Role of Village Tank Cascade Systems in establishing Food Security Status in Dry Zone of Sri Lanka: A Qualitative Exploratory Study from a Historical Perspective

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Abstract

Food security is a matter in most regions of today's world, even though per capita world food production increased with the western scientific advancements in agriculture. New discussions over food security emerged globally, particularly since the late 1970s, with four dimensions – physical availability of food, economic and physical access to food, food utilization, and stability. Thus, this study attempted to investigate how time-tested indigenous food systems in Sri Lanka have acknowledged the concept of food security using ancient village tank cascade systems in the dry zone. The study applied the qualitative interview method to 20 adult farmers (>70 years) in a typical cascade system located in 581-Maradankalla GN division in the Mihintale DS division in the Anuradhapura district. The study revealed the critical components of the ancient food supply model of the village tank cascade system, which can support ensure the food security status throughout the year. It is a holistic system that stabilizes food availability, accessibility, and utilization status in farm households throughout the year. The study identified a deviation from the main components of the ancient food supply model, and the conversion of independent ancient food model to market dependency food model through transformed agriculture in the dry zone that had aggravated the food vulnerability among the farm households and thereby, the food insecurity.

Keywords: Ancient Village Tank Cascade System, Dry zone, Food Security, Sri Lanka

1. Background

The concept of food security emerged as a topical subject in academia during the 1980s. The food was a matter to many people globally, precisely due to the agricultural transformations' outcomes and changed social and economic structures in many regions of the world. According to the World Bank estimates, about 800 million people still go to bed hungry every night, and many more suffer from the 'hidden hunger' of malnutrition (World Bank Group, 2015). During the last century, mainly the Western scientific discoveries have transformed the global food system, particularly the techniques of the green revolution, thereby considerably increasing the per capita food availability. For instance, from 1950 to 2008, the global population doubled, whereas the global output of grains increased 3.3 times, contributing to an increase in global per capita food availability by 1.2 times. The world food crisis, reported in the years 2007 and 2008, and the most prominent food crisis of the 21st century, resulted in an unexpected increase in world hungry people from 800 million to 925 million. It put all global efforts towards a hungry-free world via agricultural modernization and the 1st target of the Millennium Development Goals (MDGs) into question. It is evident that half of the deaths in the world in children under five are due to malnutrition (FAO, 2015), and thus, any form of food crisis aggravates the situation. When the rise in global output of food grains is higher than the worldwide increase in population, the question does arise why there is a global food crisis and why so many people are still hungry, having even no meal? Given this global trend, it is high time to study how time-tested indigenous food systems acknowledged the concept of food security to provide sustainable lessons to sharpen the modern view of food security.

During historical times, Sri Lanka was a country of sufficient and prosperity. Food security was not a problem and never a concern. People in Sri Lanka not only had food and other essential commodities for themselves, but they also had sufficient to share with others. Sri Lanka succeeded significantly in restoring most of the historical and archaeological sites to its glory. However, the restoration of conventional life and economic activities has been forgotten by present-day technological and cultural adaptations of contemporary improvement efforts or modernization processes. This unbalanced intervention has complicated people's lifestyles and resulted in challenging the country's food security status.

Sri Lanka, being an agricultural country, is based on an agricultural economic system and society. The ancient concept of agriculture was based on the concept of "Wewai (Tank) - Dagabai (Stupa), Gamai (Village and Fields) - Pansalai (Temple)." These four components of the ancient Sri Lankan culture were woven together to lead to prosperity. Among them, the tank is a significant part of food security in ancient Sri Lanka.

The tank contributes to food security in a variety of ways. Its primary function is gathering and supplying water through irrigation canals to agricultural fields, mainly to the paddy fields. Also, the tank is used to produce fish. Fish is enriched with health proteins, and the villagers use fish as a key protein source. Lotus (Nelumbonucifera) seeds and tubers, Olu (Nymphaeanouchali) seeds, and some green vegetable leaves, naturally grown in the tank, are harvested for home consumption and sale (Ministry of Agriculture and FAO, 2017).

A cascade system is a connected series of tanks organized within a micro-catchment of the dry zone in Sri Lanka. The tanks store water from a seasonal stream. The stored water is conveyed to other tanks in downstream and used for a variety of purposes. The tank cascade system, mostly found in dry and intermediate zones of Sri Lanka, was first defined by Prof. Maddumabandara as a “connected series of tanks organized within the meso-catchments of the dry zone landscape; there is a small percent of small tanks that do not occur within a cascade. They occur as an individual tank with their own micro catchment.” Therefore, “a ‘cascade’ is a connected series of tanks organized within a meso-catchment of the dry zone landscape, storing, conveying, and utilizing water from an ephemeral rivulet” (Maddumabandara, 1985).

In this background, this paper’s central aim is to study the role of the ancient village tank cascade system in maintaining food security status among villages in the dry zone of Sri Lanka. In this connection, the study will focus on the following specific points, 1) identify the critical components of ancient village tank cascade system-based food systems in the Dry zone, 2) explore the sustainable characteristics of ancient village tank cascade system-based food systems in the Dry Zone in a viewpoint of ancient food security, and 3) provide lessons to contemporary issues in maintaining food security status in village communities in the Dry Zone.

2. Define the Food Security

2.1 The ancient view of food security

The Dhammapada is a collection of Buddha's sayings in verse form and one of the most broadly read and best-known Buddhist scriptures. It states, "Arogyaparamalabha – Santutthiparamamdhanam" – "health is the greatest gift, contentment is the greatest wealth." The Sri Lankan culture, mainly in the dry zone villages, was based on the concept of "Wewai, Dagabai, Gamai, Pansalai" which means the culture is based on the relationship between the components, namely: "the tank, the stupa, the hamlet, and the temple" which are common to any village. So, the four essential elements of the Sinhala civilization– a Buddhist stupa, an irrigation tank, a village, and a Buddhist temple– highlights the historical importance of Buddhist philosophy, water management, and agriculture to the Sinhala civilization.

Sri Lanka is the place where Theravada Buddhist philosophy and history of the country, the apex of Theravada Buddhism. Therefore, Sri Lankan cultural elements have been integrated with Buddhism since ancient times; hence, ancient Sri Lankan agriculture and food culture were intertwined with Buddhism.

The food culture varies from country to country. Sri Lanka has unique foods, and food patterns with an extended history since Sri Lanka owns a distinct culture and a civilization. The historical literature and archeological sources, and folklore provide evidence for this. Among this literature, Mahawansa, Rasavahini, Saddarmaratnawali, Saddarmalankaraya, Jathaka Atuwa, Tupawansa, Bodhiwansa, and Inscriptions at Thonigala, Medirigiriya, Eppawala, and Wewalketiya, and Pillar Inscription at Badulla are highly significant.

According to this past evidence, ancient Sri Lankan food security is defined as the entire process of producing food, qualitatively and quantitatively, through efficient, effective, and sustainable agriculture. Its fundamental purpose is the socio-economic development of the entire state through a healthy community.

2.2 The modern view of food security

The World Food Summit (WFS) developed the modern food security definition in November 1996: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Russell et al., 2011).

The modern view of food security has four dimensions:

1. Physical availability of food - The World Food Program defines 'availability' as "The amount of food present in a country or area through all forms of domestic production, imports, food stocks, and food aid."
2. Economic and physical access to food - The World Food Summit defines 'access' as having "physical, economic, and social access."
3. Food utilization - The World Food Summit's definition of 'utilization' is "safe and nutritious food which meets their dietary needs." The availability of and access to food on their own are not enough; people have to be assured of "safe and nutritious food."
4. Stability of the other dimensions over time - The World Food Summit says that stability must be present "at all times" in terms of availability, access, and utilization for food security to exist (Uribe, Álvarez et al., 2010).

3. Methodology

This research aims to generate evidence on the role of the ancient village tank cascade-based food system in establishing the food security status of local communities in the Dry zone of Sri Lanka. The nature of the research subject to be studied led to choose a qualitative research approach as the primary tool in field data collection by applying an in-depth interview method. Data for the study was primarily drawn from an empirical survey conducted in August to September 2020 among the adults (> 70 years) farmers in a selected typical ancient village tank cascade system located Maradankalla GN Division in the Mihintale DS division in Anuradhapura District.

The study area was selected based on the history centered on the cascade system as it supports understanding time-tested knowledge on the research subject – ancient village tank cascade system-based food system in establishing food security status of local communities in the Dry zone of Sri Lanka. Twenty adult farmers were selected for in-depth interviews using purposive sampling methods. A well-structured and pre-tested interview guide was employed to conduct in-depth interviews, and each interview lasted for 1 – 2 hours.

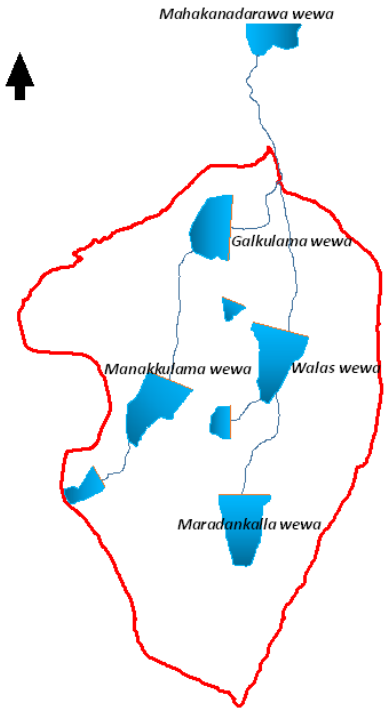

Figure 1: Map of the study area – *Maradankalla* GN Division

4. Results and Discussion

4.1 Basic components of ancient village tank cascade system-based food supply model

In-depth field interviews revealed two types of food sources – primary food sources and sources that play a complementary or balancing role in the ancient household/community food supply model, which supports them in ensuring the food security status throughout the year. The main sources and complementary or balancing sources consist of irrigated paddy land, *Chena*, and livestock, and village tank, forest, and home garden, respectively.

Table 1 presents Main food sources (plant and animal husbandry) in the ancient food supply model. It shows that the irrigated paddy field has provided the required cereals – paddy – and greens and legumes for the households. Paddy was the main food source that met ancient household calorie and protein demand. The varieties cultivated in the ancient food supply model were mainly the indigenous paddy varieties, rich in physicochemical (soluble and insoluble dietary fiber) and nutritional values. According to the field interviews, richness in dietary fiber values in paddy ease the digestion process.

Some varieties grown by the farmers had health values; for example, *Kuruluthuda* variety can control the blood cholesterol level, *Dahanala* variety is recommended for lactating mothers, young children, and diabetics patients, and *Dikvee*and *Suvedal* varieties are beneficial for diabetic patients. The *Pachchaperumal* variety consists of high iron content that helps to alleviate the anemic issues, the *Madathawalu* variety is rich in vitamin and beneficial for lactating mothers and their infants in making a healthy immune system of both, and the *Rath El* variety is recommended for diabetes and anemic, and helps to prevent the stone formation in the urinary tract.

*Kaluheen ati*variety is a traditional natural medicine for treating snake bites, and *Suduheen ati*variety is suitable for diabetics, cholesterol, constipation, and oxidative stress (Achchige *et al.*, 2019; Abeysekera *et al.*, 2017).

Also, farmers have naturally obtained the required greens from the irrigated paddy field. It clearly indicates that the village tank cascade system-based paddy fields contribute to making strong healthiness of the household members and society, proving the Buddhist philosophical base of the ancient food supply model– *Aroghyaparamalaba, santuttiparamandhanan* – and recognized as a utilization component of the modern food security model.

Under the *Chena* farming, the farmers cultivated *Chena* paddy – mainly indigenous rice varieties-specifically in the *Maha*season. Besides, *Heenmeneri, Mahameneri,* corn*, Kollu, Thanahal, Amu, and Kurakkan,* the staple foods of the ancient food supply model, were grown in the *Chena.* Spices such as *Aba* required in food preparation in the ancient food supply model have also been generated from the *Chena.* Farmers mainly grew vegetables, oil crops (*Thala*and *Ratakaju*), legumes, and condiments in the *Chena,* and greens and mushrooms were naturally produced. Under livestock in the main food source, all interviewed farmers reported undertaking animal husbandry activities, mainly cows and buffalos. It supported stabilizing the supply of milk and milk-related products, meats, and eggs to the ancient food supply model.

Table 1: Main food sources (plant and animal husbandry) in the ancient food supply model

Source	
Irrigated land (Paddy field)	**Cereal crops:** Paddy (*Oryza sativa*) **Varieties** - *Murungakaayan, Heenati, H-4, KaluHeenati, Muppanga,* 400-1*, Yakadamaran, Alisamba, Suwandal, Pokuru Samba, Rathheenati, Pachchaperumal, Wellavilankaaliyan, Sulai, Muthu samba, Suwandel, Rathdel, Kuruluthuda, Kuru wee, Suduru samba, Kahata wee, Elankalian, Madathawalu, Hetadha wee, Hondarawalu, Girisa* **Greens:** *Mukunuwenna (Alternantherasessilis)***,** *Kankun (Ipomoea aquatica)***,** *Saarana (Trianthemaportulacastrum)***,** *Lee Kola***,** *Kirihanda***,** *Udaththa***,** *Vila Pala*
***Chena* (Rain-fed upland)**	**Cereal Crops:** • Rice (*Oryza sativa*) **Varieties** - *Murungakaayan, Heenati, H-4, KaluHeenati, Muppanga,* 400-1*, Yakadamaran, Alisamba, Suwandal, Pokuru Samba, Rathheenati, Pachchaperumal, Wellavilankaaliyan, Sulai, Muthu samba, Suwandel, Rathdel, Kuruluthuda, Kuru wee, Suduru samba, Kahata wee, Elankalian, Madathawalu, Hetadha wee, Hondarawalu, Girisa* • *Meneri*(Proso millet) *(Panicummiliaceum)* **Varieties** - *Heenmeneri, Mahameneri* • *Badairigu (Zea mays)* **Varieties** - *Sudumaha, Sudukappal, Wewaliringu, Sudubaala, Nimithi, Rathukappal, Kahabaala, Oomune, Kahata, Kirawaanaa* • *Amu* (Kodo millet) *(Paspalumscrobiculatum)*, Sorghum *(Sorghum bicolor)*, *Thanahaal*(Foxtail millet) *(Setariaitalica)*, *Kurakkan*(Finger millet) *(Eleusinecoracana),* **Vegetables:** Pumpkin *(Cucurbita maxima)* **Varieties;** *Galkuruvattakka, Pettivattakka* *Wetakolu*(Ridged gourd; *Luffaacutangula)***,** *NiyanWetakolu*(Sponged gourd; *Luffacylindrica)***,** *Pathola*(Snake gourd; *Trichosanthesanguina)***,** *Diyalabu* (Bottle gourd; *Lagenariasiceraria)***,** *Heenkekiri*(*Cucumismelovarconomon*)**,** *Batu-karawila* (*Momordicacharantia*)**,** *Alupuhul*(Ash pumpkin; *Benincasahispida)***,** *Pipinga*(Cucumber; *Cucumissativus)***,** Okra *(Abelmoschusesculentus)***,** Tomato (*Lycopersiconesculentum*)**,** *Batu (Solanummelongena),Karawila*(Bitter gourd; *Mormordicacharantia), Thumbakarawila (Mormordicadioica)* **Vegetables fruits;** *Elabatu*(*Solanumsurattense*)**,** *Tibbatu*(*Solanum indium*), Water melon *(Colocynthiscitrullus),* **Greens;** *Asamodagam***,** *Rathpala***,** *Landesipala***,** *Kara kola***,** *Lee kola***,** *Mahasarana (Trianthemadecandra), Heensarana (Trianthemaportulacastrum)***,** *Sudupala***,** *Kankun (Ipomoea aquatica)***,** *Aba kola***,** *Kura thampala (Amaranthusviridis)***,** *Anguna (Dregeavolubilis)***,** *Kathuru kola (Sesbania grandiflora)***,** *Kirihanda***,** *Hadunpala, Welpenala (Cardiospermummicrocarpum)* **Legumes;**Mung bean *(Vignaradiata)***,** Cowpea *(Vignaunguiculata)***,** *Undu (Vignamungo)***,** *Kollu*(Horse gram) *(Macrotylomauniflorum)*, *Dambala (*Winged bean; *Psophocarpustetragonolobus)***,** Soybean *(Glycine max)***,** Long beans (*Vignacylindrica*) **Oil crop;** *Thala*(Sesame; *Sesamumindicum)***,** *Rata kaju*(Ground nut), *Aba* (Mustard; *Brassica juncea)* **Beverages;** Pol pala*(Aervalanata),Karapincha (Murrayakoenigii), Kottamalli (Coriandrumsativum)* **Spices;** Chilli*(Capsicum annuum), Kochchi*(Bird chillies) *(Capsicum frutescens), Nimiris (Capsicum annuumvarfasciculatum), Bola miris, KaputuKochchi, Wannimiris* **Root crops;** Sweet potatoes *(Ipomoea batatas),* Manioc *(Manihotesculenta),* Yam *(Dioscoreaalata), Katu-ala (*Buck Yam; *Dioscoreapentaphylla)* **Mushroom;** **Varieties;***Ratkevilla, HumbasHathu, MonaraHathu, WadiBimmal, PadarellaHathu, KanuHathu, Virahatu*
Animal rearing/ Livestock	**Animal Rearing for Meat Purpose -** Cattle *(Bostaurus)***,** Poultry *(Gallus gallusdomesticus)***,** Goat *(Capra aegagrushircus)* **Animal Rearing for Milk Purpose -** Cow *(Bostaurus)***,** Buffalo *(Bubalusbubalis),* Goat *(Capra aegagrushircus)* **Animal Rearing for Egg Purpose -** Poultry *(Gallus gallusdomesticus)*

Table 2 presents the food items the households received from the complementary or balancing sources. Particularly, like the main food sources of the ancient food model, the complimentary food system has also been based on traditional customs and value systems. It clearly shows that each component of the tank – *Wewa, Kattakaduwa, Gasgommana,* and *Perahana* – has provided a natural food base for every household in the village. The homes have accessed these food sources during the food shortage period or off-season or heavy dry period. Notably, most of the food varieties naturally grew well during the dry period, in and around the village tank, due to their uniqueness to such climatic conditions. Field interviews revealed that many kinds of greens such as *Thora*, *Penela, Lunuwila, Kankun, Mukunuwenna,* etc., yams such as *Kekatiya, Nelum, Olu,* etc., and fruits such as *Damba, Dan, Koon, Indi,* wood apple, etc. naturally grow up or provided foods following the area's seasonal pattern.

The farmers reported that they undertook fisheries mainly at the end of the *Yala* and commencing stage of *Maha*, where foods are deficient in the main food components of the ancient food supply model. Specifically, all farmers have harvested the fish resource using traditional methods such as *Karakgediya* during September and October, and early November each year, and shared with the village community.

Forest is the second main food component of the complementary sources of the ancient food supply model. Households had access to the forest during the off-season. The in-depth interviews revealed that the forest provides wild fruits and vegetables to the village community during the dry period. Customary, the villagers entered the forest for hunting purposes when food is a shortage in the main food components of the ancient food supply model. Farmers cultivated short- and long-term crops in their home gardens. It also contributed to the stability of the ancient food supply model. Notably, all farmers had coconut trees and jack trees in their home gardens.

These facts on the ancient food supply model revealed several specific features that directly link with maintaining the food security status of the village tank cascade-based community. First, the ancient food supply consists of two sources – primary and complementary. Each source provided ancient villages with food availability and accessibility opportunities throughout the year. Second, each food source provides a diversified food system with many kinds of greens, vegetables, fruits, legumes, etc. Most of the food is naturally grown foods in the system. Third, no household went to the market for food requirements as the food shortage was covered through complementary sources. Fourth, the nutritional richness of foods available in the ancient food supply model is high. Thus, its overall concern is about societal healthiness rather than individual healthiness, which is highly related with the Buddhist concepts.

Table 2: Complementary or balancing food sources in the ancient food supply model

Complementary source		
Tank (Main reservoir)	**Tank bund**	*Penela (Cardiospermumhalicacabum), Thora (Cassia tora), Maila (Bauhinia racemosa),* Palmyra *(Borassusflabellifer)*
	Exposed water zone (*Wewa*)	*Nelum(Nelumbonucifera)*, *Kekatiya (Aponogetoncrispus)*, *Nil manel (Nymphaeanouchali)*, *Olu (Nymphaeanouchali)*
	Salinity interceptor belt (*Kattakaduwa*)	*Mee (Madhucalongifoia), Damba (Syzygiumassimfle),* Tamerind*(Tamerindusindica), Koon (Schleicheraoleosa), Indi (Phoenix zeylanica),* Palmyra *(Borassusflabellifer), Kithul (Caryotaurens),* Wood apple *(Feronialimonia)*
	Groove of trees (*Gasgommana*)	*Thimbiri (Diospyrosmalabarica), Aththikka (Ficusracemosa), Mee (Madhucalongifolia), Bakmee (Naucleaorientalis), Karanda (Milletiapinnata), Dan (Syzygiumcumini), Maila (Bauhinia racemosa), Thal (BorassusflabelliferMuthirai), Hik (Chukrasiatabularis), Mora (Dimocarpuslongan), Kunumella (Diospyrosovalifolia), Weera (Drypetessepiaria), Divul (Limoniaacidissima), Palu (Manilkarahexandra), Kora kaha (Memecylonumbellatum),Welan (Pterospermumsuberifolium), Koon (Schleicheraoleosa)*
	Filter beds (*Perahana*)	*Lunuwila (Bacopamonnieri), Thora (Cassia tora), Godamanel (Crinum latifolium), Nelum (Nelumbonucifera), Uruwee (Oryzaperennis), Etora (Panicumrepens), Kankun (Ipomoea aquatica), Mukunuwenna (Alternantherasessilis), Kotalahimbutu*
-	**Fish species**	*Kokassa, Hirikanaya, Mas pethiya, Theppiliya, Lula, Madaaruwa, Hunga, Magura, Pethiya, Thiththaya, Kaawaiya, Angutta, Gal katta, Burampiya, Kanaya, Theliya, Aada*
Forest		**Wild Greens;** *Kiribadu, Rathuthampala, Suduthampala, Telkola, Agunakola, Thora, Lee kola, Karapincha, Kowakka, Katupila, Girapala, Karalsebo, Penela, Vilapala, Kirihenda, Mullakola, Karakola* **Wild fruit types -** *Mora (Dimocarpuslongan)*, *Damba (Syzygiumassimile)*, *Palu (Manikarahexandra)*, *Koon (Schleicheraoleosa)*, *Weera (Dryptessepiaria)*, *Karamba (Carissa spinarum)*, *Indi (Phoenix pusilla), Kataberiya, Kotalahimbutu, Karamba, Katukeliya, Gonakarapincha, Pettiamba, Kohuamba, Ulkenda* **Wild fruit trees (domesticated) -** *Divul (Feronialimonia)*, *Meeamba (honey mango)*, *Beli (Aeglemarmelos)*, *Siyambala (Tamarindusindica)*, *Velianoda (Annonasquamosa)* **Wild vegetable species (domesticated) -** *Kiridambala (Dolichoskiblab Linn)*, *Niyanvetakolu (Luffacylindrica)*, *Thumbakaravila (Momordicadioica)*, *Batu-karawila (Momordicacharantia)*, *Ela batu (Solanummelongena)*, *Thibbatuthakkali*, *Gorakathakkali*, *Wannimiris*, *Nayimiris (Capsicum chinense)* **Wild Mushrooms;** *Nerihatu, Ratkevilla, Virahatu, Kukulubadawel, Netihatu, Kirikuttanhatu, Netibimmal, Uruhatu, Metihatu, Kotanhatu, Pidurubimmal* **Wild Yams;** *Gonala yam, Katuala, Kukulala* **Wild Animal types for Meat Purpose -** *Walura (Wild boar) (Susscrofa)*, *Ithhawa (Erinaceinae)*, *Muwa (Axis axisceylonensis)*, *Gona (Rusa unicolor)*, *Haawa (Oryctolaguscuniculus)*, *Thalagoya (Varanus)* **Wild Birds types for Meat Purpose -** Jungle fowl *(Gallus lafayettii)* **Wild Animal types for Egg Purpose -** *Thalagoya (Varanusbengalensis)* **Wild Bird types for Egg Purpose -** Peacock *(Pavocristatus),* Quail *(Coturnixcoturnix)*
Home garden		**Vegetables:** *Murunga* (Drumstick tree)**,** *Ambarella (Spondiascytherea)* **Greens:** *Mukunuwenna (Alternantherasessilis)*, *Kathuru kola (Sesbania grandiflora)*, *Kohila (Lasiaspinosa)*, *Nivithi (Spinaciaoleracea)*, *Gotukola (Centellaasiatica)*, *Kankun (Ipomoea aquatica)*, *Saarana (Trianthemaportulacastrum)* **Fruits –** Banana *(Musa acuminata)* **Varieties;** *Aebulkesel, Kolikuttu, Anamalu, Alumoddan, Diyamuddan, Alukesel, Suvadel, Puvalu, Hondarawalu, Seenikesel* Mango *(Mangiferaindica)* **Varieties;** *Valuamba, Meeamba, Giraamba, Walamba, Petti amba, Kohuamba, Siniamba* Jack *(Artocarpusheterophyllus)*, Lime *(Citrus aurantiifolia)*, Wood apple *(Limoniaacidissima)*, Papaya *(Carica papaya)*, Guava *(Psidiumguajava)*, *Anoda (Annonamuricata)*, *Beli (Aeglemarmelos)*, Orange *(Citrus reticulata)*, Cashew *(Anacardiumoccidentale)*, Pomegranates *(Punicagranatum)*, Tamarind *(Tamarindusindica)* **Other -** Coconut *(Cocosnucifera L)*, *Karapincha* (Curry tree) *(Murrayakoenigii)*

4.2 Seasonality, availability, accessibility, and utilization features of ancient food supply model

Figure 2 illustrates the food available at each source. The specific feature of the ancient food supply model is the availability of the foods for all the village community throughout the year. For instance, the irrigated paddy field generates harvest during February and March in *Yala* and August and September in *Maha* seasons. *Chena* farming starts in October in *Maha* and end of March in *Yala* and ensures food availability throughout the year. *Chena* also provides cereals, vegetables, greens, yams, mushrooms, legumes, oil crops, bulbs, and condiments. The in-depth interviews revealed that the farmers had adopted indigenous techniques in *Chena* farming, specifically to establish the multi-culture cropping system in *Chena,* which contribute to ensuring food availability throughout the year. This explicitly addresses the seasonality issue of food availability in households. Animal husbandry also ensured the availability of milk and milk-related products, meat, and eggs throughout the year.

Forest, tank, and home garden in the ancient food supply model ensured the food availability for households, particularly during the off-season or food shortage periods of the main sources of the ancient food model. The farmers reported that there was no restriction in accessing forest and village tank-based food resources during the food shortage period.

"*We go to tank carrying a bag as we now go to the fair (Pola) when we need foods. We could bring a full bag of vegetables, greens, fruits, legumes, etc. We entered into the forest to hunt animals, specifically during the food shortage period, and we share the meat with our neighbors."*

It plays a balancing role in addressing the seasonality issue in supplying foods by main sources. The foods generated by complementary sources are highly adaptable to climatic conditions. For instance, villages access the forest during the food shortage period, and it is the period that naturally generates many kinds of wild fruits, yams, wild vegetables, and greens. Interviews revealed that it is also a comfortable period for hunting.

These facts indicate that the ancient food supply model addresses the main issues in ensuring food availability and accessibility throughout the year, such as handling the seasonality issue of food production in the main source, adopting indigenous cultivation techniques in *Chena* farming, accessing natural food supply sources in the system, and undertaking animal husbandry.

Seasonality and availability of food- Home garden	**Fruits**	**Fruits**	**Fruits**	**Fruits**						**Fruits**	**Fruits**	**Fruits**
	Greens	**Greens**	**Greens**	**Greens**	**Fruits**	**Fruits**	**Fruits**	**Fruits**	**Fruits**	**Greens**	**Greens**	**Greens**
	Vegetables	**Vegetables**	**Vegetables**	**Vegetables**	**Greens**	**Greens**	**Greens**	**Greens**	**Greens**	**Vegetables**	**Vegetables**	**Vegetables**
Seasonality and availability of food- Livestock	**Eggs**	**Eggs**	**Eggs**	**Eggs**	**Eggs**	**Eggs**	**Eggs**	**Eggs**	**Eggs**	**Eggs**	**Eggs**	**Eggs**
	Meat	**Meat**	**Meat**	**Meat**	**Meat**	**Meat**	**Meat**	**Meat**	**Meat**	**Meat**	**Meat**	**Meat**
	Milk	**Milk**	**Milk**	**Milk**	**Milk**	**Milk**	**Milk**	**Milk**	**Milk**	**Milk**	**Milk**	**Milk**
Seasonality and availability of food- Tank (including all)				**Wild fruits**	**Wild fruits**	**Wild fruits**	**Wild fruits**	**Wild fruits**	**Wild fruits**	**Wild fruits**		
		Fish	**Fish**	**Fish**	**Fish**	**Fish**	**Fish**	**Fish**	**Fish**	**Fish**		
Seasonality and availability of food- Forest								**Wild meat**	**Wild meat**			
				Wild meat	**Wild meat**	**Wild meat**	**Wild meat**	**Wild fruits**	**Wild fruits**			
			Wild meat	**Wild fruits**	**Wild fruits**	**Wild fruits**	**Wild fruits**	**Wild vegetables**	**Wild vegetables**			
		Wild meat	**Wild vegetables**	**Wild vegetables**	**Wild vegetables**	**Wild vegetables**	**Wild vegetables**	**Honey**	**Honey**			
Seasonality and availability of food- Chena	**Sorghum**	***Thanahal***				**Meat**			**Milk**	**Vegetables**		
	Vegetables	**Sorghum**				**Milk**				**Eggs**	**Fruits**	
	Mun	**Vegetables**								**Meat**	**Greens**	**Fruits**
	Green chili	***Mun***								**Milk**	**Vegetables**	**Greens**
	Black gram	**Black gram**									**Eggs**	**Vegetables**
	Soy beans	**Corn**	**Vegetables**				**Mun**				**Meat**	**Eggs**
	Sesame	**Sesame**	**Mun**				**Corn**	**Soy bean**			**Milk**	**Meat**
	Finger millet	**Finger millet**	**Cowpea**			***Meneri***	**Green Chili**	**Finger millet**			**Vegetables**	**Milk**
	Corn					**Sorghum**	**Sesame**	**Black gram**	**Red onion**	**Mushroom**	***Meneri***	**Vegetables**
	Thanahal	**Paddy**	**Paddy**	**Red onion**	**Finger millet**	**Sesame**	**Black gram**	**Paddy**	**Paddy**	***Mun***	***Mun***	**Green chili**
Seasonality and availability of food- irrigated paddy land		**Paddy**	**Paddy**					**Paddy**	**Paddy**			
Month	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**Sep.**	**October**	**Nov.**	**Dec.**
Season	**Maha**			**Yala**						**Maha**		

Table 2: Availability of Foods in the Ancient Food Model

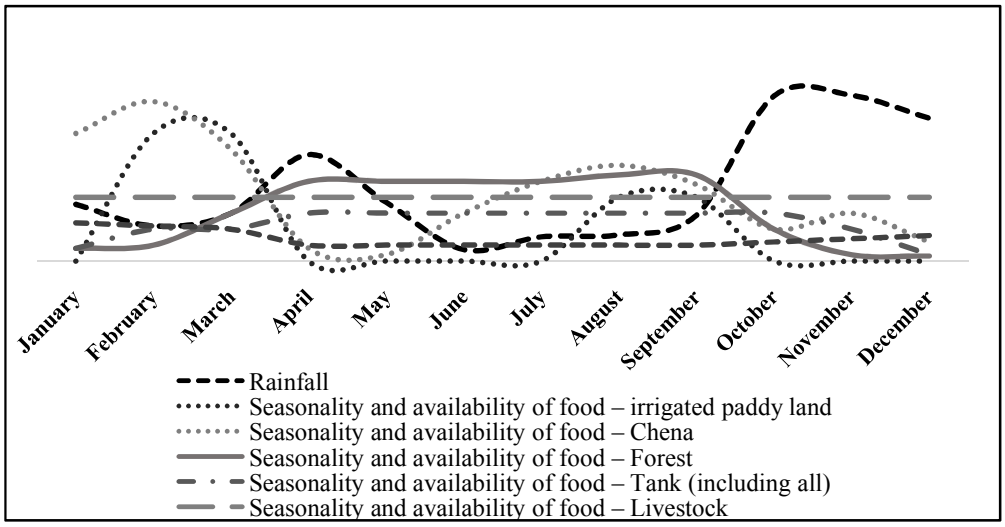

Figure 2: Seasonality and availability of food in the Ancient Food Model

4.3 Tools in maintaining food security status in the ancient food model - Surplus management and shortage address measures

The importance of the role of complementary food sources in the ancient model was identified. Ancient village main food sources are irrigated paddy land, *Chena,* and animal husbandry (livestock). Irrigated paddy land and *Chena* are seasonality production sources. These sources provide the primary food for the ancient villagers/households. As those sources are seasonal, they lead to food shortage and food surplus period. Hence, complementary/supplementary sources were necessary to address that shortfall. These kinds of complementary sources are the forest, tank, and home gardens.

According to farmer interviews, farmers have used different strategies in managing food surplus, aiming to address the food shortage at the harvesting time. The paddy harvesting period widely depends on the rainfall pattern. Paddy was harvested in August and September in the *Yala* season and in February and March in *Maha* season. Therefore, these months have a surplus of paddy. Accordingly, paddy storage practices were carried out, and paddy was used during the food shortage period. The *Atuwa* and *Waruwa* facilitated raw paddy and *Kurakkan* storage, while the *IriguAtuwa*was exclusively used for storing maize.

For food preservation, *Dummassa* helped preserve fish and wild meat, and some crops such as Maize, Cowpea, and *Mun*. Hanging of specific crops such as onion and maize on the roof is another technique the farmers used to store crops. The field interviews further revealed traditional crop variety-based preservation. For instance, traditional varieties of Pumpkin and *Puhul*-like crops were preserved by piling up on the floor.

The farmer households mostly practiced food preservation techniques, specifically in food preparation, enabling them to expand each food's shelf time.

The ancient dietary behavior of the people revealed a diversified food pattern in the household. Specifically, they have not consumed rice in three meals per day, and eaten *Kurakkan roti, Kurakkanpittu, Kurakkanthalapa, Thanahaal,* Sorghum*, and Meneri* for breakfast, lunch, and dinner, in addition to rice. The society has extensively acknowledged the food sharing principle – more food available places to less food available places.

4.4 Discussion on the difference between ancient and modern food models

As presented at the outset of the study, the modern view of food security consists of four dimensions – physical availability, economic and physical access to food, food utilization, and stability of other dimensions over time. The discussion over food security in the modern world basically emerged due to introducing capitalist agricultural systems, which primarily targeted the generation of surplus to the market. The new crop systems, mostly the monoculture systems, were introduced with western scientific advancement.

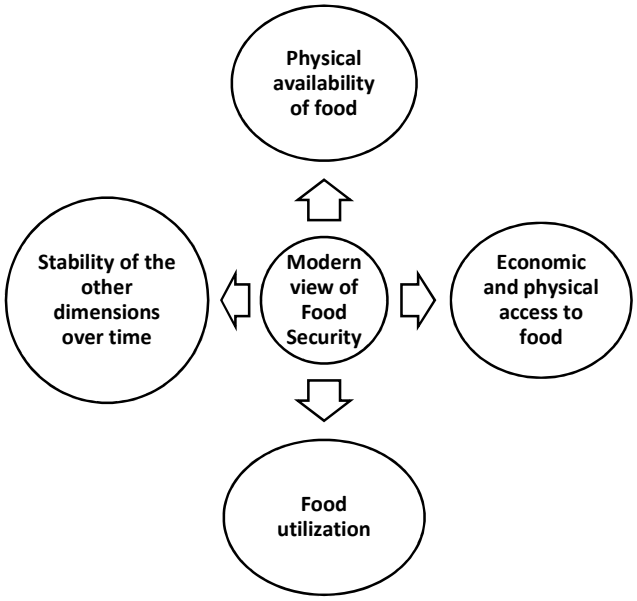

Figure 3: Modern view of food security

This transformation also occurs in Sri Lanka, particularly with the introduction of the technological package of the green revolution since the 1960s. The transformation process has not adequately considered the basic characteristics of the ancient tank-based food supply model. The following field note clearly reveals how farmers are suffering in maintaining food security status at the household level.

"At present, we mainly grow paddy. Our paddy fields provide only rice. We have to purchase the rest of the food required for the households from the market, especially vegetables, milk, fish, meat, eggs, and others. For that we need money. Paddy harvest is not sufficient enough to fulfill these market requirements. We can't generate an adequate surplus to the market. As the cost of production in modern paddy cultivation is high, our net income from paddy farming is very low. So, most of the time, we can't purchase adequate food for our households."

"However, in the past, we did not go to the market for food. There was no experience over food shortage. When we need food, we decided to go either to the tank or forest or Chena, considering the requirement. We shared them with our neighbors as well. We were self-sufficient in milk, egg, fish, and meat. But now we don't have cows, buffaloes, or any other animal. Our farming systems also do not support generating sufficient income. Thus, we do not have the ability to access adequate and nutritionally-rich food basket."

Focus Group Discussion – September 2020

The above farmers' statement indicated that the agriculture transformation process had removed the basic components of the ancient food model, which were independent of the market and introduced the market dependency food model. Introducing the monoculture food system has limited the food availability at the farm level and further expanded the farm household's market dependency, thereby constricting the physical and economic accessibility of farm households for foods.

The modern view of food security concerns the healthiness of food, but the cultivation systems do not adequately consider this point. As discussed in the previous section, in the ancient food supply model, all crop varieties cultivated in both paddy land and *Chena* had specific nutritional meaning with a particular health issue or enriched healthiness of people. However, modern agricultural practices do not support such specific concerns of food production, and thereby the term 'utilization' is questionable compared to the ancient food supply model features.

The stability of food availability and accessibility is also questioned due to the issue of climatic change and high price fluctuations in the food market, and dependency on the monoculture crop system. Particularly, household-level food preservation techniques, surplus management techniques, ancient dietary behavior patterns, wastage control methods, and food-based social value systems have been largely neglected in the modern food model. These facts indicated that aspirations of the modern definition of food security could not be met through transformed agriculture systems.

5. Concluding remarks

This paper aimed to assess the role of the ancient village tank cascade system based food supply model in establishing the food security status of farming communities in the Dry zone of Sri Lanka. The study revealed the critical components of the ancient food supply model of the village tank cascade system, which can support to ensure the food security status throughout the year. It is a holistic approach that stabilizes food availability, accessibility, and utilization status in farm households throughout the year. Notably, a balancing role of complementary food sources can be recognized as major components of the ancient food supply model of the village tank cascade

system. Further, food surplus management strategies adopted in the farm households and food shortage addressing measures could be highly considered in the food security model designed explicitly for farm households in the dry zone.

The study revealed the issues in achieving the goals of the modern food security model. Specifically, the agricultural transformation occurred since the 1960s has not adequately acknowledged the holistic nature of the ancient food supply model in the dry zone. This has led farm households' high dependency on the market for food requirements, but transformed agricultural systems do not adequately support to generate sufficient income to meet household food requirement at the market. The modern transformed society has also deviated from some influential ancient food culture-based value systems, e.g., sharing.

Finally, it could be concluded that divergence from the main components of the ancient food supply model and the conversion of independent ancient food model to market dependency food model through transformed agriculture in the dry zone have aggravated the food vulnerability among the farm households, intensifying the food insecurity.

References

Abeysekera, W. K. S, Arachchige, S. P. G, Chandrasekharan, N. V. (2017) 'Physicochemical and nutritional properties of twenty three traditional rice (Oryza sativa L.) varieties of Sri Lanka', *Journal of Coastal Life Medicine*, (August), pp. 343–349. doi: 10.12980/jclm.5.2017j7-59.

Thushara, P. A. N, Godakumbura, P. I, Prashantha. M. A. B. (2019) 'http://doi.org/10.35410/IJAEB.2019.119128', 4(3), pp. 119–128.

Madduma Bandara, C.M., 1985. Catchment ecosystems and village tank cascades in the dry zone of Sri Lanka. In *J. Lundqvist, U, Lohm and Falkernmark, (Eds) Strategies for River Basin Development, Germany Reidel Publishing Company.* pp. 99-113

Ministry of Agriculture and FAO (2017) 'A Proposal for Declaration as a GIAHS the Cascaded Tank-Village System (CTVS) in the Dry Zone of Sri Lanka', (March), pp. 44–45. Available at: http://www.fao.org/fileadmin/templates/giahs_assets/GIAHS_test/02_GIAHS_around_the_world/01_Designated_sites/02_Asia_and_the_Pacific/07_Sri_Lanka/Mar_6th_rev_GIAHS_Proposal_Sri_Lanka_March_2017.pdf.

Russell, J, Flood, V, Yeatman, H, Mitchell, P. (2011) 'Food Security in Older Australians', *Journal of Nutrition Education and Behavior*, 43(2), pp. 1–4. doi: 10.1016/j.jneb.2010.12.007.

Uribe, Álvarez, Estrada Restrepo, M. C, Summit, A, Shamah-Levy, U.N, *et al.* (2010) 'Ecuador y Bolivia son casos excepcionales en reducción de inseguridad alimentaria en la región', *Social Indicators Research*, 95(1), pp. 215–230. doi: 10.1007/s11524-010-9491-z.