Chapter 11

THE CURRENT SIGNIFICANCE AND DEVELOPMENT CONDITIONS OF LIFT IRRIGATION SYSTEMS IN THE DRY ZONE OF SRI LANKA: LESSONS TOWARDS SUSTAINABLE IRRIGATION DEVELOPMENT

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1. BACKGROUND

From ancient times, Sri Lankans have prioritized irrigation management in their development strategies, particularly in the dry zone due to seasonality and variability in rainfall. The amazing accomplishments of hydro-engineering that turned the Island's dry zone into the proverbial 'Granary of the East' are ample testimony to their endeavors.

Since regaining independence in 1948, Sri Lanka invested a large share of its resources in irrigation projects. The aim was to increase food production, improve rural welfare and raise the socio-economic standard of farming communities, address the issue of land scarcity in the wet zone, eliminate the land issue among the poorest of the poor, and upgrade the gross national product and economic growth (Farmer, 1957; Dunham, 1982; Chandrasiri, 2010). Today, over one million people have been settled in more than 110 major irrigation schemes (Chandrasiri, 2010). Undoubtedly, the high productivity of agriculture and rates of return on investment in irrigation projects are associated with optimum and efficient use of land and water. According to the mission report of the Food and Agriculture Organization, effective management of irrigation water resources for scientific and intensive agricultural production is essential to address the critical

Cite this chapter: Wijewardhane, W., Upulwehera, J. & Prasanna, R., 2021. The Current Significance and Development Conditions of Lift Irrigation Systems in the Dry Zone of Sri Lanka: Lessons towards Sustainable Irrigation Development. In: R. Prasanna, ed. *Sustainability of Agriculture Settlement Schemes in Dry Zone of Sri Lanka: Issues, Challenges, and Path ahead.* Mihintale: Rajarata University of Sri Lanka, pp. 201-217.

problems in agrarian societies, particularly in the dry zone of Sri Lanka where water is a scarce resource.

Even though successive governments had invested a substantial share of resources in establishing new irrigation schemes and revival of ancient irrigation schemes, many issues still remain in these schemes. Various studies have highlighted that the low-income status of farming communities in the schemes is due to several reasons, such as stagnated nature of farm productivity, issues in the agricultural extension network, and problems of the land ordinance specific to the major irrigation schemes (The World Bank, 2003; Prasanna, 2006; Rupasena and Wijayakumar, 2006; Kikuchi et al., 2006; Rupasena and Naik, 2009; Weerahewa, 2004; Thiruchelvum, 2005). Tolerance of farming in major irrigation schemes to adverse impacts of climate change, particularly drought, is another emerging challenge the farming communities in the dry zone face. Specifically, underutilization and low productivity of the upland of the irrigation schemes are apparent due to water management problems. Today, these issues have jeopardized the sustainability of livelihood of farming communities in major irrigation schemes. Based on the experiences of early settlement schemes in the country, Farmer (1957) noted the importance of irrigation planning to the high land of the settlement schemes, particularly in the dry zone, to enhance the land productivity and thereby the economic status of the farming system or increase the rate of return on investment in the agriculture settlement schemes. This background poses the question – how to booster the economic, social, and environmental sustainability of major irrigation schemes in Sri Lanka. Thus, it is high time to think of alternative water and land utilization systems that support addressing the issue of income vulnerability of farming communities and adverse impacts of climate change.

In modern irrigation management, Lift Irrigation Systems, known as ***'Ussana Warimarga',*** is recognized as one of the alternative methods to conventional irrigation systems, which has rarely been practiced since the 1950s in the country's major irrigation schemes. Specifically, this system was introduced as an experimental project in the 1950s in Nagadeepa, Vavunikulam, Muthuviyankattu, and Gal-Oya, but the expected outcomes were not materialized. The lift irrigation links irrigated water and highlands (upland) through an alternative water supply mechanism to promote short-term, mid-term, and long-term crop systems in highlands along with low land cultivation systems. Even though farming communities in modern irrigation schemes face severe hardships, the economic, social, and environmental benefits of the lift irrigation system are not adequately analyzed. The existing studies such as World Bank (1985), which attempted to evaluate the success or failure of the lift irrigation projects in the country, have primarily based on the focused goals at the designing stage, such as the number of acres aimed to devote for the cultivation and number of settlers aimed to settle in the scheme. Thus, the central

aim of this study is to reveal the current significance and development conditions of the lift irrigation systems in the dry zone of Sri Lanka. In this connection, the study will examine the characteristics of the ***Lift Irrigation Systems*** in the major irrigation systems in the dry zone, analyze the impacts of ***Lift Irrigation Systems*** on sustainable livelihood development of the inhabitants in the scheme, and identify current problems and challenges faced by the ***Lift Irrigation Systems*** in the major irrigation schemes.

2. RESEARCH METHODOLOGY

2.1 Reasons for selecting the study area

Due to the nature of the phenomenon to be studied, the study adopted a mixed approach (qualitative and quantitative) in the research process. The mixed approach is more suitable for this study because it could give a holistic view on research or answers the question: "how to poster the economic, social, and environmental sustainability of the agriculture settlement schemes of the country?" The empirical data for the study were drawn from the field survey conducted in the Lift Irrigation System in the *Rajanganaya* Major Irrigation Scheme situated in the North-Western dry zone of Sri Lanka. The reasons for selecting the Lift Irrigation System in the *Rajanganaya* Major Irrigation scheme area were as follows:

a. It is among the few Lift Irrigation Systems still functioning in the country. Established in 1968 as a joint project of the World Bank and the Sri Lankan Government, this is the largest lift irrigation system in the country, which operated 19 and 10 pump houses in the left and right banks, respectively. The total land area under left and right banks are 2,551 acres and 2,425 acres, respectively, and the number of families, who were direct beneficiaries of the system, were 2,031 and 1,556 in the left and right banks of the system, respectively.
b. The scheme showed good performance at the early stage of establishment, particularly in the 1980s. Specifically, the North-Western Provincial Council established the export crop villages in the scheme by considering the potentiality of the system in producing export-oriented crops. As a result, farmers could sell their products to the export market at the farm gate.
c. The performance of the scheme has gradually declined during the last two decades. For instance, today, only 38% (912 acres) and 31% (793 acres) of the land area is used for cultivation in the right and left banks in the scheme.

Thus, the lift irrigation system in the *Rajanganaya* Major Irrigation Scheme is a typical area for the study to deal with the research subject.

2.2 Sampling and data collection in the field

For dealing with the research subject, data for the analysis were drawn from a field survey conducted in the lift irrigation system in the *Rajanganaya* major irrigation system area. The data collection process involved three stages.

1) ***Field observation***: Field observation was performed to identify the structure and basic features of the lift irrigation system in the survey area and to map all beneficiary households.
2) ***Key informant interviews***: Key informant interviews were held to examine the history, sustainable characteristics, and current problems of the system, specifically the management related. In this connection, leaders of the farmer organizations, officers in the agricultural extension system and irrigation office, and adult (aged) farmers were interviewed.
3) ***Farm household survey***: Farm household survey was conducted by administering a semi-structured questionnaire to elicit the data specific to water management practices in farm households, agricultural practices, crop systems, resource use, agricultural marketing, income and cost of production, and social and environmental benefits of the lift irrigation system. The survey covered all 120 farm households in the three lift irrigation pump houses - BOP715/2, BOP 716, and BOP 560/A (see Table 1).

Table 1: Details of lift irrigation pump houses at *Rajanganaya* scheme – Right Bank

BOP No	No. of farm families for each pump house	Irrigation area for each pump house
BOP 715/1	90	90
BOP 715/2	**85**	**250**
BOP 397	81	60
BOP 716	**120**	**142**
BOP 717/1	59	59
BOP 560/A	**115**	**111**
BOP 561	41	41
BOP 560	110	107
BOP 607	125	122
BOP 717/2	360	360

Source: Divisional Irrigation Office, *Rajanganaya*

3. RESULTS AND DISCUSSION

3.1 Technical and management mechanism of the lift irrigation system in the survey area

Lift irrigation is the system that manages water from irrigated channels to up-land. Figure 1 illustrates the water supply mechanism to up-land in the survey area. The main water pump is fixed in the water pump house, located closer to the main channel (see Figure 2). The main electricity grid in the area provides electricity required to operate the water pump. Water from the main channel, the Right Bank, in this case, is pumped by a water pump to the top point of the sub-water channel located in the upper stream of the area (see Figure 3), which has no water source and with less groundwater. Water is managed from the top point of the sub-water channel in the upper stream to the fields, mainly fruit and vegetable fields and livestock activities. As Table 2 presents, the average distance between the main and sub-water channels in the upper stream is 1.5 km, and the numbers of beneficiary farmers in BOP 715/2, BOP 716, and BOP 560/A are 250, 142, and 111, respectively.

Farmer organizations formed in each system manage the lift irrigation system. They officially discuss and assess the crop systems that each member farmer plan to practice and already practice. Hence, crop-based water demand and supply and management systems could be observed. Each farmer is charged based on the number of water supply hours they use to supply water to their fields from the main water pump. The farmer organization employs a worker to provide technical service to maintain the system.

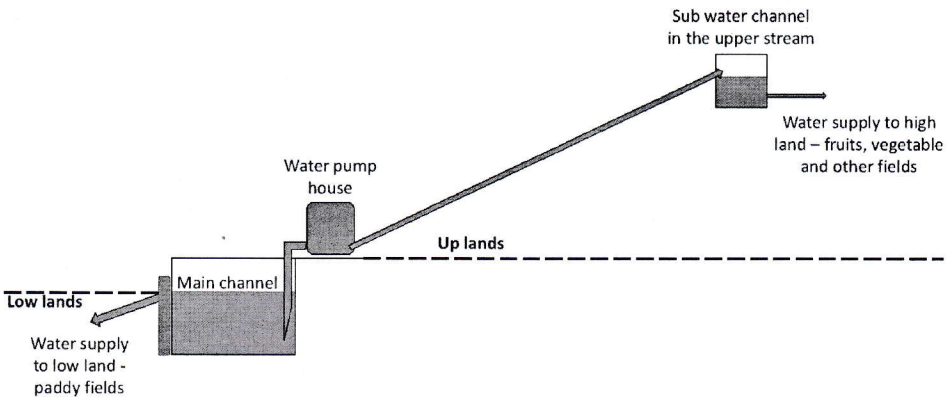

Figure 1: Water supply mechanism to up land in the survey area

Table 2: Field characteristics of the selected lift irrigation system

Selected system	Distance between main pump house at the main channel and tank in upper land (km)	A-B (height difference between the main channel and upper tank)	No. of acres	No. of farmers	Ave. farm size
BOP 715/2	1.7	45	85	250	0.34
BOP 716	1.5	30	120	142	0.83
BOP 560/A	1.7	37	115	111	1.2

Source: Field survey, 2019

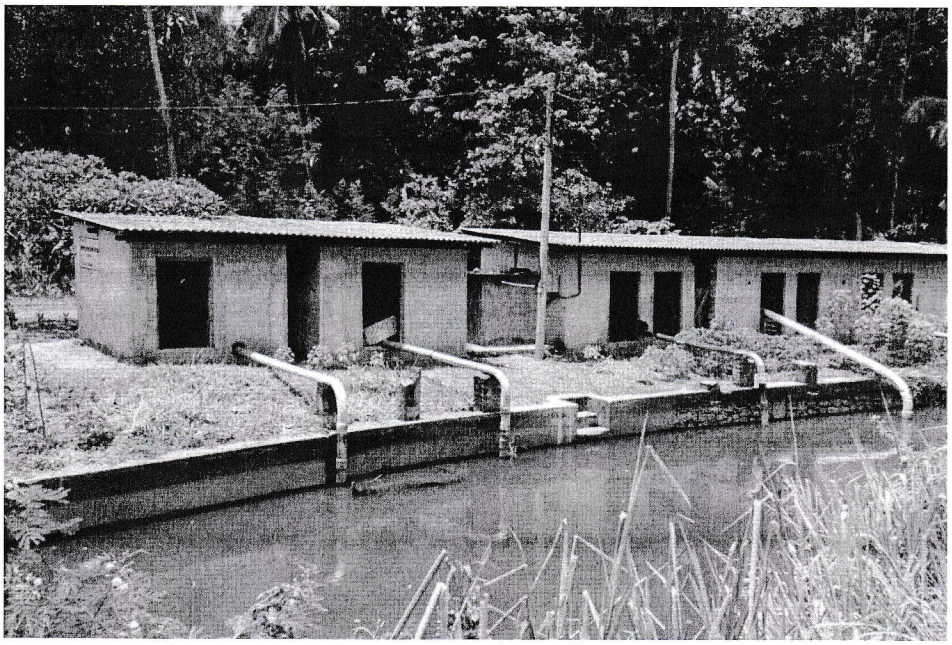

Figure 2: Pump houses near the main water channel

Figure 3: Main water point in the top point of the water channel in the upper stream

3.2 Effects of lift irrigation system

1) Land and water use pattern

Conventionally, uplands of settlement schemes are primarily used for rain-fed cultivation, and mid and long-term cultivations are difficult due to the water shortage and concurrent drought. In addition, the groundwater table level of these uplands may lie very deep or shallow comparing to lowlands. Therefore, upland farming systems are economically less viable and mainly used for *Chena* farming.

This study identified several features of the land and water use pattern in the investigated lift irrigation system. The field observation study and data collection were executed during August, which is a very dry month of the year. These field observations indicated that all the beneficiary farmers were maintaining healthy crop fields (see Figure 4). First, it signifies that the system has enabled the farmers to maintain the field crops irrespective of the natural rainfall pattern in the area. Second, the field observation revealed that farmers who grow short-term crops were passing their harvesting period, particularly in the period during which the market vegetable supply is at a minimal level. This denotes those lands are mainly used for short-term cultivations in the off-season. It proves that the lift irrigation system is contributory in stabilizing the

agriculture production of these areas, particularly in the dry seasons of the year, as water is accessible whenever required.

"We grow vegetables at the off-season because we could gain good price. Also, in those periods, we receive less rain or no rain. New varieties of vegetables could grow well in the upland during this period because of the availability of water and less damage of pests and disease, and no damage from heavy rain. Also, there is a good market for our vegetables during this period."

Field interview (1) – August 2018

The land-use efficiency of surveyed farmers revealed that 82 (68.3%) farmers were using over 75% of the potential land area given to them in the scheme in the off-season. Twenty-five (20.8%) farmers were below 25%, indicating an existing opportunity to further enhance crop production in the area by addressing the current limitations.

Table 3: Land use efficiency of selected farmers in the scheme in the off-season

Land use level from the potential area	No. of farmers	%
Over 75%	82	68.3
50 – 75%	11	9.2
25 – 50%	2	1.6
0 – 25%	25	20.8
Total	120	100

Source: Field survey, August 2018

Water use efficiency is high in the scheme as water supply to the crop field depends upon the crop water requirements. Farmers generally pump the water to the field once a week, and the average cost for watering for a one-acre crop field is Rs. 455. According to farmers' view, this is a low expenditure of watering the crop fields compared to the use of own water pump with additional labor. Thus, overuse of water in the lift irrigation system is contrasted due to the direct monetary cost of watering the fields, direct supply of water to the field, and the scheduled watering plan developed by the farmer organizations in each lift irrigation water pump. Specifically, the usage of manpower in watering the field is less in the lift irrigation system due to the established pump house system with water canals in the upper stream.

The sustainable use and management of water in agriculture are recognized as critical in modern agriculture to increase production. Hence, the lift irrigation system provides adequate evidence of its potential to share water

sustainably with other farmers, thereby nurturing the environmental and social benefits associated with this specific system.

2) Effects on crop diversification practices in the field

The field data analysis revealed that 88 (73%) of surveyed farmers were growing more than one crop in the field, aiming to achieve different objectives. Table 4 presents the perceptions of farmers on practicing the crop diversification technique in the crop fields. Field observation confirmed that farmers had grown many kinds of vegetables and fruits along with mid- and long-term crops in the field (see Figure 4). The applied crop diversification techniques at the field level showed the optimum use of land for crop cultivation in each plot. Also, many farm plots in the scheme consist of short-term, mid-term, and long-term crops, indicating the system's ability to generate income throughout the year. This permit reduced economic uncertainty for farming livelihoods in the area. Practicing these diversification techniques help farmers to reduce the adverse effects from climatic change to both biotic and abiotic factors in upland farming systems, which threaten the production and sustainability in the schemes. Such a diversified crop system in the scheme could be recognized as one of the long-term effects of the lift irrigation facilities in the upper stream of the *Rajangana* agricultural settlement schemes. Therefore, stability in the water supply to the upper stream is a key determinant that could promote sustained crop diversification practices in the long run.

Table 4: Farmers' perception of crop diversification practices in the lift irrigation system (N = 88)

Perception	No. of farmers	%
1. To better the farming income	75	85
2. For the optimum use of water for higher farm productivity	70	79
3. For the optimum use of inputs in the field	66	75
4. To control the pest attacks and diseases	52	59
5. To maintain soil fertility	52	59

Source: Field survey, August 2018

Figure 4: Crop fields in August 2018

3) Analysis of marketing and productivity gains of crop planning in the scheme

"We generally grow short-term crops at the off-season. The reason is that we observed in every year that price went up to an unprecedented level at the main markets – Dambulla and Thambuththegama."

Field interview, August 2018

The above statement of a farmer in the scheme revealed that farmers had been allowed to gain the price advantages aiming the harvest at the off-season. Conventionally, upland farming systems in Sri Lanka are largely dependent upon the rainfall pattern of the country – *Yala* and *Maha* monsoons. Thus, cultivation practices periods are in parallel in all regions of the country in terms of short-term crops. Thus, bulk production or an excess supply of the production could be observed in the market during the harvesting time, resulting in a drastic reduction of the market price of agriculture commodities. Figure 5 empirically illustrates the seasonal price and harvest movements of crop systems in conventional and lift-irrigation systems. It indicates that farmers in the lift-irrigation system adopt off-season cultivation practices aiming at price gains from agriculture marketing. Therefore, they can compete with the other farming communities in the country and survive in infeasible market conditions.

As illustrated in Figure 5, the main benefit of the lift irrigation-based crop cultivation system is the ability to address the supply shortage in the market during the off-season and thereby stabilize the market price at a certain level above the general equilibrium price of peak season. Thus, the lift irrigation system in the *Rajanganaya* settlement scheme has improved the producer surplus and limited the deterioration of consumer surplus in the vegetable market in the country (see Figure 6). This scheme could be considered as one of the main sources of off-season vegetable suppliers of the country.

"In the 1980s, we were encouraged to grow export-oriented crops. Then, the Chief Minister of the North-Western Province introduced this program. A large amount of our harvest was purchased by the export companies at the farm gate. However, the authorities later did not pay attention to sustain the program."

Field interview, August 2018

"We could obtain the highest production by practicing crop cultivation in the off-season. We have fertile lands. The availability of water for crop fields is important. The Ussana Warimarga provides us the opportunity to water the fields easily during the dry periods. Also, there are no issues concerning labor as it is the off-season."

Field interview, August 2018

According to the above field interview statements, crop productivity is high in the scheme, mainly due to the watering facility. Crop diversification, labor availability, and minimal pest and disease attacks are recognized as some other causes for the higher productivity in the farming system in the scheme. Differently, the statements revealed a pernicious failure in authorities, which prevented them from exporting their products.

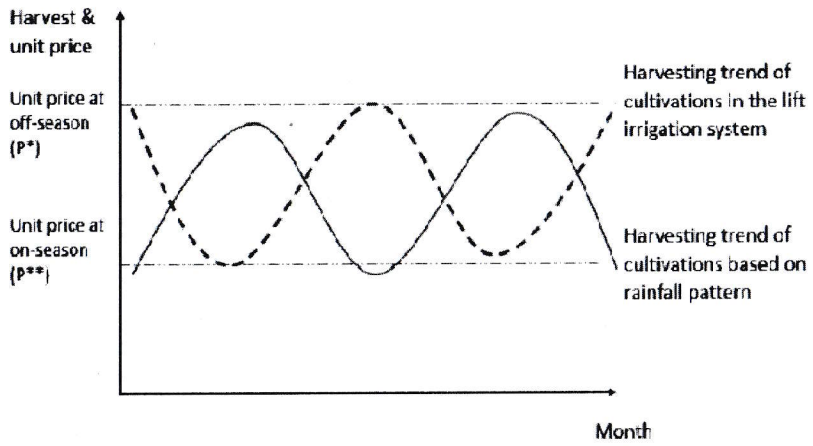

Figure 5: Harvesting and unit price movements of crop systems in conventional and lift irrigation systems

Source: Authors' illustration based on field interviews

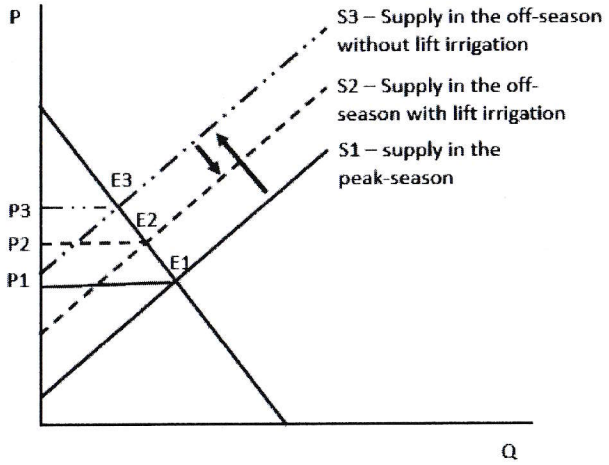

Figure 6: Effects on consumer and producer surplus in the vegetable market during the off-season

Source: Authors' illustration based on field interviews

4) Economic effects on household's economic and living conditions

In this section, we assess the long-term effects of the lift irrigation system on farm household economic and living conditions. Table 5 shows that farmers in the lift irrigation system have received long-term economic benefits from growing vegetables and fruits under lift irrigation facilities. The main effect is that lift irrigation facilities have resulted in stabilizing the farming income while improving the income status of farming. It is noted that each farmer in the scheme is given one acre of upland for farming. Sufficient water availability in the main channel, which could maintain a constant water supply to the upper stream, is the main reason for continuous farming activities throughout the year.

Secondly, farmers' long-term experience in vegetable marketing has inclined them to change the cultivation pattern from peak season to off-season. This has resulted in generating satisfactory farming income due to supply ability during the shortage period. Thirdly, the farmers reported that long-term irrigation practices at the upper stream have led to establishing a favorable farming environment, mainly through cultivating mid-term and long-term crops, specifically coconuts and different types of fruits. This has resulted in generating agricultural income throughout the year and establishing a more diversified crop system. Improved social cohesion was noted as a long-term impact of the scheme, particularly due to the involvement of farmer organizations, particularly in water management in the upper stream.

Table 5: Long-term effects of the lift irrigation system – from the farmers' perspective

Effect	Rank	Mean score	Std. Dev.
1) Increased and stabilized the farming income	1	3.78	0.056
2) Changed cropping pattern from peak-season to off-season	2	3.53	0.185
3) Established the condition for sustainable farming	3	3.44	0.155
4) Improved the social cohesion	4	3.40	0.132

Source: Field survey, August 2018

3.3 Current problems the farmers face in the lift irrigation system

The main problem of the system is the lack of forwarding market contracts with the vegetable value chain (Table 6). Specifically, farmers expect segmented markets for their products as lift irrigation systems support them to produce quality products. Fifty-four percent of farmers reported the issues about catering their products to the export market. This is mainly due to the lack of a stable link with the export market-led value chain. In this regard, the farmers noted less

support from agricultural extension networks. Forty-eight percent of farmers reported the issues related to management and maintenance of pump houses due to technical issues. This is mainly due to the less support or attention of institutional settings related to irrigation and paying inadequate attention to alternative energy sources such as solar power systems to lower the energy costs. The farmer interviews specifically revealed the less support provided by extension officers in planning the scheme's crop schedule and providing technical know-how.

Table 6: Constraints of farming in the lift irrigation system

Constraint	No. of farmers (N = 120)	% farmers
1. Lack of contracts in the forward market	65	54
2. Management and maintenance issues	58	48
3. Issues related to agricultural extension network	45	37.5
4. No export market opportunities	33	27.5
5. Lack of agro-based industries	20	17

4. CONCLUDING REMARKS

This study attempted to reveal the current significance and development conditions of the lift irrigation system by considering the *Rajanganaya* Lift Irrigation System as a case. It is learned that the studies in the field of lift irrigation systems in the country have assessed the success and failure status of the systems, mainly considering the established expected goals at the planning stage.

First, the study revealed higher land and water use efficiency in the scheme, particularly in the off-season, which is the period in which vegetable supply is minimal at the market. Most of the farmers use the optimal level of land for cultivation at the off-season. Water usage in the field was found to be dependent upon the field requirements, indicating the higher water use efficiency.

Second, it revealed that farmers gained a higher margin from vegetable marketing by growing vegetables in the off-season and supplying them to the market during the shortage period. The farmers experienced higher productivity in terms of aggregate output of the farm as they practiced crop diversification techniques.

Third, one of the main effects of the system which supports farmers regarding the constant supply of vegetables to the market in the shortage period is the ability of the system to address the supply shortage in the market during

the off-season and stabilize the vegetable price at a certain level above the general equilibrium price of peak season, thereby generating welfare gains to both producers and consumers in the market.

Fourth, the study identified several long-term impacts of the lift irrigation system, such as stability in farming income, improved status of farming income, change in cultivation pattern and crop schedule, and improved social cohesion due to farmer organizational activities.

The study identified several conditions required to sustain the system. Specifically, it must establish a forward contract system for marketing and promote farmers toward an export-oriented crop system with proper integration with a value chain of the export market to improve the agricultural income of the farmers in the system. The study specifically revealed that farmers experience intensifying stress from the irresponsible behavior of institutional settings, including agricultural extension services in the area, and some management and maintenance-related issues in farmer organizations were also identified. As these systems help food security and food availability in the country during the off-season, it is the respective institutions and officers' responsibility to establish suitable conditions for the effective functioning of these systems. However, the authorities remain negligent, with several issues unresolved.

Based on the sustainable gains of the lift irrigation system to the area's farm economy, the authors suggest promoting this model in other agricultural settlement schemes in the dry zone of the country. The specific aim here is to address the vegetable shortage in the market during the off-season and stabilize the market vegetable price. Landscape, resources, and crop economizing models practiced in the area could be introduced to other farming communities in the dry zone to enforce them to confront a range of climate change scenarios. These actions would help farmers to adopt optimal strategies for sustaining their production, income, and ultimately, their livelihoods.

It is also recommended to apply the model at the small or micro-level with appropriate technical support to the farmers aiming at the export-oriented crop system. Hence, understanding the potential of promoting the lift irrigation system among farm systems in the dry zone is essential for government bodies and authorities to help farmers adapt to climatic and economic variabilities in the future.

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