Proceedings of the 10th International Conference on Agriculture, Vol.8, Issue 1, 2023, pp.1-11

ISSN 2682-7018 online
DOI: https://doi.org/10.17501/26827018.2023.8101

COMMUNITY-COLLECTIVE ACTION AND RURAL FOOD SECURITY IN RESOURCE SCARCE CONTEXTS: A CASE-STUDY OF VILLAGE-IRRIGATION TANK CASCADE BASED FARMING SYSTEMS IN SRI LANKA

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Abstract: Sustenance of local farming systems (FS) is inevitably linked with resource-endowment and the attributes of communities associated with them, playing a key role in ensuring rural food security. Hypothesizing that the local communities adopt collective action under resource-scarce contexts in community-managed FSs, this study explores the drivers and role of collective action in sustainable management of rural FSs. The study context refers to resource scarcity induced by impacts of climate change and severe economic crisis on the FSs established under Village-Tank-Cascade-Systems(VTCS) in the rural dry zone of Sri Lanka. Medde-Rambewa cascade system located in Nawagattegama, Puttalam district of Sri Lanka was the geographical scope of the study. Case-study approach was used with mixed methods of data collection and analysis. A household questionnaire survey (n=88), focused group discussions, in-depth interviews and field observations were used for primary data collection. Based on the findings, community members were found to adopt collective strategies for scarce resource management when they perceive themselves as key stakeholders in the sustenance of resource systems, coupled with awareness on causes ($X2(1, N=88) =4.29$, $p=0.038$) and effects ($X2(1, N=88) =6.41$, $p=0.011$) of resource degradation in the FSs established under VTCS. Collective irrigation-water sharing (Bethma) in lowland FSs (92%), sharing of labour (34%) and other farming inputs (seeds, fertilizer and machinery) (64%) were found to be adopted as strategies in response to resource scarcity. Findings support the hypothesis and the study concludes that resource scarcity itself, community members' recognition on their role as key stakeholders of resource management and awareness on the nature of resource endowment are drivers of collection action within communities managing FSs established under VTCS, ultimately contributing to ensure rural food security.

Keywords: community, collective action, rural, farming systems, resource scarcity, food security

Introduction

As defined by the United Nations' Committee on World Food Security, it means that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life. Food security is not only a global goal, but also considered as a global public good which requires collective action, in order to be ensured

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(Josling,2014). This is equally applicable to local settings where food security creates a sense as a public good at the grassroots-level-communities. Over decades, changing climate, growing populations, rising food prices and environmental stressors have had significant, yet uncertain impacts on food security and the urgent need for adaptation strategies and policy responses is thoroughly felt at present (IFPRI,2023). Food insecurity is a major problem affecting the poverty-stricken rural communities who depend partially or completely on agriculture for their livelihoods. Hence, adaptations at individual, household and community levels is essential to ensure local food security amidst multiple challenges (IFAD,2016).

According to the World Food Programme, 6.3 million people (over 30% of total population) in Sri Lanka were "food insecure" in 2022, followed by the impacts of severe economic downfall and policy failures that led to poor agricultural productivity caused by inadequate supply of fertilizer and unaffordability of essential material inputs in the recent past. Although the situation has slightly improved by the year 2023, around 17% of the population is still under moderate acute food insecurity. This study focuses on the resource scarcity context characterized by recent severe economic crisis and agricultural policy failures (including banning the importation and use of chemical fertilizers and agrochemicals) in Sri Lanka, which have added to the adverse climatic impacts that cause natural-resource scarcity for sustenance of local farming systems, thus intensifying the food insecurity. Rural farming communities whose food security as well as livelihoods mostly depend on local farming systems highly relying on natural resources, are being greatly affected by these resource constraints. A major proportion of local farming systems mainly comprise of the paddy lands contributing for the country's' staple rice production. The dry zone spreading through almost 70% of Sri Lanka's land mass is accommodating these farming systems which are irrigated through major, medium reservoirs or minor tanks, also known as village tanks. About 40% of the rural farming communities in the low-country dry zone of Sri Lanka are solely dependent on the village tanks for irrigating their farmlands. These village tanks are constituent units of the Village Tank Cascade Systems (VTCSs), i.e. the only globally recognized agricultural heritage system of Sri Lanka (FAO,2018) which are social-ecological systems facilitating human-environment coexistence in the dry zone. The VTCSs, or in other words; village tanks, catchment forests and tank-based farming systems (upland farms and lowland paddy fields) have been managed by the local communities using traditional indigenous knowledge and their experience since centuries ago (Abeywardana et. al, 2019). This communally managed aspect of village-tank based farming systems have evolved up to the institutionalized community-based management system of Farmer Organizations (FOs), at present.

Collective Action and Rural Food Security

There is ample evidence from previous literature on the potential of collective action among traditional local communities for sustainable management of common resource systems such as irrigation systems, forests, shared farmlands and fisheries through context-specific response mechanisms (either by state interventions or through collective action of local communities). The management of irrigation water for farming by rural communities in Sri Lanka has already been evaluated as a relationship between community and commons (Ostrom,1990; Steins and Edwards,1999; McCarthy et.al.,2004). Recent evidence from in-depth studies conducted in rural regions exhibit the emergence of local social institutions for collective action where people organize themselves to overcome multiple stressors including adverse climatic impacts, in order to improve rural food security (Andersson and Gabrielsson, 2012).

At present, it is worthy of exploration on whether there is emergence of collective action in order to tackle multiple challenges faced by local farming communities, amidst rapidly transitioning socio-economic and cultural dynamics. In this study, we hypothesize that the village-tank based rural communities in the dry zone of Sri Lanka, adapt collective action under current resource-scarce context, in order to sustain the local farming systems and to ensure food security. Therefore, objectives of the study are to explore the (a) drivers and (b) role of collective action in ensuring food security in a resource-constrained context, with reference to a case-study of a VTCS-based community in the low-country dry zone of Sri Lanka.

Study site

This study was conducted in the Medde Rambewa Cascade System (MRCS) which is located in Nawagattegama Divisional Secretariat Division (DSD) of Puttalam District in the North Western Province of Sri Lanka. The area belongs to Low-country Dry (DL1b) agro-ecological zone of Sri Lanka. The cascade system encompasses two Grama Niladhari Divisions (GNDs, the smallest administrative unit of Sri Lanka) namely Moragahawewa and Maha-meddewa. There are 24 village tanks within the cascade, of which 18 of them are used to irrigate paddy lands while the others are under the recognized as forest-tanks. At present, there are nine (09) FOs established within the MRCS for the management of village-irrigation tank-based farming systems.

Figure 1: *An area of paddy fields irrigated by a village tank at Moragahawewa, in preparation for the next cultivation season. [Captured by the author in March,2022]*

Methodology

Case-study research approach (Yin,2003) was used to conduct the study. The data collection was conducted from April to December, 2022 using a household survey, in-depth interviews, focused group discussions (FGDs) and field observations as tools for primary data collection. Permission from the local government authorities and informed consent of the study participants were obtained prior to the

data collection. Seven FGDs were held with members of nine (09) Farmers' Organizations (FOs) established under the village tanks in the MRCS. FGDs are widely used for in-depth exploration of peoples' perspectives regarding natural resource management, livelihood adaptation practices and indigenous knowledge systems (Nyumba,2018). Composition of the FGD participants is as shown in the Table 1.

Table 1: Composition of Focused Group Discussion participants

FGD#	Farmer Organizations	Participants	Age range (years)
1	02	15	27 - 89
2	02	15	35 - 68
3	01	06	30 - 75
4	01	07	29 - 65
5	01	07	38 - 69
6	01	05	28- 73
7	01	14	33 - 75

Household survey and in-depth interviews

The household survey was coupled with in-depth interviews with a sample of 88 households residing in the two villages (or GNDs) within the *Medde-Rambewa* cascade system, who were selected using convenience sampling method. Face-to-face interviews were held with the head of the household, or spouse in cases where the head was absent. Challenges posed by rapid changes in the socio-economic and political context of the country, upon the farming systems and livelihood and how they respond or adapt to such challenges at both household and community levels were explored through in-depth interviews. Data on the demographics, economic status, farming information, engagement in community organizations and perceptions on the management of common resources related to local farming systems were collected through a structured questionnaire. A total of 16 statements were used to assess the perceptions of local residents on the causes and effects of common resource degradation and engagement in collective adaptation strategies. A five (05)-point Likert scale ranging from "Strongly Agree" to "Strongly Disagree" was used to assess the perception level through each statement. Indicators for perception analysis were first identified as themes that emerged during the discussions with community members. Five (05) individual statements were used to assess the perception on capacity of community organization for farming system management and participation in collective activities related to the maintenance and restoration of VTCS ecosystem components linked with the local farming systems. Two composite indicators C1 and C2 were computed in order to assess the awareness on causes for VTCS resource degradation and effects of VTCS resources degradation respectively, followed by "reliability analysis" (by testing for Cronbach's alpha value) of two sets of statements. The computed composite indicators had Cronbach's alpha values of 0.833 (C1 using 04 items) and 0.660 (C2 using 07 items). A general accepted rule is that a Cronbach's alpha value of 0.6 - 0.7 indicates an acceptable level of reliability, and 0.8 or greater a very good level (Hulin, Netemeyer, and Cudeck, 2001).

Pearson's Chi-square test was used to analyze the associations between perceptions of the community members and their participation in collective action. Qualitative interpretation of data collected through FGDs and in-depth interviews was done. Descriptive and inferential statistical analysis were conducted with survey data, using the IBM SPSS 28.0 and MS Excel software.

Results and Discussion

Background of the cascade-based community

The total cascade-based population includes inhabitants representing two main traditional tank-villages, Mahameddewa and Moragahawewa. Total number of families residing in the administrative boundary of MRCS is 738, while the total population is 2,042 (Divisional Secretariat Statistics, 2022). The survey sample comprised of 88 households representing both villages. Majority of the households (82%) were male headed while only 16% were female-headed. Out of 16 female-headed households in the sample, 13 of the females were widowed. The mean size of a household was 04 members.

According to the results of the household survey, the main income source of majority (83%) of the households was crop farming (paddy and other field crops). The main source of irrigation water available for these farmers is village tanks. It was evident with the fact that 85% of the respondents were found to be engaged in paddy farming under one or more village tanks within the cascade territory. While the upland farms are either rainfed or irrigated by agro-wells where possible, village tanks are the main sources of irrigation water for paddies and lowlands. This reveals the fact that the main livelihood of most of the community members still rely on the village tanks and they are highly dependent on the natural resources (land and water) within the cascade system. A larger proportion (42%) of the households had no alternative sources of income other than farming. Some households were engaged in self-employment (15%) and animal husbandry (14%) as alternative income sources.

In this section, results of the study will be discussed under two sub-sections. First, we explore the nature and role of collective strategies adapted by the community of interest in the current resource-scarce context, in order to sustain the local farming systems. In the second section, the perceptual drivers affecting the engagement of residents in collective action will be discussed.

Collective action in response to multiple constraints

As revealed through the FGDs, local people adopted collective strategies for managing limited resources and inputs that are essential to sustain the local farming systems during times of crisis. Such collective strategies could be identified as emerging under two mechanisms. The first is, formal institutionalized collective action, which includes collective decision making on lowland farming through Farmers' Organisations. These FOs constitute of registered farmers under the organisation as members and a committee of office bearers who are also farmers, and elected by the fellow members. Department of Agrarian Development acts as the local governing authority responsible for monitoring the decisions and actions of FOs. The second mechanism of collective action is, informal collective adaptations that emerge organically and occur through social institutions (relationships such as kinship ties, neighbourhood and friendship ties) in times of emergency or resource scarcity.

Seasonal cultivation planning and irrigation water sharing

The main collective actions adopted through FOs are related to seasonal cultivation planning and village-tank irrigation water management in the lowland command areas. Collective irrigation-water sharing for lowland paddy farming is not a novel practice for the village-tank based farming communities, since it has been practiced since times immemorial, termed as *Bethma* by the traditional communities even-though without formalized institutions. *Bethma* is a practice that temporarily

redistributes proportionate plots of land among shareholders (paddy landowners) considering the command area as a common unit that is irrigated by the available water level of a village tank during drought periods (Dharmasena,2020). In adopting *Bethma*, the optimum collective benefits to the farming community under a particular village tank is prioritized over achieving the maximum productivity from individually owned plot of paddy lands. Hence, it is one of the best examples for emergence of collective action in a resource-scarce situation. It was found that even at present, all FOs within the cascade adopt this practice during water-scarce conditions resulted by severe, prolonged drought seasons. This was confirmed by the survey results, where 92% of the households were found to have engaged in irrigation water sharing for paddy cultivation through *Bethma*. This enables all farmers to cultivate the optimum productive land area up to which the irrigation water can be distributed, depending on the available tank-water level, without restricting irrigation water access to those who own paddy fields at the tail-end of the command area. According to the villagers, although in the past *Bethma* practice had to be followed only during the minor cultivation season (*Yala*) which receives a lower rainfall, at present, they have had to follow the same for major cultivation season (*Maha*) which usually receives a higher rainfall, given to the gradual decline of the water storage capacity and irrigation potential of village tanks within the cascade in an increasing rate during the past two decades.

At present, in addition to sharing the limited available irrigation water for paddy cultivation, the farmers adopt collective cultivation of other field crops such as ground-nuts, (which is a low-water consuming, non-fertilizer demanding crop) in the rest of the cultivable land area which cannot be irrigated by the tank water. According to the experience shared by the FO members, cultivation of ground-nut has served as a highly profitable collective endeavour in the context where water scarcity was coupled with the critical issue of supplying agro-chemicals and fertilizers for cultivation of other crops. However, this decision had been supported by the collaborated efforts of Department of Agriculture and development agencies that have been serving in the area during this time period (2018-2022). Therefore, this could be viewed as the emergence of an adaptive collective action in response to resource-scarce contexts.

Sharing farming inputs amidst severe economic crisis

In addition to the above explained formal-institutionalized collective action implemented through FOs, collective responses were found to have emerged through organically formed social relationships, in response to emergency and resource-scarce situations. As revealed through the FGDs and in-depth interviews, it was found that the local residents adopt collective strategies to share labour, farming inputs, and also to face the threat of wild-elephant attacks to crops and property, which is a severe problem in the area.

Based on the survey results, 34% of the respondents had adopted sharing of labour with the neighbours and fellow villagers (relatives or friends) for farming operations (including cleaning, land preparation, sowing and harvesting). Labour sharing has also been practiced since past as a traditional collective activity termed as Aththam during paddy farming operations in the lowland. Unlike in the past, labour sharing is mostly used for upland farming operations at present. As explained by the FGD participants, the limited time available for lowland paddy farmers to complete the farming operations due to highly unpredictable seasonal weather conditions makes it difficult for them to engage in labour sharing, since it is more time-consuming to finish operations in one persons' land and then move to the next persons' land as they did in the past. Therefore, most of the famers have to engage in lowland farming operations at their own individual plots in parallel, mostly using agricultural machinery. But, in case of upland farming systems (mainly commercial cultivation of field crops, vegetables or perennial crops) where

the use of agricultural machinery has not become convenient and feasible, provision of labour has become a critical issue due to lack of labour in the villages caused by out-migration of people in seek of alternative livelihood opportunities, hence the cost of labour has also become highly expensive. In such a scenario, people utilize their social relationships to collectively get the operations accomplished with the help of small circles of relatives, neighbours or friends.

Further to the scarcity of irrigation water and labour, the current context of resource scarcity has been aggravated by the recent economic and political crisis within Sri Lanka. Farmers had to face a sudden shock of terminating the supply of fertilizers and agro-chemicals (which they had been using for a long time) due to the government policy on banned importation of chemical fertilizers and other agrochemicals in 2021. Followed by this, the severe political instability and economic crisis caused the cost of commodities including seeds, fuel and machinery to rise to unaffordable levels by the farmers. As a result, they faced extreme difficulties in acquiring the farming inputs in adequate amounts and on time. According to the respondents, this extreme crisis and input constraints led them to share all possible farming inputs that would be sufficient to manage the optimum possible extent of farming systems. Accordingly, they have adopted sharing of seeds (available from those who preserve seeds from the previous cultivation seasons) and machinery (sharing the cost of fuel and burrowing/purchasing cost) with fellow farmers. Nevertheless, an interesting strategy for the lack of fertilizer had been adopted by the local people, which is collecting the abundant exotic aquatic plants that have become a problem to the village tanks and using them to collectively produce organic compost fertilizer. A majority of the household survey respondents (64%) had adopted all or at least one of the above-mentioned collective sharing of farming inputs (seeds, fertilizer and agricultural machinery) in the current crisis context.

Collective response to the threat of wild-elephant attacks

Apart from the resource constraints posed by economic and policy barriers, another major challenge faced by the residents of MRCS was found to be the threat of wild-elephant attacks to farmlands and property. It has been continuing since several decades ago, but the severity has been increased during the past decade, along with increased destruction of forest area causing the wild elephants to invade into the villages in search of food. Hence, the threat to property as well as human life was reportedly severe due to wild-elephant invasions so that measures have been taken by the government to control the issue, and officers from the Department of Wild-life Conservation have been appointed to each village in order to minimize the human-elephant conflicts. However, according to the villagers, the measures introduced by the government (such as construction of electric elephant-fencing and provision of fire crackers to frighten and chase away the elephants during an attack) have neither been sufficient, nor sustainable in controlling the problem. Therefore, people have adopted their own collective measures such as setting up crop-protection huts on tall tree-tops at farmlands to protect shared areas on shift-basis as agreed with fellow farmers, and establishing strong-communication networks to seek support at an emergency attack. This reflected the trust of local people on the community cohesion to respond emergency threats, rather than relying on the measures implemented by the government.

From all above discussed arenas of collective action, it is well evident that resource scarcity itself has turned out to be a main driver for the emergence of collective action among local people, while it also has contributed to create a sense of responsibility to the people as key stakeholders in the management of common resources associated with the local farming systems.

Perceptions on the management of common resources related to local farming systems

Perceptions held by local people in a particular context derived through observation and experience has been often found complementary to global scientific knowledge on environmental change (Berkes, 2009). It has been empirically proven that the reliance of people on locally managed resources and their perceptions on human-environment issues can influence collective action (Sullivan et al.,2017). In this study, the analysis of perceptions of local community members on the strength of community organizations including FOs, participation in collective activities for village-tank ecosystem restoration and awareness on the causes and effects of VTCS resource degradation was done as an effort to identify the driving perceptions that influence collective action. Mean values of all perceptions assessed indicate values within the range of 3.41 to 4.30 (Table 2) indicating higher level of satisfaction on the role performed by the FO, trust on traditional leadership within the community, trust on strong community cohesion, higher level of participation in village tank ecosystem maintenance activities assigned by the FOs and other collective activities, higher level of awareness on causes and effects of VTCS resource-degradation respectively.

Table 2: Mean levels of perceptions and awareness of the local residents. [Author's survey data, 2022]

	Statement	Mean	Standard Deviation
A	The role performed by the Farmer Organization for management of village tanks and the ecosystem is satisfactory.	3.69	1.235
B	There are well experienced adult members in the community, who possess traditional knowledge and act as leadership figures to guide the community members during crisis situations.	4.26	0.634
C	Even at present, there is a strong capacity for community organization and cohesion to overcome conflicts or common issues.	3.65	0.831
D	I/my family definitely contribute for village-tank ecosystem maintenance activities assigned by the FO.	4.28	0.660
E	I/my family members definitely take part in collective activities organized for village-tank ecosystem conservation/restoration.	4.18	0.838
C1	Awareness on the causes for VTCS resources exploitation	3.53	0.970
C2	Awareness on the effects of VTCS resources exploitation	3.96	0.499

[1]

Associations between the perceptions were analysed using the Pearson's Chi-square test and it was found that perceptions on causes as well as effects of VTCS resource exploitation showed significant

[1] Likert scale 5 -Strongly Agree, 4 -Agree, 3 -No idea, 2 -Disagree, 1 -Strongly Disagree

Mean analysis 1.0 to 1.8 Strongly Disagree, 1.81 to 2.60 Disagree, 2.61 to 3.40 Neutral/No idea, 3.41 to 4.30 Agree, 4.31 to 5.0 Strongly Agree

associations (X2(1, N=88) =4.29, p=0.038 and X2(1, N=88) =6.41, p=0.011 respectively) with the participation of cascade inhabitants in collective VTCS rehabilitation actions. The contribution of the cascade inhabitants for maintenance of village tank and its ecosystem at household level as assigned by the FO was found to have a significant relationship with the perception on effects of VTCS resources degradation (X2(1, N=88) =8.06, p=0.005). This reflects that the local peoples' perceptions and awareness on the resource endowment related to the local farming systems act as drivers for their collective engagement for the conservation/restoration of common resources as well as the farming systems, ultimately contributing to ensure local food security.

Conclusion

Food security of rural communities depending on the VTCS-based farming systems in the low-country dry zone of Sri Lanka has been challenged by the resource constraints for the sustenance of such local farming systems. These resource constraints are characterized by multiple scenario including adverse impacts of climate change, socio-economic changes and government policy failures in the current context. It is well-recognized that the VTCS-based farming systems including both lowland and upland, have been traditionally managed by local communities. Based on the findings of this in-depth exploration, there is evidence for emergence of collective action among local community members in *Medde Rambewa* cascade system located in Nawagattegama, Puttalam district of Sri Lanka, in order to cope with resource-scarce conditions in the present context as well. Collective responses related to management of farming systems were found to be two-fold, as formal institutionalized actions coordinated through FOs and organically emerged actions through existing social relationships. Collective decision making on cultivation planning, irrigation water management, sharing of labour and other farming inputs and collectively dealing with threat of wild-elephants were found to be the main collective activities adopted by the local people. Perceptions held by the local community members on the status of resource endowment, especially on the causes and effects of resource degradation were found to be significantly associated with the peoples' participation in collective action. The study concludes that the resource-scarcity itself, community members' recognition on their role as key stakeholders of resource management and awareness on the nature of resource endowment are drivers of collection action within local communities who manage farming systems established under VTCS, ultimately contributing to ensure rural food security.

Since these findings are generated through a case-study of a single VTCS-based community, there is potential for deeper empirical analysis on the impacts of communal collective action on rural food security within a more inclusive geographical scope of several VTCSs representing different agro-ecological regions.

Acknowledgements

The generous people of the two villages Moragahawewa and Mahameddewa in Nawagattegama division of Puttalam district, Sri Lanka are respectfully acknowledged. Highly appreciate the support extended by the local government officers, field coordinators and SAPSRI staff members affiliated to the CRIWMP project implemented at the Medde-Rambewa cascade system. The corresponding author extends her gratitude to the government and people of Japan for awarding the Monbukagakusho scholarship as financial support to her doctoral research including this study.

Declaration of Interest Statement

The authors declare no conflict of interests.

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