Legal Evidence-Based Analysis of Agricultue Water Management in Sudan, Final Report. https://www.fao.org/fileadmin/user_upload/agwa/docs/IA_Sudan_Final.pdf

These institutions have overlapping roles in the formulation of policies, management, implementation, regulations, coordination at national and international level, research and funding of national programmes. Table 6 shows the groups of institutions based on their working domain.

Table 6. Institutional mapping based on their role in agricultural water management

Group	Institution
Policy formulation	All cabinet ministries with technical and policy inputs from the line agencies.
Implementation agencies	- Department of irrigation - Department of agrarian development - Mahaweli authority of Sri Lanka - Provincial offices of irrigation departments
Management agencies	- Department of irrigation - Department of agrarian development - Mahaweli authority of Sri Lanka - Provincial irrigation departments - Department of agriculture - National water supply and drainage board - Department of community water supply - District and division secretariats
Regulatory bodies	- Department of irrigation - Central environmental authority - Department of agrarian development - Department of agriculture - Mahaweli authority of Sri Lanka
Coordinating bodies	- Central coordination committee on irrigation management (CCCIM) - Mahaweli water panel - Provincial coordination committee - District coordinating committee - District agriculture committee - Divisional coordinating committee
Research and academia	- Rice Research and Development Institute (RRDI) - Engineering Council (EC), Sri Lanka - National Water Supply and Drainage Board (NWSDB) - Kothmale International Training Institute (KITI)
International and regional organizations	- Food and Agriculture Organization of the United Nations (FAO) - United Nations Development Programme (UNDP) - United Nations Environment Programme (UNEP) - International Water Management Institute (IWMI) - International Union for Conservation of Nature (IUCN) - Lanka Jalani (LJ)

(Cont.)

Table 6. Institutional mapping based on their role in agricultural water management *(cont.)*

Group	Institution
Funding institutions	- The World Bank (WB) - Asian Development Bank (ADB) - Japan International Cooperation for Development (JICA) - Japan Ministry of Agriculture Forestry and Fisheries (MAFF) - United States Agency for International Development (USAID)

Source: authors' own elaboration.

4.3 MAPPING OF WATER LEGISLATIONS

In Sri Lanka, there are more than 50 laws and regulations related to major aspects of water resources such as irrigation, land management, agriculture development, drinking water supply, inland fishing, and hydropower generation. Several legislative enactments also address water allocation, water management in different sectors and the right to access water. These acts have passed in response to a variety of water related issues that emerged over time. The following legislations are the most significant provisions which identify the legal status and authority of water institutions in the country and the rights of its citizens to water use.

Irrigation ordinance (No. 48 of 1968)

Paddy land irrigation ordinance (1856) was the first legislation made by the British colonial administration to legalize customary irrigation practices and the conditions for water extraction, particularly for paddy cultivation. This ordinance was amended from time to time to keep pace with the changing socioeconomic conditions and requirements. The transformation of this ordinance is summarized below, and Appendix (Table A3) details the gradual changes introduced to the paddy land irrigation ordinance of 1856 and how the current irrigation ordinance No. 48 (1968) came into enforcement. These changes show the key policies followed for irrigation, paddy cultivation and water management under different reigns in the absence of a separate water policy document:

- Irrigation and cultivation of paddy lands (1856).
- Ceylon government gazette (3264/1861) for Batticaloa area customs.
- Paddy lands irrigation ordinance (No. 21 of 1861).
- The paddy cultivation ordinance (No. 21 of 1867).
- Amendment to above, by 42/1884.
- Irrigation and paddy cultivation ordinance (23/1887) and (23/1889).
- Irrigation and paddy cultivation ordinance 1892.

- Irrigation ordinance (No. 16 of 1906), (No. 45 of 1917), (No. 45 of 1946).
- Amendments to irrigation ordinance of 1946 (1951).
- Irrigation ordinance (No. 48 of 1968), ("Principal enactment").
- Amendments to irrigation ordinance 1968 (1983, 1990 and 1994).

Mahaweli authority act No. 23 of 1979

In addition to the irrigation ordinance, the Mahaweli authority act No. 23 of 1979 provides legal support for empowering Mahaweli authority of Sri Lanka (MASL) to optimize agricultural productivity and employment potential and to generate and secure economic and agricultural development within any special area posted under the Mahaweli act.

Agrarian development act 46 of 2000

The agrarian development act No. 46 of 2000 is the current law on agrarian development in the country. Table A4 summarizes the changes introduced to the paddy lands act number 01 of 1953 and how the current agrarian development act 46 of 2000 came into enforcement. These changes also show the key policies followed for paddy cultivation management in the absence of a separate water or agricultural policy.

Provincial councils act (No. 42 of 1987)

The 13th amendment to the constitution of 1987 led to the most recent and significant change to the institutional framework of Sri Lanka. The provincial councils act No. 42 of 1987 established nine provincial councils covering the entire national territory and outlined the setting for power, functions and finance sharing between the centre and the regions. The 9th schedule to the 13th amendment sets out three lists:

- devolved list (functions devolved and carried out by the provincial councils);
- reserved list (non-devolved functions, to be carried out by the central government); and
- concurrent list (which defines matters upon which both parliament and provincial councils have jurisdiction).

State lands ordinance (No. 8, Part IX) of 1947

This Act defines public and private water resources and specifies the water uses for which no permit is required.

4.4 MAPPING OF POLICIES AND STRATEGIES FOR WATER MANAGEMENT AND AGRICULTURE

National policies on water resources provide guidance on the integrated management of resources and ensure equity, accountability and efficiency in its distribution and consistency with the national development goals.

4.4.1 National water policy initiatives

Sri Lanka does not have a national water policy. During the last three decades, several attempts are made to introduce a comprehensive water policy, but every time the effort ended up as a sectoral initiative. Most of these attempts failed due to the lack of political will and the declared intention only up to the recommendations level. Some of these initiatives include:

- Policy framework for participatory irrigation management (1980s): A broad policy framework to encourage the participation of the irrigation water users in the management, jointly submitted by the secretaries of irrigation and agriculture ministries, approved by the cabinet in 1988.

- Irrigation management policy support activity (1990s): This initiative was supported by the United States Agency for International DEvelopment which led to several reforms, including the amendment of the agrarian services act and irrigation ordinance to register and offer legal powers to farmers' organizations, projects for sharing natural resources, and comprehensive water resources plan. Nationwide consultative workshops were held to identify the policy intervention. Some of the proposals were later implemented on individual basis.

- Comprehensive water resources management plan (2001): This initiative was fostered by the recommendations of the irrigation management policy support activity and was funded by the Asian Development Bank. This initiative focused on the assessment of institutional capacity, development of overarching policy, drafting legislation, formation of an apex body for water governance and establishment of a data and information system to support decision making. The policy proposed the creation of three parallel organizations, the national water resources authority, the water resources council, and the water resources tribunal. The proposed policy and institutional arrangement formulated was approved by the cabinet of ministers. However, the act was not passed by the parliament as a law, due to strong campaign against several key provisions.

- Establishment of a ministerial task force (2002): This task force was established to analyse and recommend follow up actions of previously proposed policy initiatives. The recommendations of this task force included downsizing of the department of irrigation and Mahaweli authority, privatization of the water resources board, transfer of policy advisory function to the proposed national water resources authority, transfer of all tertiary irrigation schemes to farmer's organizations, and the creation of five regional water authorities to decentralize water management. This task force and their recommendations were abandoned with the change of government in 2004.

- The water services reform bill (2003) that regulates the water services in drinking water supply through the empowerment of the public utility commission of Sri Lanka was published in the government gazette. The bill, however, did not receive the support of the provincial councils and could not be approved by the parliament, since water is a devolved commodity.

- In 2004 a new task force was appointed by the ministry of irrigation to formulate a policy framework. The committee submitted a report outlining a framework and recommendations for a water policy. However, it remained only a report and was confined to the ministry.

- In 2013 the secretary of the ministry of irrigation appointed a committee to review previous drafts of water policies and propose suitable amendments to address the current challenges in water resources sector. The committee conducted consultative workshops and submitted a new policy framework. The draft framework was published in the national newspapers for public deliberation, and the feedback and comments were incorporated in the final version. With the subsequent change of government, the proposal was dropped again.

- In 2020 a new committee was appointed to review the proposed water policies of the past and make recommendations for a new draft. The recommendations by the committee along with proposed institutional arrangement and legislation were referred to stakeholder organizations for review. The overall objective of this policy is to encourage integrated water resources development and management to ensure that the water resources are conserved, efficiently managed, and fairly allocated among all stakeholders to meet the needs of the society and the environment with an ultimate goal towards sustainable economic development of the country. It is also intended to address the emerging challenges of climate change, natural and man-made disasters, urbanization and population dynamics, and poor governance.

4.4.2 Sectoral policies

In the absence of an overarching water policy, sectoral policies address specific needs on non-controversial issues to mitigate the adverse impacts in water and irrigation sector. Sectoral policies focus on areas such as drinking water, hydropower, watershed management, climate change, wetland, forest, environment, and disaster management, hence partly filling the policy gap. However, their operational frameworks do not address the need of a national water policy. Some of the major sectoral policies are discussed below:

- The national forestry policy (1995) provides clear directions for safeguarding the remaining natural forests of the country to conserve biodiversity, soil and water resources. The policy promotes the protection and conservation of watersheds and ecosystems and improved land management for agriculture.

- The national policy for wildlife conservation (2000) ensures the commitment of the government to conserve wildlife resources and promotes conservation, protection of ecological processes and life-sustaining systems, management of genetic diversity and the sustainable utilization and share of equitable benefits from biodiversity.

- The national environment policy (2003) aims to promote sound management of the environment, balancing the needs for social and economic development and environmental integrity. This policy highlights the need for sound land management and agricultural practices in all cultivated lands, particularly in the wet and intermediate zones, where the problem of land degradation has reached to an acute level.

- The national watershed management policy (2004) aims to conserve, protect, rehabilitate, and sustainably use and manage the watersheds through participatory approaches.

- The national policy on wetlands (2005) helps in the implementation of the national environment policy and other relevant national policies while respecting national commitments towards relevant international conventions, protocols, treaties, and agreements to which Sri Lanka is a party.

- The national physical planning policy and physical plan (2011–2030) is one of the ongoing initiatives with an expected impact on water resources development, including the protection of watersheds, rivers and inland water bodies. It specifies certain principles and strategies to achieve conservation and effective management of water resources.

- The national policy for the protection and conservation of water sources came into effect on 22 December 2014 through the government gazette No. 1894/3. Under this national policy, different issues of water resources sector are addressed, including strategies practiced in conservation and protection of water resources, identification and demarcation of hydrologic boundaries, strengthening of institutions, monitoring and evaluation, funding and operational mechanism for water development works, and terms of reference of the operational committee. This policy attempts to foster a holistic approach for the management of water resources.

- The national drinking water policy of the ministry of city planning and water supply, which aims to supply safe drinking water to the public and provides a framework for the water sector to guide its allocation strategies. The government acts as the custodian of the water resources and manage such resources on behalf of the people in an effective, efficient and equitable manner, in line with the social, economic and environmental needs of present and future generations. This policy also targets the improvement of national services for safe drinking water through the mobilization of all stakeholders.

- In 2019 the irrigation department analysed the previous policy proposals and identified certain gaps related to irrigation water management in its new strategic plan for water resources development and management. Considering the recent changes in weather pattern, land use and increased demand of water from various sectors, this strategic plan emphasized on the need to develop a national water resources development and management strategy based on scientific data and facts. Under the plan, the existing irrigation and water resources infrastructures were classified and divided into 103 river basins. It reiterates that the development of new water resources infrastructures will be guided by the extensive water resources database maintained by the irrigation department.

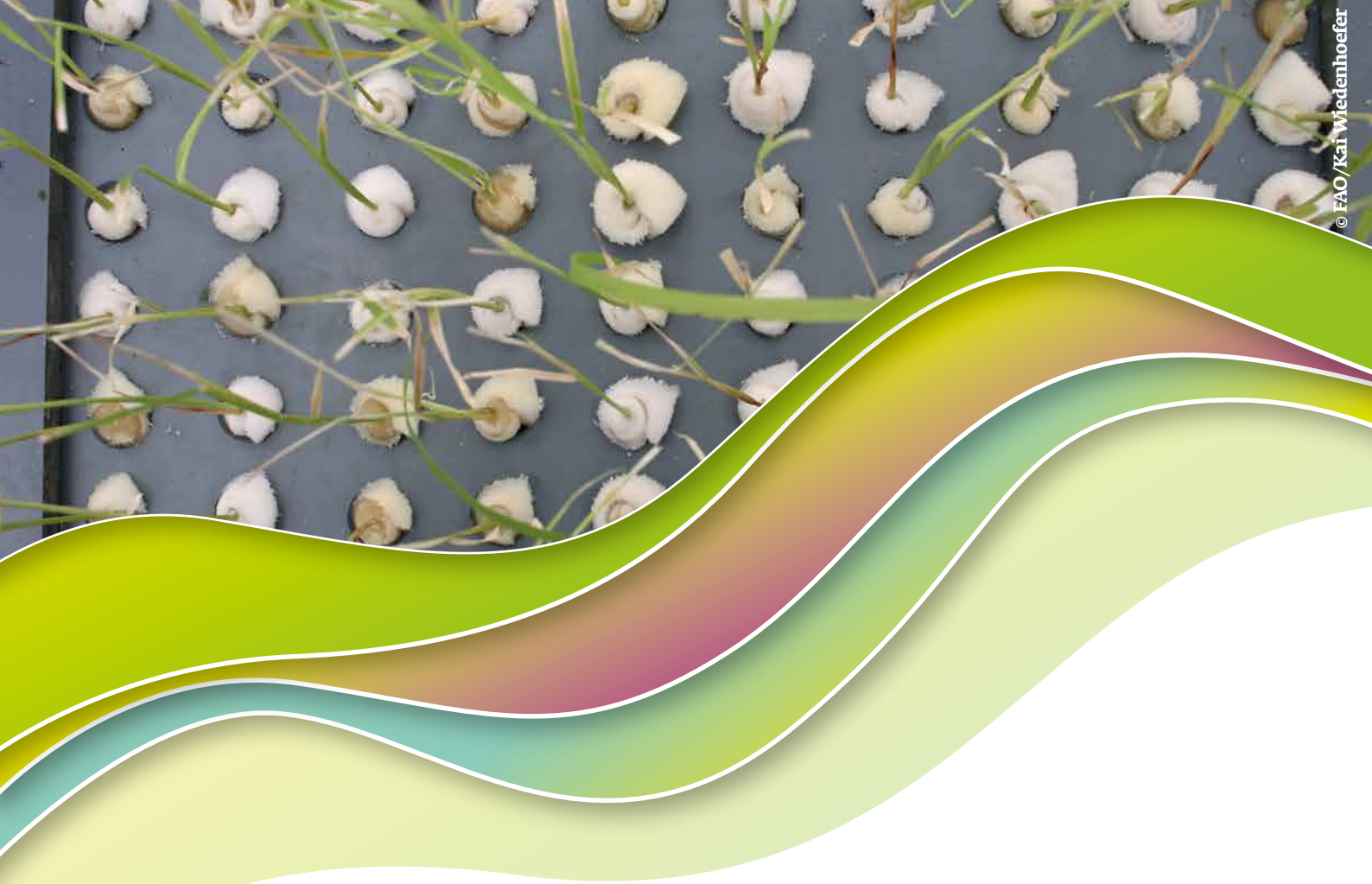
- The national policy on rainwater harvesting (2005) mandates rainwater harvesting in all areas under the jurisdiction of municipal and urban councils, within a period prescribed by law, and for certain categories of buildings and development works. The policy promotes groundwater recharge along the Wewa and Kulam reservoirs to enhance the water levels of the Pathaha reservoir as well as of dug and tube wells, spring, and other water source. It also encourages rainwater harvesting in the agriculture and plantation sectors by minimizing runoff to improve yields.

- The overarching agriculture policy (2021) outlines the vision for a vibrant and dynamic agricultural sector that achieves food security and national prosperity. The policy aims to guide the design of agricultural strategies and programmes. It covers all subsectors including food crops, plantation crops, export crops, livestock and poultry, inland fisheries, and aquaculture, land, irrigation, agrarian development, environment, and natural resources. Through this policy, the government aims to achieve globally competitive production, processing and marketing enterprises based on socially acceptable, innovative, and commercially oriented agriculture, while sustainably managing natural resources of the country.

4.4.3 Vistas of prosperity and splendour 2020

The vistas of prosperity and splendour 2020 is an officially declared multi sectoral national policy framework. It includes ten key policies for the achievement of the four outcome: i) productive citizenry, ii) contented family, iii) disciplined and just society, and iv) prosperous nation. Agriculture is considered as a key sector in the vistas of prosperity and splendour 2020 and several initiatives listed below have been identified to prioritize:

- Increase in agriculture productivity and water saving.
- Addressing the inequity in water allocation across key economic sectors including agriculture.
- Addressing unsustainable pumping of groundwater resources.
- Development of a regulatory framework for water pricing for large scale commercial agricultural production.
- Minimizing the adverse impacts of agriculture on surface and groundwater quality.
- Considering the needs of aquaculture in water resources development planning and design.
- Improving water management practices and water use efficiency.
- Assessment of funding needs for efficient operation and management of irrigation systems.
- Increased coordination among and within institutions responsible for agricultural water management at national and provincial levels.
- Long term strategic planning based on scientific assessment of resources.
- Strengthening the legal framework and improved focus and resourcing towards effective implementation of integrated water resources management.
- Ensure provision of adequate resources to authorities responsible for the conservation of watersheds, water resources, waterways, reservoir, and tanks.



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5. Policy gap analysis

The analysis of the existing and proposed policies and strategies has shown that there is a lack of responsibility and political will in formulation and implementation of most of the water related policies. The lack of coordination and flexibility among the concerned institutions and a non-holistic approach were also some of the major factors in reaching an overarching conclusion. The institutions have mostly adopted silo approaches to develop sectoral strategies and common issues such as the impact of climate change on water resources and agriculture and their mitigation measures were not considered in the true spirit. Due to climate change, water scarcity is going to be a major concern for all, and there is a need for improved coordination and cooperation between the farming community and water management institutions.

Institutionalizing integrated water resources management has become ever significant that needs more research for assessing water requirement by all sectors of the economy, recycling and reuse, watershed management, and on-farm water management to ensure equity, ecological integrity and efficiency of water use. There are multiple agencies dealing with water management for different uses, ranging from drinking, irrigation, power generation and ecosystem services. These agencies should be linked through strong institutional coordination mechanism functioning at ministerial, district and village levels, with the objective to increase water use efficiency.

Similarly, there is a very large number of legislations dealing directly or indirectly with water resources. However, the legal support and implementation strategies for collecting water charges and controlling water pollution are inadequate. The large number of legislations and overlapping roles of institutions are cited as the major reasons of mismanagement of water resources. The use of economic instruments in water resources management is a debatable subject in several countries of the world including Sri Lanka, which needs to be evaluated among different social groups and effective legal cover should be provided to water tariffs in irrigated agriculture.

Although the country is self-sufficient in producing staple food for its population, agriculture production, as a whole, is still characterized by low levels of productivity. Sri Lanka has high potential to increase water productivity through improved irrigation technology; however, there is a lack of policy and institutional direction in the implementation and upscaling of productive best practices at large scale in irrigated agriculture. To optimize water productivity at the national level there is a need to cultivate low delta cash crops, especially those with higher demand in the international market. Private investment is especially required to run value addition chains to achieve the required quality standards. This requires policy measures to open the irrigated agriculture areas to private investments.

Except the Mahaweli project, currently there is no systematic arrangement for water allocation from major water courses or water bodies for various purposes. The government decides on water allocation for various purposes on a case-by-case basis which gives rise to several issues in water distribution and hampers the performance of institutions. The lack of a water distribution mechanism or institution to address the problem of bulk water allocation is a large gap that needs to be addressed in an overarching policy. The riparian has the basic right to use water of the respective streams, but there is also a need for reallocation, especially due to climate change and the government priority of supplying safe drinking water to maximum population. In the context of water reallocation, an appropriate mechanism needs to be established which will help to decide on the need of reallocation and safeguarding the interest of affected and marginalized parties.

Demand management is another area which lacks research and policy coverage. At present, there are no incentives for water saving and no surcharge for overuse of water in irrigation which makes it difficult to manage the demand. Deployment of water accounting tools and adoption of on-farm water management and modern irrigation technologies require significant investment. Due to the current financial condition of the farmers and government institutions, the engagement of private sector should be strategically considered and pursued to adopt these technologies.

Currently, there are heavy restrictions on converting a paddy field into other types of land use and such a conversion needs the approval of the department of agrarian development. In the wake of increased demand of water and non-paddy crops, the conversion of paddy fields into other land uses is inevitable. In rural areas where livelihood opportunities are limited, there are increasing attempts of encroachment and subsequent conversion of forest lands for subsistence farming. On one side, these complex restrictions, and on the other side, the unchecked process of converting natural forests into agricultural fields, cause severe damage to the ecosystem and creates an imbalance in resource use efficiency. Responding to this practice and making optimum use of land and water resources are some of the priority actions that require significant policy and intervention by the government.

Conclusively, the policy gaps in water resources and agriculture sector are complex and overlapping, which are summarized, together with proposed policy recommendations, in the gap analysis matrix in Table 7.

In the past, the development of a national water policy was not successful because it followed a top-down approach with less consideration of ground realities and local experiences. Some of the proposed policy measures are politically sensitive as they may challenge the current status quo. But to address this, an inclusive and broad institutional and social dialogue is required to identify responsible actors and institutions for formulation and implementation of an overarching policy framework.

Table 7. Gap analysis matrix

Gap	Problem	Status	Recommendations
Administrative	- Complex and unclear roles of large number of institutions (41 institutions are identified) in water resources planning and management. - Lack of awareness among certain officials on the clarity of their responsibilities.	- Sectoral approach in dealing with challenges and opportunities.	- Institutional capacity and coordination need to be strengthened at all levels.

(Cont.)

Table 7. Gap analysis matrix *(cont.)*

Gap	Problem	Status	Recommendations
Information	- Historical hydrological data for planning and management of water resources infrastructure is lacking. - Water monitoring network is sparse. - There is very little information available on the account of groundwater resources. - There is no systematic mechanism to translate agriculture demand into supply.	- River flows are roughly estimated, and stream flow monitoring system is only available in Mahaweli ganga. - The irrigation department is the sole custodian of historical data on water resources and infrastructure. - The concept of water use efficiency and water productivity is rarely considered in the water sector (metering is only applicable for urban water supply). - There is a lack of demand management at irrigation scheme level.	- Gaps in data and information collection, archiving and sharing needs to be closed through digital resources. - The flow of information between institutions needs to be effective. - Capacity of farmers and community organizations should be strengthened in calculating water demand. - Community and district coordination committees should be strengthened to effectively communicate water demand projections.

(Cont.)

Table 7. Gap analysis matrix *(cont.)*

Gap	Problem	Status	Recommendations
Legal and policy	- There is no overarching national water policy and a legal system for sectoral water allocation and pricing. - Water pollution is uncontrolled, and the institutional roles of water resources development, management and distribution are unclear.	- Issues of water distribution are dealt on case-by-case bases which lacks transparency and equity.	- Water distribution should be according to a prescribed legal criterion with the objective to achieve equity in water distribution. - The tariff structure and cost recovery mechanism should be transparent and institutionalized.
Capacity	- Lack of master planning approach by the water institutions which can be considered as the root cause of mismanagement of water resources. - Lack of opportunities and interest in conducting studies on water use efficiency and productivity.	- Weak linkages between research and capacity building institutes and the industry.	- Refresher courses and on the job trainings of the staff of ministries and technical departments should be mandatory for promotions. - Ministries should sponsor and promote research studies on the pressing issues of water resources management.

(Cont.)

Table 7. Gap analysis matrix *(cont.)*

Gap	Problem	Status	Recommendations
Funding	- Budgetary constraints of the government in allocating funds for the water sector.	- Reliance of water institutions on state allocations and foreign projects funding. - Weak system of cost recovery and high inflation rate.	- Institutions need to diversify their funding sources by providing competitive services and attracting private investment in the form of public private partnerships.
Objective	- The general objective is to develop maximum water resources.	- The institutions are finding alternate means of water resources through rainwater harvesting and expanding the storage capacity.	- After gaining self-sufficiency in rice production, the government and relevant institutions need to shift their focus on enhancing water use efficiency and water productivity backed by research evidence.
Accountability	- Lack of accountability in water allocations, and in operation and maintenance of irrigation and water infrastructure.	- Institutions tend to monopolize their roles in water resources management.	- Water accounting and integrated water resources management approaches should be implemented in true spirit.

(Cont.)

Table 7. Gap analysis matrix *(cont.)*

Gap	Problem	Status	Recommendations
Coordination and cooperation	- Weak coordination on water governance at the national level (between central coordination committee for irrigation management, national water supply and sanitation steering committee and national community water trust) due to which the institutions try to adopt sectoral approach in water management.	- The water management panel (WMP) only coordinates water governance in the Mahaweli ganga and the linkage between the rest of divisions and districts coordination committees with a central coordination committee is weak.	- Coordination among district coordination committees, district agriculture committees and the divisional coordination committees need to be interlinked and strengthened. - Links between the field and community level administrative institutions with the national institutions needs to be strengthened.

Source: based on FAO. 2015. Tool for Institutional, Policy and Legal Evidence-Based Analysis of Agriculture Water Management in Sudan, Final Report. https://www.fao.org/fileadmin/user_upload/agwa/docs/IA_Sudan_Final.pdf

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Appendix

Table A1. Classification of agroecological regions of Sri Lanka

Zone		Agro–ecological region	75% rainfall (mm)	Terrain	Soil group	Land use
WET ZONE	Upland	WU1	> 3 100	Mountainous, steeply dissected, hilly and rolling	RYP, mountain regosol and lithosol soils	Tea, forest plantation, natural forest
		WU2a	> 2 400	Steeply dissected, hilly and rolling	RYP soils	Tea, forest plantation
		WU2b	> 2 200	Mountainous, steeply dissected, hilly and rolling	RYP, mountain regosol and lithosol soils	Tea, forest plantation, vegetable
		WU3	> 1 800	Hilly and rolling	RYP soils with prominent A1 horizon and RYP soils with dard B horizon	Tea, vegetable, pasture, home gardens forest plantation
	Midland	WM1a	> 3 300	Mountainous, steeply dissected, hilly and rolling	RYP soil with semi prominent A1 horizon and lithosol soils	Tea, natural forest
		WM1b	> 2 900	Steeply dissected, hilly and rolling	RYP soil with semi prominent A1 horizon and Lithosol soils	Tea, natural forest, mixed home gardens
		WM2a	> 2 200	Steeply dissected, hilly and rolling	RYP, RBL and LHG soils	Tea mixed home gardens, export agricultural crops, natural forest, paddy
		WM2b	> 1 800	Steeply, hilly and rolling	RBL, IBL, LHG and RYP soils	Mixed home gardens, paddy, export agricultural crops, tea

(Cont.)

Table A1. Classification of agroecological regions of Sri Lanka *(cont.)*

Zone	Agro–ecological region		75% rainfall (mm)	Terrain	Soil group	Land use
WET ZONE	Midland	WM3a	> 1 600	Steep, hilly, and rolling	RBL, IBL, LHG and lithosol soils	Mixed home gardens, paddy, export agricultural crops, tea, rubber
		WM3b	> 1 400	Hilly rolling, undulating and steep	RBL, IBL, LHG soils	Mixed home gardens, paddy, export agricultural crops, tea, vegetable
	Lowland	WL1a	> 3 200	Rolling, undulating and hilly	RYP, RYP soils with semi prominent A1 horizon and LHG soils	Tea, rubber, mixed home gardens, paddy, cinnamon
		WL1b	> 2 800	Undulating and rolling	RYP and LHG soils	Rubber, mixed home gardens, paddy
		WL2a	> 2 400	Rolling, undulating, flat	RYP, LHG, Bog and Half – Bog soils	Rubber, tea, coconut, mixed home gardens, paddy, export agricultural crops
		WL2b	> 2 200	Steeply dissected, rolling and undulating	RYP, RYP soils with strongly mottled sub soil, RBL and LHG soils	Rubber, coconut, mixed home gardens, paddy
		WL3	> 1 700	Rolling and undulating	RYP soils with soft and hard laterite, LHG and regosol soils	Coconut, fruits, mixed home garden, paddy
INTERMEDIATE ZONE	Upland	IU1	> 2 400	Mountainous, steeply dissected, hilly and rolling	RYP, Mountain regolith and lithosol soil	Tea, cardamom, natural forest, and forest plantation
		IU2	> 2 100	Mountainous, steeply dissected, hilly and rolling	RYP, mountain regosol and lithosol	Tea vegetable, mixed home garden, natural forest, and forest plantation
		IU3a	> 1 900	Steeply dissected, hilly, and rolling	RYP and mountain regosol	Tea and forest plantation

(Cont.)

Table A1. Classification of agroecological regions of Sri Lanka *(cont.)*

Zone	Agro–ecological region		75% rainfall (mm)	Terrain	Soil group	Land use
INTERMEDIATE ZONE	Upland	IU3b	> 1 700	Mountainous, steeply dissected, and hilly	RYP, mountain regosol and lithosol	Tea, natural forest, and forest plantation
		IU3c	> 1 600	Steeply dissected, hilly, and rolling	RYP and LHG soils	Tea, vegetable, and paddy
		IU3d	> 1 300	Steep, hilly, and rolling	RYP, mountain regosol and lithosol soils	Tea, vegetable, forest plantation and natural forest
		IU3e	> 1 400	steep dissected, hilly, and rolling	RYP and LHG soils	Tea, vegetable, paddy, mixed home garden
	Midland	IM1a	> 2 000	Very steep and hilly	RBL, RYP, IBL, LHG and lithosol	Tea, vegetable, mixed home garden, paddy, and forest plantation
		IM1b	> 2 000	Hilly, rolling and undulating	RBE, RBL, LHG, mountain regosol and lithosol	Natural forest, mixed home garden, paddy, and grassland
		IM1c	> 1 300	Very steep, hilly and rolling	RBL, IBL, mountain regosol and lithosol	Natural forest, vegetable
		IM2a	> 1 800	Steep, hilly, and rolling	RBL and RYP	Export agricultural crops, mixed home garden, tea, and vegetable
		IM2b	> 1 600	Very steep, hilly, and rolling	RBL, IBL, RYP, LHG and Lithosol	Natural forest, mixed home garden, paddy, tea, and vegetable
		IM3a	> 1 400	Hilly, rolling, and steep	IBL, RBL and LHG	Mixed home garden, export agricultural crops and paddy
		IM3b	> 1 200	Rolling and undulating	RBL, RBE and LHG soil	Mixed home garden, export agricultural crops, rubber, vegetable, paddy
		IM3c	> 1 100	Steeply dissected, hilly, and rolling	RBL and IBL	Vegetable, tea, mixed home garden, export agricultural crops

(Cont.)

Table A1. Classification of agroecological regions of Sri Lanka *(cont.)*

Zone	Agro–ecological region		75% rainfall (mm)	Terrain	Soil group	Land use
INTERMEDIATE ZONE	Lowland	IL1a	> 1 400	Rolling, undulating and flat	RYP soil with strong mottled sub-soil, RYP, LHG, RBL and regolsol	Coconut, mixed home garden, export agricultural crops, paddy, and rubber
		IL1b	> 1 100	Rolling, undulating and flat	RYP, RBL, RBE, LHG and regosol	Coconut, paddy, mixed home garden, export agricultural crops
		IL1c	> 1 300	Rolling, undulating and flat	RBL, RBE, LHG and IBL	Mixed home garden, rubber, paddy, and sugar cane
		IL2	> 1 600	Rolling, hilly and undulating	RBE, LHG and RBL	Mixed home garden, paddy, rainfed upland crops, scrubs, sugar cane and citrus
		IL3	> 1 100	Undulating	NCB, RBE and LHG	Coconut, paddy, and mixed home garden
DRY ZONE	Lowland	DL1a	> 1 000	Rolling and undulating	RBE and LHG	Mixed home garden, paddy, forest plantation, scrub, sugar cane and natural forest
		DL1b	> 900	Undulating	RBE and LHG	rainfed upland crops, paddy, scrub, mixed home garden, forest plantation
		DL1c	> 900	Undulating	RBE and LHG	Rainfed upland crops, paddy, scrub, natural forest, forest plantation and sugar cane
		DL1d	> 900	Undulating and flat	RBE regosol and LHG	Rainfed upland crops, scrub, and paddy
		DL1e	> 900	undulating	RBE and LHG	Rainfed upland crops, paddy, scrub
		DL1f	> 800	Undulating	RBE, LHG and grumusol	Rainfed upland crops, paddy, scrub, and natural forest

(Cont.)

Table A1. Classification of agroecological regions of Sri Lanka *(cont.)*

Zone	Agro–ecological region		75% rainfall (mm)	Terrain	Soil group	Land use
DRY ZONE	Lowland	DL2a	> 1 300	Undulating	NCB, RBE, LHG and old alluvial	Rainfed upland crops, paddy, natural forest, sugar cane and scrub
		DL2b	> 1 100	Undulating and flat	NCB, RBE, old alluvial, LHG, regosol and Bolodize-Solonetz soil	Paddy, rainfed upland crops
		DL3	> 800	Flat and slightly undulating	RYL and regosol	Cashew, coconut, condiments, scrub, and natural forest
		DL4	> 750	Flat	Solodize-Solonets, Solonchaks and Grumusol soils	Scrub, paddy, rainfed upland crops
		DL5	> 650	Undulating and flat	RBE with high amount of gravel in sub-soil, LHG and Solodized-Solonetz soils	Scrub, natural forest, rainfed upland crops and paddy

Agro–ecological areas which are suitable for rice cultivation have been highlighted in green.

IBM: Immature brown loam; LHG: Low humic gley; NCB: Non calcic brown; RYL: Red yellow latosol; RYP: Red yellow podzolic; RBE: Reddish brown earth; RBL: Reddish brown latosol

Source: Department of Agriculture. 2003. Agroecological regions of Sri Lanka, Council for agriculture research policies. Natural resources management centre, department of agriculture

Table A2. Maturity age of rice varieties and their highest yield recorded

Age group	Variety	Highest yield recorded (tonne/ha)
2.5 months	Bg 250	9.0
	Bg 251	8.3
	Bg 252	9.95
	Ld 253	10.1
3 months	Bg 300	7.0
	At 303	6.9
	Bg 304	7.4
	Bg 305	8.0
	At 306	5.2
	At 307	8.0
	At 308	7.1
	At 309	7.1
	Bg 310	7.5
	At 311	7.8
	Bw 272-6B	4.0
3.5 months	Bg 350	8.5
	Bw 351	5.0
	Bg 352	8.4
	At 353	6.5
	At 354	6.7
	Ld 356	7.4
	Bg 357	8.8
	Bg 358	6.3
	Bg 359	8.8
	Bg 360	5.7
	Bw361	10.0
	At 362	10.0
	Bw 363	7.0
	Bw 364	7.0
	Ld 365	7.9
	Bg 366	7.7
	Bw 367	7.9
	Ld 368	7.0

(Cont.)

Table A2. Maturity age of rice varieties and their highest yield recorded *(cont.)*

Age group	Variety	Highest yield recorded (tonne/ha)
3.5 months	Bg 369	10.8
	Ld 370	11.1
	Bw 371	4.6
	Bw 372	7.7
	Bg 374	10.6
4 to 4.5 months	Bg 379-2	-
	Bg 380	-
	Bw 400	-
	Bg 400-1	-
	At 401	6.1
	At 402	7.5
	Bg 403	8.6
	Bg 406	5.0
	Bg 407 H	13.0
	Ld 408	7.4
	Bg 450	6.4
	Bg 455	7.7
5 to 6 months	Bg 745	6.0
	Bg 3-5	-
	Bg 38	6.0

Source: Department of Agriculture. 2022. Rice Research and Development Institute (RRDI) Sri Lanka, Rice varieties.

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations

Title of legislation	Purpose of legislation	Highlights
Paddy land irrigation ordinance, 1856	- To revive the enforcement of ancient customs regarding irrigation and cultivation of paddy lands. - To remedy the defects and remove delays in the settlement of differences and disputes among cultivators relating to water rights.	- The first step forward in introducing legislations, which showed the government policy recognizing the rights of paddy farmers. - Attention was paid to the restoration of ancient irrigation schemes. Village councils were established consisting of selected paddy farmers and presided over by the government agent (GA).
Paddy land irrigation ordinance No. 21 of 1861	- Superseded the first irrigation ordinance. - Creation of irrigation districts (the ordinance provided powers to GA to organize various parts of the country into irrigation districts). - Election of irrigation headman whose duty was under the direction and control of GA. - The proprietors had the option of selecting the way of executing rules, whether it was through headman or village council.	- The headman (elected by farmers) had the authority to take quick preventive action against to damage of irrigation system and such action was not allowed to investigate by the village council and the expenditure incurred by the headman could be recovered by GA with an order by police court (generally double the expenditure incurred). - If the headman acts using his/her authority beyond his/her limits and bad behaviour, he/she would be guilty of an offence.

(Cont.)

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Paddy cultivation ordinance No. 21 of 1867	- The main aim was promoting irrigation maintenance and extending paddy cultivation in the country. - Government assistance could be requested when farmers were unable to construct, repair or improve any irrigation works by their contribution alone. - The governor had the authority to direct his officers to prepare proposal and estimates for the repair or improvement works.	- The Government officers carried out the work and proprietors were given the option to attend the earthwork. The proprietors were liable to pay the expenditure incurred to repair or improvement works in instalments and any case of default the GA had the authority to seize and sell land, crops, produce and movables. - Any survey plan covering tanks, channels, watercourses etc prepared by surveyor general were considered as legally authorized proof of the irrigation scheme.
Irrigation and paddy cultivation ordinance No. 23 of 1889	- Repealed all the previous acts relating to paddy land irrigation. - Formation of irrigation fund.	- Technical intervention in restoration works were ensured with the formation of central irrigation boards (CIB) and provincial irrigation boards (PIB). - GA was empowered to decide releasing of government funds for the irrigation works maintained by proprietors.

(Cont.)

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Irrigation Ordinance No. 10 of 1901	- Ordinance to amend the irrigation and paddy cultivation ordinance of 1889 and 1892. - Allowed utilization of funds for construction, restoration and maintenance of irrigation works, which benefit crown lands.	- Punishment declared for irrigation offences such as obstruction or encroachment to irrigation works, illegal tapping of irrigation water and wasting irrigation water, etc. - Interpretation of appropriate words to include "the cultivators" and also the actual person such land was defined as "any person nominated by GA to represent the crown when crown lands are benefited by such irrigation works". Accordingly, the act provided opportunity to define persons who occupy colonization lands also as "proprietors".

(Cont.)

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Irrigation Ordinance No. 16 of 1906	- Repealed the irrigation and paddy cultivation ordinance No.23 of 1889. - Central Irrigation Board and Provincial Irrigation Board abolished, and the irrigation fund was ceased. - Governor was empowered of demarcating irrigation districts, to declare any irrigation scheme, which shall be placed under control and management of director of irrigation (Irrigation department was formed in the year 1900). - GA was empowered to fix the rate for maintenance based on the estimate prepared by the director of irrigation. - When the government fund was not expected, the contribution of landowners was determined by them and approved by GA. - Village committees were formed to provide financial assistance for people to cultivate crown lands.	- Annual programmes for maintenance, flood protections, river training, and drainage management were introduced. - Similar to the power of GA on other schemes, director of irrigation had powers to make rules appointing irrigation officers who were similar to irrigation headman. - Water management, irrigation practices, crop diversification and water for other uses were outcome. - Developed correct technical approach for better water management. (e.g. area capacity curves). Apart from village fund, government provided grants for paddy cultivation. Violating rules were referred to village tribunal through GA and punishments for offences had been explained clearly.

(Cont.)

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Irrigation Ordinance No. 45 of 1917	- This elaborated some of the clauses in previous ordinances irrigation ordinance, No.16 of 1906 and followed two amendments No.20 of 1908 and No.11 of 1915. - GA was empowered to fix the irrigation rates with the assistance of director of irrigation and survey general. - Director of irrigation was empowered to issue permits for diverting water from public streams for the persons who wanted to do irrigated agriculture. - Director of irrigation was able to appoint an arbitrator in a court of arbitration. - Governor had the authority to take steps to rectify the defects of poorly maintained irrigation works by proprietors and recover the cost from them.	- Clear definition for irrigation rate was mentioned in the ordinance and it covered direct use of irrigation water as well as indirect use of irrigation water such as use of drainage or seepage water, taking water using mechanical appliances etc. Director of irrigation was authorized to issue permits for using such mechanical appliances. Discharge curves, rainfall curves, progress plans, land application plans were developed. Propose to cultivate coconut, cocoa, cotton, with irrigation facilities. - Protection of irrigation works and conservation of water were explained and the Governor was empowered to make rules on utilization of irrigation (diversion, prevention of obstructions to irrigation works, etc). Special attention was paid on irrigation offences strengthening rural courts with added powers for prosecution of persons for such offences.

(Cont.)

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Irrigation Ordinance No. 32 of 1946	- The Irrigation ordinance No.45 of 1917 was repealed by this ordinance. - District agricultural committees (DAC) were set up under the chairmanship of the GA. members of this committee consisted of government officers who were dealing with agricultural development in the district. - Advisory committees were established for each scheme comprising director of irrigation, Director of agriculture, GA and at least 12 members elected from proprietors. GA chaired the committee.	- Major and minor irrigation works were defined separately (major schemes as constructed and maintained by director of irrigation and all other schemes as minor). The powers of irrigation headman were defined clearly. - Rules were enforced on paddy lands that were not under irrigation water but under rain, well or any other source ('manawari' lands).

(Cont.)

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Irrigation Ordinance No. 48 of 1968	- This is referred to as the "Principal enactment" of irrigation ordinance and still valid with subsequent amendments that Act No. 23 of 1983, Act No.34 of 1990 and Act No.13 of 1994. - Power was given to the commissioner of agrarian services to carry out their duties under the irrigation ordinance, in line with paddy land Act No.01 of 1958. Some of the duties carried out by GA under previous irrigation act came under the commissioner of agrarian services. - Cultivation committees and their agents were given powers. - The post of irrigation headman was abolished. - Irrigation agent appointed by the cultivation committee took over the authority of irrigation headman.	- With the implementation of paddy land act No.01 of 1958, cultivation committees (farmer–elected) were established with the authority of carrying out all activities connected with irrigation maintenance works and implementation of irrigation rules. - However, the cultivation committees had to face many problems, as the irrigation ordinance No.32 of 1946 was still valid and as a consequence of that a breakdown of rural irrigation sector was observed. The situation was taken into consideration by the government amended the irrigation ordinance No.32 of 1946.

(Cont.)

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Act No. 23 of 1983	- GA was empowered on removal of obstruction or encroachment upon any ela (stream), channel, water course or tank and repairing damages to any irrigation structure and recovering the cost incurred to such removals or repair works. - Recovery of contribution from persons other than allottees and tenant cultivators were further elaborated covering landowners and encroachers. - Rural court was replaced with magistrate court related to irrigation. - Formation of irrigation fund from fines and penalties over irrigation offences.	- Cost recovery through participatory irrigation management practices were introduced. Farmers' involvement for operation and maintenance of canal below distribution canals were also introduced.
Act No. 34 of 1990	- The section 118 of the "Principal enactment" was amended by the substitution for the definition of "government agent", including an additional GA, an assistant government agent, and secretary to the minister of the board of ministers of a province in charge of the subject of irrigation and divisional secretary of a provincial council.	- GA power was delegated. It can be applied only for schemes within the area of divisional secretary.

(Cont.)

Table A3. Development phases of irrigation ordinance and key polices for irrigation and water management as reflected in the legislations *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Act No. 13 of 1994	- The main purpose of this amendment was to provide legal backing for the new concepts in participatory management. - The expression "cultivation committee" in the principal enactment was replaced by the expression "farmer organization". - Powers given to cultivation committees in principal enactment have passed to "farmers' organizations (FOs)".	- Establishment of "Project management committee" for the schemes which are specified by the secretary to the ministry in charge of irrigation. - Project management committees has mandate for seasonal planning, crop selection, productivity management, water management, water allocation and marketing. - Farmers' organization that has taken over operation and maintenance activities for distributary and field canals system in the command area of organization were exempted from irrigation tax.

Source: authors´ own elaboration.

Table A4. Development phases of Agrarian Development Act 45 of 2000 and its transformation from the Paddy Land Act No. 01

Title of legislation	Purpose of legislation	Highlights
Paddy lands act No. 01 of 1953	- Paddy lands bill 1951 was presented to resolve some of the tenure problems on paddy lands but passed in 1953. It required tenancy arrangements to be written and registered. - During the period of such an agreement, election of a tenant was permitted only for certain specified causes and for such ejection a court order was required.	- No. proper implementation mechanism was introduced and hence not been effective. - The main aim is to ensure tenure security and to regulate the rent paid by tenants to the landlords.
Paddy land act No. 01 of 1958	- Department of agrarian services was established. - Cultivation committees were established with the authority of carrying out all activities connected with irrigation maintenance works and implementation of irrigation rules. - The cultivation committees were farmer–elected organization, and it termed the role of irrigation headman invalid.	- Joint decision–making system introduced. - Study the progressive and optimum utilization of water and related land resources were started.
Agrarian services act of 1979	- Acts (the paddy lands act No. 01 of 1958, agricultural productivity law of 1972 and the agricultural land law of 1973). - Aimed at securing tenure rights of tenant cultivators of paddy and improving the productivity of such lands. It is considered as a more realistic approach in solving the problem of the paddy sector.	- This policy was considered to be in conformity with open economic policies and the macroeconomic needs to affect higher flexibilities in basic resources governing food production, employment and income creation.

(Cont.)

Table A4. Development phases of Agrarian Development Act 45 of 2000 and its transformation from the Paddy Land Act No. 01 *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Agrarian development act 46/2000	- Repealed the agrarian services act of 1979. - The preamble for the act states: "Whereas it has become necessary to set up national policy in relation to the right of tenant cultivators and the restrictions to be imposed on persons using agricultural lands for non-agricultural purposes, in order to ensure maximum utilization of agricultural land for agricultural production". - Empowered commissioner general of department of agrarian development (DAD) with powers of a district judge to implement the provisions in the act. - Created major changes in rights of persons who cultivate paddy lands. Regarding selling of paddy lands the owner of such land shall give first priority to tenant cultivators of such land. - When tenant cultivator fails to meet the offer given by owner, agrarian development council shall decide the price in consultation with the owner. - Tenant, who fails to act in line with the decision taken by the said council, could be evicted from the land. - Tenant can transfer his rights to the landowner if he wishes to do so.	- Commissioner general may decide that certain land is paddy land or not and also in consultation with farmers' organization and agrarian development council, the commissioner general shall do identification of paddy lands, which can be cultivated with paddy and other crops. The commissioner general and the officers have the powers to inspect such lands to find out the purpose of which the land is used. Any person, using A-10 paddy land other than cultivation without the permission of commissioner general, shall be guilty of an offence under this act. - Identified the necessity of setting a national policy to safeguard the rights of tenant cultivators. - Ensure maximum utilization of agricultural land by imposing restrictions on conversion of agricultural land into non-agricultural uses.

(Cont.)

Table A4. Development phases of Agrarian Development Act 45 of 2000 and its transformation from the Paddy Land Act No. 01 *(cont.)*

Title of legislation	Purpose of legislation	Highlights
Agrarian development act 46/2000 *(cont.)*	- Other matters relevant to tenant cultivators, such as maximum extent of cultivation, leasing of paddy lands, evictions of tenant cultivators, paying of rent by tenant cultivators etc are elaborated in the act. - Cultivating agricultural lands shall be the duty and responsibility of owner cultivator or occupier and when the Commissioner General is informed that an agricultural land is not being cultivated, owner cultivator or occupier could be kept under Commissioner General's "supervision Order". Owner cultivator or occupier who fail to obey the "supervision Order" shall pay compensation to the credit of agrarian development fund.	- Commissioner general may decide that certain land is paddy land or not and also in consultation with farmers' organization and agrarian development council, the commissioner general shall do identification of paddy lands, which can be cultivated with paddy and other crops. The commissioner general and the officers have the powers to inspect such lands to find out the purpose of which the land is used. Any person, using A-10 paddy land other than cultivation without the permission of commissioner general, shall be guilty of an offence under this act. - Identified the necessity of setting a national policy to safeguard the rights of tenant cultivators. - Ensure maximum utilization of agricultural land by imposing restrictions on conversion of agricultural land into non-agricultural uses.
Agricultural land management regulations No. 01 of 2009	- Every owner, cultivator or occupier of any agricultural land or a paddy land, as the case of maintains standards of cultivation.	- Under this recommended varieties and strains of crops shall be cultivated, irrigation water shall be efficiently managed, and the land shall be properly maintained in order to ensure the maximum conservation of soil and water, necessary steps shall be taken for the protection and preservation of crops which are being cultivated and crops harvested or in the process of being harvested.

Source: authors´ own elaboration.

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