

# Ancient Small-Tank Irrigation in Sri Lanka

## Continuity and Change

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This paper shows that winds of change are blowing in the dry zones of north-central Sri Lanka, the original hydraulic civilisation of the world. The social organisation of tank irrigation – which for centuries had combined a stylised land-use pattern, a system of highly differentiated property rights, and elaborate rules of community management of tank irrigation – has now been morphing in response to demographic pressures, market signals, technical change and modernisation. What are the lessons for south Asia and sub-Saharan Africa?

### 1 Hydraulic Civilisation of the Dry Zone of Sri Lanka

**A**mong all of Asia's ancient rice irrigation civilisations, the three most celebrated ones were in Tanjore (in today's Tamil Nadu), Cambodia and Sri Lanka. A dense network of long-continued, well-spaced alignment of perfectly parallel canals was the contribution of the Chola kings to the rice irrigation systems of Tanjore (Wilcocks 1984). Rice irrigation systems that created and sustained the powerful Angkor empire in Cambodia were remarkable for their chequerboard design, with regularly demarcated, perfectly square rice paddies framed by small raised dykes that also served as cart routes (Himel 2007). Ancient Sri Lanka's irrigation civilisation was based on the social organisation of village communities around small irrigation tanks, established as a cascade along a watershed (Leach 1959).

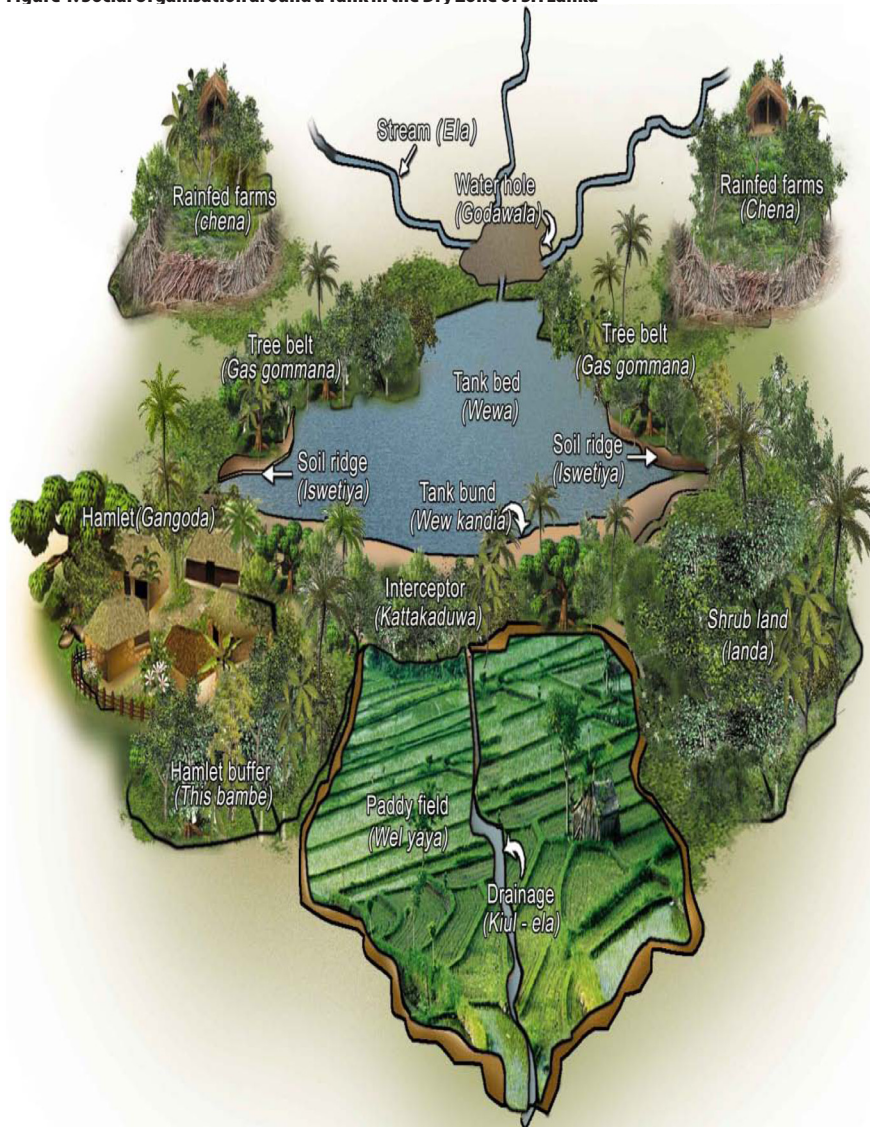
The irrigation civilisation of the Tanjore delta morphed under pressure of modernisation during the colonial and post-colonial eras. Cambodia's Angkor empire was at its zenith around the 13th century and collapsed in the 15th, taking with it its chequerboard irrigation systems to the ruins. Much as the Khmer Rouge tried to revive them during the 1970s, at a cost of 1.7 million lives lost, chequerboard irrigation systems today remain part of the folklore of Angkor Vat.

Sri Lanka's dry zone is the only ancient irrigation culture that can boast of an unbroken history of local management of village tanks for rice irrigation over millennia. The ancient Sinhalese kingdom of Anuradhapura in today's north-central province fell to Chola invasions during the 11th century. However, during the 20th century, several scholars described social organisation around small and large tanks to have remained intact. References to ancient Sri Lanka as a hydraulic civilisation can be explained by the relics of the large irrigation systems built by kings and overlords of Anuradhapura, as well as the tank cascades in the dry zone. The design of these cascades demonstrates a profound understanding, on the part of ancient tank builders, of trigonometry, geomorphology, as well as the hydrology of landscapes (Panabokke nd). In 1981, after an extensive aerial survey to identify an ideal site for a dam across Maduru oya under the multipurpose Mahaweli project, a team of local and foreign engineers discovered the ruins of an ancient dam and sluice, constructed several centuries earlier on that very site (de Silva 2005: 33)!

From about the 13th century, large state-controlled irrigation systems atrophied as the state bureaucracy went into decline. However, small tank systems continued to thrive. Managed by village communities without much interference

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Figure 1: Social Organisation around a Tank in the Dry Zone of Sri Lanka



- 1 *Chenna* – area where shifting cultivation is practised.
- 2 *Perahana* – literally means a sieve or filter in English. A grass strip on the periphery of the water body (dark green in ppt) that acts as a silt trap
- 3 *Godawala* – “Upland hole” in English. Upstream sediment trap
- 4 *Gasgommana* – (gas= trees; gommana = plenty). An area planted with large trees of the same species that act as a wind breaker to minimise evaporation from the tank surface. It also provides some ecosystem services: dry season fruits, timber, nesting for birds
- 5 *Iswetiya* – upstream conservation bund built on the periphery of the water body
- 6 *Relapanawa* – an earthen construction to prevent damage to the tank bund due to wave action
- 7 *Thisbambe* – tis = thirty. Bambe = a linear measurement – 6 ft. A strip of reserved land around the hamlet for protection
- 8 *Kattakaduwa* = Downstream wind breaker
- 9 *Landa* = scrub jungle
- 10 *Akkara wela* = “acre field”. Area outside the old (*purana*) field that was subsequently developed for paddy cultivation. This was during the time of the colonial administration where each applicant for additional paddy land was allowed to develop a maximum of 1 acre.
- 11 *Kiul Ela* = common drain of the irrigated area

Source: Dharmasena (2010).

from the state, these continued to function and grow even after the collapse of the state, and provided the basis for irrigation agriculture in the dry zone of the island.

The resilience of the small tank system is explained by the synergy between the tank ecology, social capital and institutional structures, especially secure property rights to land and water that provided the community with the incentive to contribute resources, primarily labour, to operate and maintain these tank irrigation systems (Abeyratne 1986; Leach 1959; Madduma Bandara 1985; Panabokke 2010; Tennakoon 2002).

## 2 The Tank and Its Socioecology

The exact number of tanks in Sri Lanka’s dry zone is unclear. According to the Department of Agrarian Services (2006), there are some 11,260 small tanks with a total command area of about 2,20,000 hectares. The density of tanks declines from the heavily populated west to the uninhabited east (Panabokke nd). Figure 1 is a schematic representation of the physical layout and the various components that make up the

small tank farming system. Each component served to facilitate resource conservation and minimise or prevent the damage brought about by natural calamities such as droughts, pests, wind damage and sedimentation (Dharmasena 2010). Traditionally, tanks formed part of a farming system that was based on a threefold system of land-use, centring on irrigated rice cultivation in the tank command, shifting cultivation (*chennas*) of other crops in the communal uplands under rain-fed conditions, and perennial crops, mostly trees, in the home garden, which made use of sub-surface moisture. While the tank and its command formed the pivot of the farming system, rain-fed upland plots under shifting cultivation provided elasticity to the system, enabling the farm household to expand (or contract) its operational landholding in response to intra-household demographic pressures. Moreover, shifting cultivation provided a means for earning cash income in contrast to irrigated rice production, which provided the household with its staple food. It is the combination of all three forms of land-use and the social organisations surrounding them that facilitated

resource access and use, which in turn made the system viable and enabled its continuity.

A topographical study of the dry zone shows that, much like the tank cascades of Tamil Nadu, tanks in Sri Lanka's dry zones are also interconnected in series or parallel links within a single micro-catchment. Under this layout, water is continuously recycled. Surplus water from the upstream tank and return flows from rice irrigation are captured in downstream tanks, and are thus used again in the command area of the second reservoir. This system helps to surmount the irregular rainfall, the non-availability of large catchment areas, and the difficulty of constructing large reservoirs. The sources of water supply to the tanks are direct rainfall and run-off water from their own catchment areas. Most of the tanks are shallow and have a high ratio of water spread area to the area irrigated.

As in many traditional irrigation communities, property forming and reproducing activities were key factors in the persistence of small tank systems in Sri Lanka. In a pioneering study based on several months in a village in the 1950s, Edward Leach provided a detailed description of the intricacies of village organisations centred around a small tank – Pul Eliya, located near the ancient city of Anuradhapura in the north-central dry zone. Leach listed several types of land and tenure systems: *Puranawela* or the old field – the area first developed by a new group of settlers in the tank command – house sites and gardens (*gamgoda*); free-hold land (*sinakkara*); one-acre plots of irrigated area or *akkawela* subsequently developed for paddy; forested highland used for shifting cultivation (*chenna*); and lease-hold (*badu*) land.

Throughout history, however, the most stable has been the tenurial arrangement in the Old Field – that is, rectangular flat terraces for rice irrigation under traditional tenure (*paraveni*) from ancestral times, governed by the traditional Kandyan law. Under the traditional system, holders of a share of land (*panguva*) in the Old Field also held the rights to a certain length of the irrigation ditch and an entitlement to the tank's water supply. The Old Field was divided into an upper and a lower field, which were divided in their turn into three sections (*baga*): upper, middle and lower, situated at right angles to the tank bund. Each *baga* is further divided into a specific number of equal shares (*pangu*), such that the original stakeholders who had constructed the tank have a share each in both the upper and lower fields (Figure 1). Thus, for every share of land (*panguva*) held in the upper field, there was a corresponding share in the lower field. Accordingly, each villager in the settlement would hold land in both the head (the most easily irrigated) and tail (the least easily irrigated) areas. This implies that what was shared was not land rights, but water rights (Leach 1959: 158). Even today, ownership of land in the *puranawela* (Old Field) is central to the social organisation of small tank communities. It confers an identity on the holder and his/her descendants – as the original property owner. It also confers an entitlement to a share of the tank water, fishing rights, as well as the basis for selecting and replacing leaders.

The basic layout of the Old Field in Pul Eliya, which Leach observed in 1954, remains intact till date (Weeramundra and

Damayanthi 2011: 50). It continues to sustain the institution of *bethma* under which, in times of water scarcity, the lower field is left out, while everyone has a share in the upper field that is being irrigated. Mahasena, a Farmer Organisation (FO) leader we interviewed in a village near Madawachchiya in Anuradhapura, asserted that while the *bethma* institution has weakened, it has not withered away; in his village, it was last invoked in the 2009 *yala* season<sup>1</sup> to share scarce water equally among farmers.<sup>2</sup>

Another institution that has survived is the *Vel Vidane*, the water manager, introduced and formalised by the British under the Irrigation Ordinance of 1889. The *Vel Vidane*'s role was to extract a consensus on the rice sowing date and declare the irrigation schedule, open the sluice gates, manage orderly water distribution, oversee the preparation of field channels and, critically, “commandeer” voluntary labour to maintain both common canals and the tank bed. Especially in the *yala* season, *Vel Vidane* operated a rotational irrigation system similar to the *warabandi* system in northwestern India and Pakistani Punjab. *Vel Vidane* was vested with judicial powers under colonial rule. Traditionally, *Vel Vidane* was rewarded with a field in the tank command; now, though, most *Vel Vidanes* are paid (if at all) half a bushel of paddy per acre of tank command. After independence, the institution of *Vel Vidane*, considered a remnant of colonialism, gradually weakened. In time, the *Vel Vidane* was replaced by an elected Cultivation Committee under the Paddy Lands Act of 1958. These remained defunct and made way for FOs, which came with a diffused mandate. In most villages, the traditional *Vel Vidane* was elected the chairman of the FO.

### 3 Fertiliser Subsidy and Power of Farmer Organisations

Irrigation institutions in Sri Lanka's dry zone have probably changed more during the 60 years since Leach's fieldwork than they had in the previous 600 years. While the original layout of the tank command has remained, its centrality to village economy and society has declined. As population pressure increased, the colonial administration allowed new 1 acre paddy plots – *akkaravela*, adjoining the “Old Field” – to be opened up. Moreover, *chenna* lands, the upland forest area used for shifting cultivation, have become increasingly privatised and converted into regular fields for the cultivation of vegetables, millets, lentils and trees. The fact that the institution of *Vel Vidane* has weakened and FOs have remained mostly timid and largely ineffective has not helped Sri Lanka's rice economy either.

Rulers of Sri Lanka – then as well as now – have accorded high priority to maintaining self-sufficiency in rice production. For a long time, farmers' priorities have been to cultivate cash crops on *chenna* land, which the colonial administration tried to restrict. Even in 1954, Leach noted that had there not been these restrictions, most villagers would have devoted their energies to cash crop cultivation and bought rice instead of growing it. Today, the lure of cash crops is even stronger. To promote rice cultivation, the current Government of Sri Lanka procures farmers' paddy at an attractive price. However, to

check the procurement bill, purchase is limited to 1,500 kg per registered (“*asweddumized*”) paddy acre, up to a maximum of 3,000 kg per farmer. In addition, for 15 seasons in a row, the government has provided paddy farmers fertilisers at a subsidised price of LKR<sup>3</sup> 350/50 kg bag, which today makes for a 70-75% subsidy<sup>4</sup> since the market price of urea is LKR 1,200-1,400/bag.<sup>5</sup> To limit the fertiliser subsidy bill, in 2003 the Sri Lankan government decided to route subsidised fertilisers to farmers through FOs, that too, for only registered paddy acres. Members are to register their paddy area and indent their fertiliser requirement (along with advance payment) with the FO, which pools these indents and submits a collective demand to the Agrarian Services Centre. The Agrarian Services Centre will then order their fertiliser on behalf of each FO, and the FO would then lift the fertiliser, cart it to the villages, and distribute it among the farmers.

Under this arrangement, FOs received a big boost. Before this, farmers had to be coerced to become FO members, to pay the annual membership fee, and adhere to irrigation rules. But now there was a rush to become FO members since only members could benefit from the fertiliser subsidy, forgoing which amounts to a significant personal cost for the farmer.<sup>6</sup> Moreover, FO leaders now enjoy greater clout in all village affairs and agricultural matters. In several villages where we interviewed FO presidents as well as Vel Vidane, they confirmed that it is now easier to get farmers to contribute labour towards maintaining the common segments of the canal network, follow the sowing and irrigation schedule, and adhere to the sluice operation discipline imposed by Vel Vidane. In our visits to system H in the Mahaweli irrigation project, the FO leaders we met agreed that since becoming the monopoly distributors of subsidised fertilisers, FOs are now stronger than they have ever been. FOs’ income from their annual membership fee of Rs 120/member, fertiliser carting charge, as well as commission on the tank maintenance contract received from the Agrarian Services Division have also soared after their becoming monopoly fertiliser distributors at the village level.

In 2010, International Water Management Institute’s (IWMI) Ariyaratne, a co-author of this paper, surveyed 18 FO leaders and 230 farmers in the command area of the Gal Oya irrigation system in the Eastern Province. These FOs, catalysed and nurtured under a programme undertaken by Cornell University and Sri Lanka’s ARTI<sup>7</sup> during the 1970s, were better than in other systems. The key results of Ariyaratne’s enquiry, summarised in Tables 1 and 2, confirm the hypothesis that routing subsidised fertilisers through FOs has strengthened and enhanced farmer participation in FO affairs, including irrigation management.

Despite the growing power and influence of FOs, we found that in many villages, neither the FO leader nor the committee member positions – nor, as a matter of fact, that of the Vel Vidane – were much sought after. Candidates who are both wise and widely accepted have to be persuaded to take up these roles. We also found surprisingly little support for our hypothesis about the leakage of fertiliser meant for rice to other crops,

**Table 1: Panel Data of 18 FOs in Gal Oya Command during the 1980s and at Present**

	1980s	Now
Average reserve funds for reporting FOs (LKR)	20,000	1,49,583
No of FOs who collected annual membership fee	8	12
No who earned commission on maintenance contracts	1	9
No who spent on operation and maintenance of the irrigation system	8	15
No of FOs keeping records of meetings	10	16

This is based on selected management parameters.

Source: Ariyaratne (2010).

**Table 2: Panel Data of 230 Farmers in the Gal Oya Irrigation System**

	1980s	Now
Sample farmers who were FO members	103	212
Sample farmers paying annual membership fee	52	213
No who contributed to the irrigation maintenance fund	38	127
No participating in desilting, cleaning and weeding in the distributory canal	120	185
No participating in desilting and weeding the field canal	92	109

Source: Ariyaratne (2010).

although studies on fertiliser subsidies in Sri Lanka suggest significant leakage (Ekanayake nd: 3; Weerahewa et al 2010: 1).<sup>8</sup> As if on cue, in May 2012 the Government of Sri Lanka changed its policy yet again, and subsidised fertilisers will now be available for all crops.<sup>9</sup> Only time will tell what the impact of this decision on paddy cultivation, as well as on the power and vitality of Sri Lanka’s FOs, will be.

#### 4 Belated Boom in Agro-well Irrigation

During the 1970s through to the 1990s, when most of south Asia experienced a boom in groundwater irrigation, Sri Lanka bucked the trend. Studies by IWMI (Kikuchi et al 2002) and others showed that irrigation from wells was important only in the Jafna peninsula, characterised by its hard rock. Elsewhere in Sri Lanka, diesel and kerosene pumps were increasingly being used, but mostly for pumping water from streams or other surface sources.

In the course of our fieldwork in the dry zone, however, we found that agro-well irrigation had taken agriculture by storm. Almost every farming household in the dry zone has an agro-well; many have two or three. Some enterprising farmers invested in agro-wells as far back as the 1970s and 1980s. However, around 2000, making agro-wells became something of a movement. Mechanised excavators made them cheap and quick; a well could be completed in a week and fitted with a pump at a cost of LKR 4,00,000 (\$3,000) in 2000. Galenbindunuwewa village in Anuradhapura district, which we visited, had only one agro-well for two decades until 2005; it added over 100 in the next five years. To gauge the relative economic returns to agro-well irrigation, we asked farmers in several villages about the number of acres of irrigated paddy that would be equivalent to an acre of agro-well irrigated land. The responses ranged from 5-15 acres! The farmers we met in this village of Anuradhapur told us that an acre of agro-well irrigated vegetables earns them 10-15 times the net cash income that an acre of irrigated paddy would fetch.

Much of Sri Lanka has *karst* aquifers. Agro-wells are large open wells – with a diameter of 30-35 feet and a depth of 30-50

feet – of the kind we find in many hard rock areas of India, such as Saurashtra in Gujarat, or Karnataka, Andhra Pradesh and Tamil Nadu. Most agro-wells in Sri Lanka dry zones are located in the vicinity of a tank or a stream. A typical agro-well costs LKR 4,00,000-5,00,000 (\$3,076-3,846) to construct. Agro-wells on privately owned, titled land are *pucca*, generally lined with brick and cement. However, farmers who do not have secure titles on their lands use shallow dugouts as agro-wells. Their large size helps agro-wells function like storage wells. Traditional paddy irrigation in tank commands – which has been the lynchpin of agrarian lives in the dry zone – is rapidly losing its centrality. In its place, the cultivation of vegetables and other market crops on chenna land with the help of agro-well irrigation is rapidly gaining ascendancy in the agrarian economy of Sri Lanka's dry zone. Even in Pul Elia, celebrated by Edward Leach as a symbol of Sri Lanka's tank irrigation civilisation, every household had an agro-well or two; and irrigating market crops in the uplands has become the mainstay of agrarian livelihood, eclipsing paddy irrigation. Karunaratne, the former president of Pul Elia whom we interviewed, had two agro-wells of his own, both fitted with 2 hp electric pumps and some buried pipelines for water distribution. Agro-wells are seldom used for irrigating paddy or other subsistence crops. Instead, they are used to support “value farming” – watering high-value vegetable crops for the market. Karunaratne used his agro-well to irrigate papaya, capsicum, brinjal, banana, coconut and green maize, which were sold in Dambula market. Market-savvy farmers make huge windfalls: Sri Lanka depends on Indian imports for onion seeds; recently, however, when the Indian onion seed developed a fungus, Sri Lankan agro-well irrigators of onion seed earned LKR 7,00,000-8,00,000 (\$5,400-6,100)/acre, net of all costs.

Agro-well irrigation has become hugely popular because vegetable cultivation is so much more profitable compared to paddy irrigation. Urbanisation and rising non-farm incomes has increased the demand for fresh fruit and vegetables. To gauge the relative profitability of agro-well irrigation, we asked farmers how many acres of tank irrigation of rice would be needed to generate the net income yielded by 1 acre of agro-well irrigation. The responses we got varied from 5-15 acres. According to Karunaratne, Amrapala, and other farmers we met in Pul Elia and nearby villages, in terms of net household income, an acre of agro-well irrigation is equal to 5-8 acres of paddy irrigation on an average! All that an acre of irrigated paddy offers is a net income of LKR 40,000-50,000; in contrast, an acre of agro-well irrigated capsicum or chilli or onion seeds can offer eight to 10 times as much if the market is good. Naturally, small holders with limited registered paddy land in tank command are drawn more towards agro-well irrigation than farmers with large paddy landholdings. The spread of agro-wells is relatively rapid in villages with poorly endowed small tanks (Jinapala, personal communication, 2012). While agro-well irrigation in chenna land and gardens has grown, paddy lands are going at a discount in informal lease markets. All that an acre of the once prized paddy land fetches today is a rental of 15 bushels (approximately 400 kg) of paddy/season.

In Galenbidunuwewa (Anuradhapura district), we engaged a group of young farmers in a focus group discussion on the changes that the agro-well boom has brought about in the agro-ecology of their village. Table 3 summarises the picture that emerged. While paddy cultivation in both *maha* and *yala* has remained unaffected, everything else has changed, all in the matter of a decade. Shifting cultivation of millets and lentils has declined; vegetable cultivation for the market has expanded. Animal husbandry has changed profoundly, as cattle breeding for work animals has given way to breeding for milk production; open grazing has been replaced by stall feeding and green fodder cultivation, which will lead to a high milk yield, has expanded. Many agro-well owners also grow perennial crops such as coconut, jackfruit, lime, tangerine, mango, guava, cashew, drumstick, betel and banana near the boundaries of their fields. Still further towards the periphery, many grow valuable timber trees such as teak (Perera 2010: 93-100). Urbanisation, changing diets and new markets are working in cohort with the agro-well boom to transform the traditional agrarian economy in Sri Lanka's dry zone. While the landscapes of their home gardens have morphed, agro-well irrigators have prospered. They are now able to educate their children, aspire to bigger and better dwellings, and drive two or four-wheelers (Jinapala, personal communication, 2012).

**Table 3: Agro-ecological Transformation of Galenbidunuwewa after the Agro-Well Boom**

	Before the Agro-well Boom	Now
Low land maha season paddy cultivation	+++++	+++++
Low land yala paddy cultivation	+++++	+++++
Supplemental irrigation to rice	++	+++
Mung and cow pea cultivation in chenna land	+++++	++
Vegetable cultivation	++ (only for home consumption)	+++++ (for market)
Other market crops	+	+++++
Cattle	++	+++++
Focus of cattle husbandry	Milk for home consumption;	Milk production for the market
	work animals	
Approach to cattle husbandry	Extensive, based on grazing	Intensive, based on stall-feeding
Green fodder cultivation for milch cattle	+	+++++
Tree crops	+++	++++

Unlike the rest of south Asia, agro-wells of Sri Lanka have a smaller energy foot-print, most using 1 or 2 hp electric or kerosene pumps. Those with roadside dwellings are more likely to draw a cable to connect an electric pump to their domestic electricity connections. Those further away from the road often do not have domestic electricity connections, and are forced to use the more expensive kerosene pump. At LKR 150 (\$1.1)/litre, kerosene is an expensive fuel; irrigating an acre of onion with a kerosene pump may cost anywhere up to \$500-700. Naturally, farmers actively manage their groundwater use to save on energy costs.

Jayakodi (2006) wrote about the alarming rate at which agro-wells in the dry zones have been drying up, suggesting that 30% may have been out of use. In several villages, we tried to explore whether the agro-well boom had led to the depletion of aquifers, as it has in western India. Most agro-well owners agreed that they had observed a temporary fall in the

water level in their wells, especially during droughts and during the yala season; however, no one we met had to deepen his agro-well or had faced a dry well. Most agro-wells are situated close to tanks, which, when full, help them to recharge. The farmers we met all affirmed that agro-wells are hydraulically linked to tanks, and that the water level in both moves in unison. Moreover, thanks to the high energy cost, groundwater demand for irrigation in a typical dry zone village is less than in, say, Tamil Nadu, where farmers receive free electricity.

### 5 Pump Irrigation Boom in Mahaweli Command

Large canal commands have also not been spared by the agro-well irrigation boom. In Mahaweli systems, agro-wells were unheard of even a few years ago. Now, though, they are common. In Balaluwewa village, FO leader Jayasena told us that 25 agro-wells supported non-paddy market crops – papaya, banana, vegetables – which occupied 100 of the village's total 240 hectares. There has also been a pump irrigation boom in surface irrigation in some parts of the dry zone of Sri Lanka. This is widespread in many areas of India, where gravity flow irrigation is increasingly giving way to lift irrigation, even from surface water sources. However, this has now spread to the dry zone of Sri Lanka.

The best example we have is that of the feeder canal, dug during the 1990s through forested areas to transfer surplus water from Mahaweli from the Bowetenna reservoir to Huruluwewa. This was a cut canal in the sense that the land on both sides of the canal rose above it. The canal passed through many traditional villages that were not surveyed during the colonial era, and even after. As soon as water began flowing into the feeder canal, many traditional residents of the area as well as some migrants with temporary cultivation permits began clearing shrubs and bringing more land under vegetable cultivation, using either lift or siphons to irrigate from the 25 km long feeder canal. The government tried to put an end to this and even made lifting water illegal, in much the same way that the Government of Gujarat has tried to control lifting from the Narmada canal (Shah et al 2010).

According to the president of one FO, some 1,500 farmers are using the feeder canal to irrigate 4,000 ha of land to grow all kinds of vegetables, such as brinjal, capsicum, cabbage, tomatoes, onions, chilly, and even some paddy. Seventeen FOs along the feeder canal now have only one mission: lobby hard to ensure water delivery in the feeder canal. Thanks to this massive lift irrigation economy, Dambula, a small town in north-central Sri Lanka, has emerged as the vegetable capital of the country, serving as the clearing house for vegetable supply throughout Sri Lanka. Earlier, Dambula's vegetable trade used to be carried out on the roadside, but the boom in this trade led to a perennial traffic jam and the government had to build a large market shed. While the government's objective behind the inter-basin transfer of water from Mahaweli to Huruluwewa remains undermined during the years of water scarcity, the feeder canal has emerged as a highly productive irrigation system.

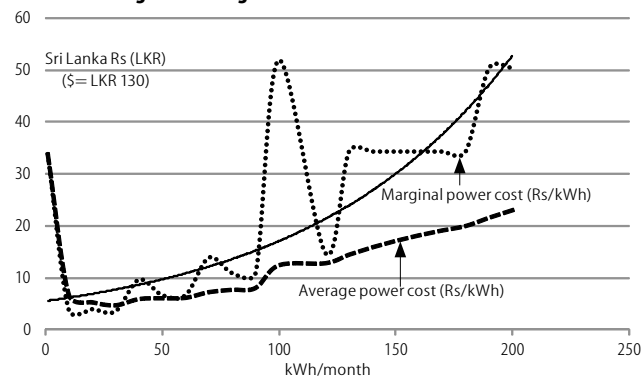
After the end of the war, the profitability of agro-well irrigation seems to have taken a hit. After years of inactivity, Jaffna, the

traditional agro-well-irrigated vegetable supplier of the island, has begun to reclaim its leadership of the market for fresh vegetables and fruit. Moreover, the army, now free from war duties, has deployed soldiers in vegetable cultivation for the market on government-owned land around cantonments. However, the impact of the army supply on the vegetable market is likely to be insignificant. Central and provincial governments have also been actively encouraging private kitchen gardens in urban areas, whose demand for vegetables had kept the agro-well irrigation booming. Farmers also complained of the imports of onions and fruits from India, Pakistan and China, which flooded the market when the local crops were ready. Farmers we interviewed also complained about the soaring farm wage rates, at LKR 1,000 (\$7.7)/day for men and LKR 800 (\$6.2)/day for women workers; but even at such high wages, labour is hard to find. Many agro-well irrigators we interviewed thought the agro-well revolution was moving towards extinction. But the more perceptive among them felt that these were the inevitable hiccups faced by an agrarian economy in transition. They believed that the agro-well boom would strengthen and spread, if only because of the myriad livelihood alternatives that agro-well irrigation had opened up, beyond the traditional paddy irrigation.

### 6 Sri Lanka's Unique Energy-Irrigation Nexus

The boom in agro-wells has led to an increase in the demand for domestic electricity connections in the villages of the dry zone. Electricity use in agro-well irrigation in Sri Lanka is insignificant at present, but it is likely to grow rapidly. This is not

**Figure 2: Average and Marginal Cost of Power Use in Sri Lanka's Agro-Well Irrigation**



because electricity is cheap, but because irrigating with kerosene/diesel pumps is even more expensive. The cost of irrigating an acre of onion with an electric pump, using 315 kWh of electricity, is LKR 15,000; but with a kerosene pump, which will need 430 litres/acre, the cost will be three times as much (Figure 2).

Unlike many Indian states, where the groundwater irrigation boom is driven by the electricity subsidies offered to farmers, Sri Lankan farmers pay a steep and progressive power tariff. While industrial and commercial users pay for power

**Table 4: Schedule of Domestic Electricity Rates**

Electricity Consumption (kWh/Month)	Fixed Charge (LKR/Month)	Variable Charge (LKR/kWh)
0-30	30	3.75
31-60	60	6.645
61-90	90	10.885
91-120	315	29.40
121-80	315	34.30
180+	315	50.40

at LKR 12 and 24/kWh, respectively, domestic users pay a low rate of LKR 3.75/kWh up to 90 kWh per month. Beyond that, however, the price/kWh rises steeply; beyond 180 units/month, it rises to over LKR 50/kWh. This basically means that using a domestic connection for running an irrigation pump can be extremely expensive. Even so, there is an increasing demand for three-phase connections by households, as well as for rice mills. Rice mills are understandable because they would get power at LKR 12 per unit; however, households using power to run pumps would end up paying a very high price. This situation is exactly the opposite of what prevails in most of India, where agricultural power use is very heavily subsidised.

The schedule of electricity prices for domestic consumers in Table 4 (p 63) shows that at 180 kWh per month and beyond, the cost of power is over LKR 50/kWh (\$0.45). A 2-hp pump of average efficiency would use around 1.6 kWh/hour, and deliver 50-100 m<sup>3</sup> of water. At these rates, it would be hard for most farmers irrigating an acre or more of vegetables to keep their monthly power consumption below 180 kWh. Most agro-well irrigators of Sri Lanka thus pay \$0.45-0.5/kWh for energy used in pumping, way above anywhere else in south Asia. Karunaratne of Pul Elia told us that his normal electricity bill is LKR 2,500 (\$12.6)/month. But in the months that he pumps from his agro-well, his bill shoots up to LKR 14,000 (\$109)/month. At such high marginal pumping costs, we had expected that: (a) there would be a strong demand for micro-irrigation for energy efficiency more than water use efficiency; (b) farmers would be choosy about growing high-value crops that justify the use of costly energy for pumping groundwater; and (c) there would be rampant power theft by hooking or meter tampering. We found little evidence to support or refute the last point; there was not much awareness or spread of drip irrigation; however, we found not a single case of farmers using agro-wells to grow paddy or similar crops. This suggests that agro-well-based irrigation development in Sri Lanka – akin to Kerala in India – represents a new category of groundwater socio-ecology in south Asia, in which expensive energy and scarce groundwater is used only for “value farming”, while low-value, water-intensive paddy is irrigated by gravity flow.

### 7 The Kerala-Sri Lanka Model of Groundwater Irrigation

Table 5 outlines four distinct energy-irrigation-livelihood nexus scenarios obtaining in south Asia. Of these, scenarios three and four, representing western and southern India, are problematic because here, perverse energy subsidies have created a groundwater-based agrarian livelihood system that has bankrupted electricity boards and depleted groundwater aquifers to support the extensive use of groundwater for irrigating low-value crops. Scenario two, referring to Bihar, eastern Uttar Pradesh, Assam, Bangladesh and coastal Odisha, involves abundantly recharged alluvial aquifers that can promote livelihoods but remain

**Table 5: Four Energy-Irrigation-Livelihoods Nexus Scenarios of South Asia**

E-I-L Zones of South Asia	Power Subsidy	Groundwater Structures	Type of Agriculture	Net Income/ha (\$)	Groundwater Externality
1 Kerala, Dry Zone of Sri Lanka (mostly humid and hard rock)	Nil or negative	Shallow, open wells, 1-2 hp pumps in millions	Garden cultivation of high-value market crops	\$1,500-3,000/ha	Nil or insignificant
2 Eastern India, Bangladesh, Nepal, Pakistan Punjab and Sind (humid and alluvial)*	Little power; so no subsidy	Shallow tubewells with 5-7 hp diesel pumps	Mostly rice or wheat; some market vegetables	\$500-1,000/ha	Nil bar arsenic; opportunity lost
3 Indian Punjab, Haryana, west Rajasthan, alluvial Gujarat (arid and alluvial)	Heavy power 150-400/ha	Deep tubewells; 10-120 hp electric pumps	Mostly wheat or rice; some high-value farming	\$800-1,200/ha	Depletion; fluoride and other geogenic contaminants
4 Hard rock peninsular India (semi-arid and hard rock)	Significant power subsidy (\$70-250/ha)	Dug-cum-bore/bore wells with 5-12 hp electric pumps	Mostly grains and Bt cotton; some high-value farming	\$600-1,000/ha	Huge negative

\*West Bengal is an exception. Farmers here have 24 x 7 power supply, but it is metered and charged at near commercial rates.

underutilised because of an absence of electricity or the high costs of energy needed to pump groundwater. There is a growing demand for energy subsidies as an instrument for unleashing a “green revolution” in this region. The danger is that an unplanned energy subsidy may stimulate groundwater demand for low-value grain crops over vast areas, and a few years later, improved agricultural production may be unable to justify energy subsidies and depleted aquifers. In many ways, Sri Lanka and Kerala represent an ideal scenario where low-value crops are flow irrigated and only high-value market crops – fruit, vegetables, spices, rubber, coconut – are lift-irrigated, using 1-2 hp pumps run on domestic electricity connections. The high and progressive electricity tariff automatically ensures that groundwater demand is kept within limits, and wells are used only for “value farming”.

### 8 Summary and Conclusions

The hydraulic civilisation of the dry zone of Sri Lanka is in the throes of a transition. Urbanisation, economic growth, dietary changes and globalisation are chipping away at the social organisation of agriculture around small tank cascades, as well as in large irrigation projects. This raises several new questions for irrigation and agrarian policy in Sri Lanka.

First, since the agro-well boom in the Sri Lankan dry zone is driven by the high profitability of high-value market crops, it is very likely that agro-well irrigation has already spread or will soon spread into the wet zone as well. Market crops require a high level of water control – the capacity to apply water in specified quantities, at specified times of the year – which agro-wells offer, but surface irrigation does not in a smallholder context. Therefore, Sri Lanka’s irrigation commands will experience the same crop diversification towards high-value crops supported by pump irrigation that much of Asian rice irrigation areas have experienced during recent years. While agro-well irrigation may rapidly increase the incomes of small farmers, growing competition between tank irrigation of rice and agro-well irrigation of market crops may create perverse incentives, encourage elite encroachment on government lands, promote the intensive use of agro-chemicals close to settlements, and erode the social capital accumulated around traditional tank irrigation (Jinapala, personal communication, 2012). These need careful monitoring and research.

Second, Sri Lanka's fertiliser subsidy policy has been generally assessed for its direct impact on increasing paddy cultivation and production. However, the current policy – which has created FOS as village-level monopoly distributors for subsidised fertilisers for registered paddy areas – has had an indirect impact: it has imparted strength and power to FOS members, which they had never enjoyed before. This in turn had a beneficial impact on proactive farmer participation in irrigation management. The new policy – recently declared – will have a far-reaching impact on FOS, as well as the agro-well boom. Presumably, the new policy has been driven, at least in some part, by leakages of subsidised fertilisers from paddy to non-paddy crops. Now that subsidised fertilisers will be available over the counter in markets, the village-level monopoly of FOS for the distribution of subsidised fertilisers will weaken, which in turn will rob FOS of the authority they have enjoyed over farmers, especially in local irrigation management under both tanks and canals.

Third, the open market distribution of subsidised fertilisers for all crops will provide a strong push to the cultivation of non-paddy crops, and further to agro-well irrigation. We should expect to see the balance going against paddy irrigation and towards the cultivation of market crops and dairy production, against tank and canal irrigation and in favour of agro-well irrigation.

Fourth, Sri Lanka's electricity pricing policies need to recognise the growing electricity use in agriculture. There is arguably a case for treating agro-well owners as a distinct category with a distinct pattern of electricity demand. The present, steeply progressive, schedule of domestic electricity prices heavily penalises the rural households that use electricity for

agro-well irrigation; they end up paying an average price that is twice that charged to industrial users (LKR 12.075/kWh). In Kerala, which has an agro-well economy similar to Sri Lanka's, electricity for irrigators is metered but cheaper than for all other users, including domestic users. In contrast to Sri Lanka, Kerala's agro-well irrigators pay INR<sup>10</sup> 0.65 (LKR 1.55)/kWh, domestic users pay INR 1.15 (LKR 2.73)/kWh, industrial users pay INR 3.25 (LKR 7.73)/kWh, and commercial users pay INR 5.45 (LKR 12.97)/kWh. The incremental cost of power paid by agro-well users is even higher at LKR 45–60/kWh for monthly use beyond 180 kWh. Moreover, it is not clear what the spikes in the incremental cost introduced by changing the fixed component for different levels of monthly use are supposed to achieve. In our judgment, most agro-well users are likely to keep their monthly consumption to less than 90 kWh to avoid the very high incremental costs of power beyond 90 kWh.

Fifth, agro-well users, if metered as a separate category, can play a powerful role in electricity load management. In India, the West Bengal Electricity Utility has fixed Time-of-the-Day (TOD) meters on irrigation tube wells and offered farmers an enticingly low rate for off-peak night hours. Since farmers can irrigate during the night, the irrigation demand for power can be used to flatten the load curve facing the power utility. Treating agro-well irrigators as a separate category can also permit the design of a tariff plan that is rational, fair and beneficial to the utility itself. We need to note that poorer farmers with small paddy areas are more dependent on agro-well irrigation for their livelihoods than farmers with large paddy lands. Electricity pricing and supply policies can be a powerful tool for pro-poor agricultural growth.

#### NOTES

- 1 With its bi-modal rainfall pattern, Sri Lanka has two main cropping seasons, maha, during October-March, and yala, during May-August.
- 2 In another unique land tenure pattern in some small tanks, referred to as "Katti Maruwe", cultivating family members owning land strips (Panguwe) in the tank command rotate tail-end portions that are typically less fertile, due to salinity. This self-enforcing tradition ensures a semblance of fairness in sharing soil fertility among family members.
- 3 LKR = Sri Lankan Rupee. \$1 = 130 LKR = 55 INR (Indian Rupees).
- 4 <http://www.asiantribune.com/news/2011/06/21/rs-50-billion-fertilizer-subsidy-investment-re-establish-sri-lanka%E2%80%99s-past-glory-and>, accessed on 11 June 2012.
- 5 In 2005, when the subsidy was introduced in its present form, it was as high as 90%.
- 6 Non-members can also apply for subsidy, but their application has to be endorsed by the FO.
- 7 Agricultural Research and Training Institute, Colombo.
- 8 <http://krushikarma.blogspot.in/2010/06/anomalies-in-distribution-of-subsidized.html>, accessed on 11 June 2012.
- 9 [http://www.colombopage.com/archive\\_12/May21\\_1337575373CH.php](http://www.colombopage.com/archive_12/May21_1337575373CH.php), accessed on 11 June 2012.
- 10 Sri Lankan Rupee (LKR) = 0.42 Indian Rupee (INR).

#### REFERENCES

Abeyratne, Shymala (1986): "Rehabilitation of Small-Scale Irrigation Systems in Sri Lanka: State

Policy and Practice in Two Systems", Country Paper-Sri Lanka, No 6, International Irrigation Management Institute, Colombo, Sri Lanka.

de Silva, K M (2005): *A History of Sri Lanka* (Colombo: Vijitha Yapa Publications).

Department of Agrarian Services (2006): *Role of Irrigation Tanks in Agricultural Development of Dry Zones of the North Central Province*, Department of Agrarian Services, Government of Sri Lanka, Colombo.

Dharmasena, P B (2010): "Traditional Rice Farming in Sri Lanka", *Economic Review*, 36(1&2): 48-53.

Ekanayake, H K (nd): *The Impact of Fertilizer Subsidy on Paddy Cultivation in Sri Lanka*, Central Bank of Sri Lanka, Colombo.

Himel, J (2007): "Khmer Rouge Irrigation Development in Cambodia" in *Deathpower in Cambodia*, available at <http://leahbowe.com/deathpower/2007/04/12/khmer-rouge-irrigation-projects/>

Jayakodi (2006): "Large Diameter Shallow Agro-wells – A National Asset or a Burden for the Nation?", *The Journal of Agricultural Sciences*, 2(1).

Kikuchi, M, R Barker, P Weligamage and M Samad (2002): *Irrigation Sector in Sri Lanka: Recent Investment Trends and the Development Path Ahead*, International Water Management Institute (IWMI), Colombo, VI, 48.

Leach, E R (1959): *Hydraulic Society in Ceylon, Past and Present* (Oxford University Press).

Madduma Bandara, C M (1985): "Catchment Ecosystems and Village Tank Cascades in the Dry Zone of Sri Lanka: A Time-Tested System of Land and Water Management" in J Lundqvist et al (ed.), *Strategies for River Basin Management* (Linköping, Sweden).

Panabokke, C R (2010): "Evolution of Indigenous Village Irrigation Systems of Sri Lanka: Colombo, Sri Lanka", *Economic Review*, 36(1&2): 3-9.

– (nd): "Small Tank Heritage of Rajarata", Convocation Address, Rajarata University.

Perera, Muditha (2010): "Integrating Agro-forestry Characteristics into Agro-Well-Based Agriculture" in Weligemege, Godaliyadda and Jinapala (ed.), *Irrigation for Food Security*, proceedings of the National Conference on Water, Food Security and Climate Change in Sri Lanka, Vol 1.

Sakthivadivel, R, N Fernando and J D Brewer (1997): "Rehabilitation Planning for Small Tanks in Cascades: A Methodology Based on Rapid Assessment", Research Report 13, International Irrigation Management Institute, Colombo.

Shah, T, S Krishnan, P Hemant Kumar, S Verma, A Chandra and C Sudhir (2010): "A Case for Pipelining Water Distribution in the Narmada Irrigation System in Gujarat, India", Colombo, IWMI Working Paper 141.

Tennakoon, M U A (2002): *Evolution of Small Tank Systems in Food Security and Small Tank Systems*, National Science Council, Colombo.

Weerahewa, J, S S Kodithuwakku and A Ariyaratana (2010): "The Fertiliser Subsidy Program in Sri Lanka", Case Study 7–11 of the Program "Food Policy for Developing Countries: The Role of Government in the Global Food System", Cornell University.

Weeramundra, A J and M K Nadeeka Damayanthi (2011): *Pul Eliya Revisited: A Case Study of Agrarian Change*, Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo.

Wilcocks, Sir W (1984): *Ancient System of Irrigation in Bengal* (New Delhi: B R Publishing Corporation).