Integrating Agroforestry Characteristics into Agro-well-based Agriculture

Muditha Perera
Lecturer, Department of Geography, University of Peradeniya, Sri Lanka

Abstract

The major challenge for the dry-zone farmers in non-irrigated areas in Sri Lanka is water scarcity. This situation is a major barrier to the sustainable use of resources and maintaining income generation activities throughout the year. In this context, these farmers realized the need for another source of water. The strategy was the construction of large diameter wells (agro-wells) to tap the shallow groundwater in low-lying areas, either near the small tanks or the small streams. Since 1982, the rate of construction of agro-wells has accelerated with the interventions of the Agricultural Development Authority and the Provincial Council. Generally, cultivation of perennial crops using agro-wells is not common. Only seasonal crops are cultivated and income was obtained only during a particular period. As a new trend, some farmers in the dry zone of Sri Lanka used this shallow groundwater opportunity to cultivate perennial crops as well as seasonal crops throughout the year. Furthermore, farmers aimed to grow woody tree species for their timber requirements and economic purposes in their own agricultural land. A lot of farmers have realized that these woody trees such as teak and halmilla may be disturbing their crops. Therefore, they moved these trees to the marginal areas or tail end of the lands. In addition, some farmers attempted to maintain animal husbandry such as rearing cows under the perennial crops, using the shade and grass under the trees. This context provided a unique opportunity to explore this new land use pattern revealed in the dry zone of Sri Lanka, recently. Field research for this study was conducted covering 20 agro-well-based agricultural lands out of the total of 68 in the 'Aluth Divulwewa sub-watershed' in 'Yan Oya watershed', in the dry zone of Sri Lanka. The collected data was analyzed using qualitative and quantitative methods. The land equivalent ratio (LER) has revealed that 90 % of the lands represent more productivity, and canopy cover has increased up to 41.5 % from 7.9 %. Further, evolution, composition, characteristics, layers, and spatial arrangements of these land use patterns, represent 100 % of agroforestry characteristics according to Nair's classifications. Thus, this context has successfully proven that these agro-well-based agricultural lands have been converted into 'more productive and diversified agricultural systems' with agroforestry characteristics.

Introduction

The major challenge for farmers in non-irrigated areas in the dry zone of Sri Lanka is water scarcity. This situation is a major barrier to the efficient use of resources and to maintain income generation activities throughout the year. The use of a supplementary source of water is essential. The construction of large diameter wells (agro-wells) to tap shallow groundwater was identified as a potential solution. Agro-wells were constructed in low lying areas, either near small tanks or small streams. The rate of construction of agro-wells has accelerated with the interventions of the Agricultural Development Authority that began in 1982, and later by the interventions of the Provincial Councils.

Seasonal crops are cultivated using agro-wells. The use of water from agro-wells to irrigate perennial crops is not common. Therefore, regular income is received only during a particular period. A new trend is emerging of utilizing the shallow groundwater opportunity to cultivate perennial crops in addition to seasonal crops. Farmers include woody tree species for timber requirements and economic purposes. As farmers recognized that woody trees, such as teak and *halmilla*, disturb other crops, they moved trees to the peripheral areas of their lands or to tail ends of surface irrigation ditches. Some farmers attempted to incorporate animal husbandry such as rearing cows under the perennial crops, using the shade and grass under the trees. This study explores this emerging land use pattern in the dry zone of Sri Lanka.

Methodology

The objective of this study was to understand the holistic background of the agro-well based agriculture, such as a) the nature of shallow groundwater utilization, b) the nature of the agro-wells, c) historical changes in land use pattern and current land use d) characteristics of farms including, canopy cover and structures and species composition and e) documented agronomic practices.

Field research for this study was conducted in the Aluth Divulwewa sub watershed in the Yan Oya watershed in the dry zone of Sri Lanka. Twenty agro-well based farms, out of the total of 68, were selected using the purposive sampling method. A structured survey schedule was used to gather respondents' perceptions as well as historical and current information. This was supplemented by a field survey, field mapping, aerial photograph analysis, interviews and field observations. Land equivalent ratio (LER value) was used as the measure of land productivity. This is calculated as the sum of ratios of yields of an intercrop and the potential yield of the same crop if planted as a single crop in the same land area. LER for land with intercrops is obtained by using the following equation by Nair (1990).

(1) Land equivalent ratio $LER = Ry_{1} + Ry_{2} + \ldots\ldots\ldots\ldots, + Ry_{n}$

Where, Ryi is the intercrop yield for i^{th} crop/sole crop yield of the ith crop

Results and Discussions

There are two main factors that determine the distribution of the agro-well based agriculture in the Aluth Divul Wewa sub watershed area. They are a) the availability of comparatively low lying lands, and b) availability of roads / accessibility. Aluth Divul Wewa sub watershed is naturally rich with groundwater because of the two mountain ranges situated in its eastern and western boundaries. Chena lands situated in low lying land areas were the most popular lands for excavating agro-wells. Farmers have constructed agro-wells in the vicinity of small tanks or near seasonal streams. According to Dharmasena (1998) there should be a minimum distance of 100 m between two wells due to the shallow groundwater situation in the dry zone of Sri Lanka. This scientific guideline is naturally followed in the study area due to large land extents. All the farmers have 2-5 acres of lands.

There are two major trends in land utilization patterns, a) the decrease in chena (shifting) cultivation, and b) increase in the use of agro-wells. The percentage of lands allocated to chena of all cultivated highlands has declined from 30 % in 1994 to 22 % in 2004. Land under agro-wells has increased from a mere 0.3% to 6% during the same period.

A large majority of farmers (80 %) cultivate crops using agro-wells as the sole source of irrigation. Twenty percent of farmers irrigate their fields using both agro-wells and minor tanks. Farmers usually cultivate chilies, brinjals, soybean, pumpkin, ma-beans, green-gram, bitter-gourd, bottle-gourds, *thibbatu*, okra, and manioc as seasonal crops, during either or both *maha* and *yala* seasons. However, farmers in general do not get enough returns to meet all their annual household needs. Income from seasonal crops is usually spent on debts and day-to-day requirements. Farmers usually do not accumulate any savings.

In this context some farmers incorporate perennial crops such as coconut, jack, lime, tangerine, orange, mango, guava, breadfruits, cashew, drumsticks, betel-leaves, and banana, to increase productivity and to ensure that the flow of income from their lands is smooth. These farmers invest in perennial crops as a mixed system with seasonal crops. (Figures 1 and 2). In such a system, irrigation has to fulfill the water needs of both seasonal and perennial crops simultaneously.

Figure 1. A large diameter agro-well with coconut trees in the background.

Figure 2. Agro-well farming unit with seasonal ground layer crops and perennial crops in the periphery.

A considerable fraction of farmers reserve a part of their land for timber trees such as teak. Timber trees are usually grown in the periphery of the farm and at the tail ends of irrigation ditches. Farmers also plant live fences using Glidsiria sepium, teak, and kohomba (margossa) with the expectation of meeting firewood and timber needs. In addition, lots of farmers grow many timber trees in their lands for economic purposes. This was an easy income-generation activity using degraded areas of their agro-well based lands.

Other than crops, farmers practice animal husbandry as a part of the cropping system. They especially like rearing cows because of the low cost. Fifteen percent of the farmers in the study area practice rearing cows in their agro-well based farmland using tree shade and ground layer grasses in the proximity of the agro-wells. They supplement the household requirements of milk and get extra income by transporting and selling the cow milk to the internal or external market, daily or weekly.

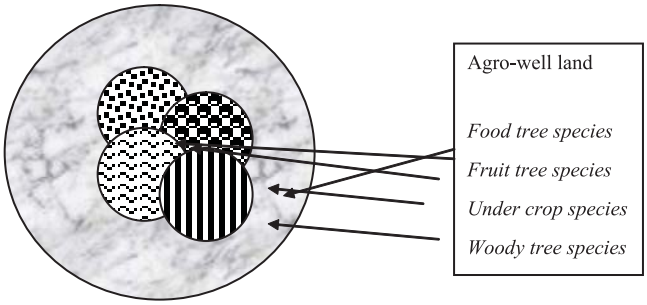
These agro-well based lands convert to ‘seasonal and perennial cultivation system with woody trees’ or ‘seasonal and perennial cultivation system with woody trees and animal husbandry’ within 5- 6 years. With this background, cropping pattern under these agro-wells, are being converted to ‘agroforestry systems’.

Interventions

All the farmers have integrated trees into these systems and all farmers develop their lands every year. This situation tends to increase the number of trees in their lands. Farmers have introduced various ‘food trees’, ‘fruit trees’, ‘under crops’, as well as ‘woody trees’ to this area, in addition to the seasonal crops (Figure 3).

Farmers cultivate these trees around the agro-well or around the hut (dwelling within the farmland) according to the water requirment or labor requirement. Crops requiring more water such as tempering leaves, ginger and sugercane are placed around the well. More labour required crops such as friut trees are placed around the hut. The result was the emergence of many diverse crop lands.

Figure 3. Various tree types based on utility.

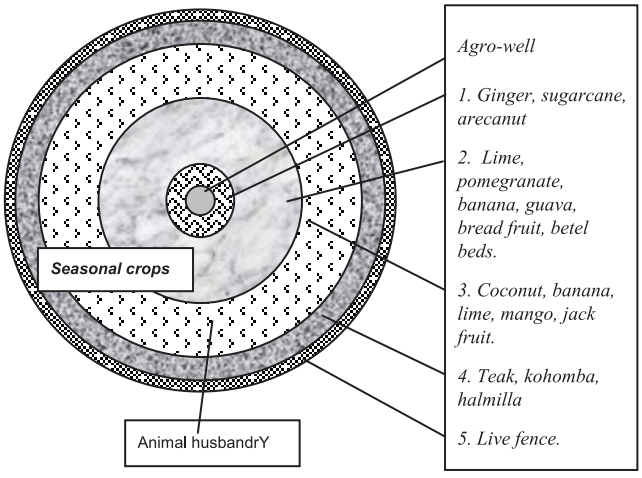


A general spatial pattern of the location of different trees in this cropping system can be identified. The trees with greater water needs and that require a high level of maintenance are grown around the well. Farmers especially use short crops or trees for this zone due to damages from leaves and roots to the well. Eighty-five percent of agro-wells showed this pattern. The composition of several zones that are arranged in concentric rings around the agro-well can be identified. The species composition of these zones with increasing distance from the agro-well are:

1. Ginger, sugarcane, arecanut;
2. Lime, pomegranate, banana, guava, bread fruit, betel beds, with seasonal crops;
3. Coconut, banana, lime, mango, jack fruit with seasonal crops and / or animal husbandry;
4. Teak, *kohomba*, *halmilla* with or without seasonal crops and;
5. Live fence.

This generalized pattern of all agro-well lands, is illustrated using the sketch diagram in Figure 4.

Figure 4. Generalized spatial distribution of these systems*.



* *Source*: - Field survey

Tree Stratification

Further, there is an obvious pattern of tree stratification in this farming system. Different strata mimic the morphology and the function a forest. There are five identifiable components in a well developed land:

1. Seasonal crops/paddy
2. Beetle beds, thibbatu
3. banana, lime
4. mango, jack
5. coconut teak

One hundred percent of well-developed lands represent successful tree stratification. At least three layers can be identified in all lands. The most common components are, 'seasonal crops/paddy', 'banana/lime', and 'coconut/teak'.

Conservation Farming

Motivated by water scarcity and the need to avoid further land degradation, farmers in the area use various conservation farming practices. They also need strong boundary fences for the protection of their crops from wild animals. Inexpensive methods of fencing using trees including Gliricidia sepium are practiced. In addition farmers are also using the leaves of Gliricidia and dry grass to enrich the soil of the lands further, and for animal husbandry. One hundred percent of the farmers use live fences and dry field systems. The dry field system helps to control soil erosion and conserve limited water resources. Forty-five percent of farmers use the mulching system, using dry grass and paddy straw to improve their lands. In addition 20 % of farmers have practiced contour earth bunds for controlling soil erosion. (Table 1).

Table 1. Use of conservation strategies.

Conservation strategy	Number of lands on which method is practiced	Lands on which method is practiced as a % in total well-developed lands
Live fences	20	100
Earth bunds	4	20
Drains	4	20
Mulching	9	45
Dry field system	20	100

Source: Field survey

Canopy Covert Development

The development of canopy cover helps to conserve soil moisture, reduce soil erosion, and maintain bio-diversity. The area under the perennial canopy has been increasing in every agro-well based land. Seventy percent of the lands have more than 30% of land area covered

by perennial crops; while 25 % of the lands have more than 50 % of the land area covered by canopy.

Land Productivity and Income

The land equivalent ratio (LER) shows that that 90 % of farms reports higher land productivity than the moncocultured system. Twenty-five percent of the lands indicate LER values of more than 1.5. The highest land equivalent ratio (more than 1.75) is represented in 15 % of the lands. This background gives evidence to prove that the agro –well-based agricultural lands are more productive and effective land use systems when compared to the conventional systems.

Operators of all studied farms obtain year-round incomes. Fifteen percent of farmers obtain more than Rs. 100,000.00 annually and 60 % of farmers obtain more than Rs. 50,000.00 annually, using perennial and seasonal crops. In addition, 15 % of farmers earn annual incomes of around Rs. 50,000.00 from animal husbandry. In addition, these systems contribute vegetables, fruits, spices, firewood, timber, medicines, milk, shade, organic matter, fodder, soil moisture, wind breaks, and aesthetic value, as unquantified and unvalued benefits to the farm household.

Conclusion

This study will help to focus attention on issues and solutions on the need for a comprehensive approach to agro forestry cropping systems with water scarcity. The evolution, composition, characteristics, layers, and spatial arrangements of these land use patterns, represent 100 % of agroforestry characteristics according to Nair's classifications (Nair, 1990). Thus, this context has successfully proven that these agro-well-based lands have converted into 'more productive and diversified agricultural systems' with agroforestry characteristics.

According to our professionals (Panabokke, 2002), (Dharmasena 1994), there is a sufficient groundwater situation, in the dry zone of Sri Lanka during the north-east monsoon period, and a sufficient groundwater level in the vicinity of small tanks, throughout the year. Similarly there is an adequate groundwater level in the low lands and near the temporary dry streams. So, similar lands throughout the dry zone are suitable for constructing agro-wells using appropriate groundwater technology. Then the existing agro-well lands can be converted into more productive lands, with two or three cultivation periods, combining conservation farming, perennial trees, woody trees, and livestock.

This proves that, the attractive 'agro-well-based agroforestry systems' could be stabilized under these available agro-wells and potential lands in due course. Furthermore, it would be timely and very useful to adopt this trend for 'other degraded watersheds' in the dry and dry and intermediate zones of Sri Lanka.

References

American Society of Agronomy. 1988. Agro Forestry Land Use Systems- Symposium Proceedings, Anaheim, California.

Consultative Group on International Agricultural Research (CGIRA). 2003. Challenge Program on Water and Food, International Water Management Institute, Colombo, Sri Lanka.

Dharmasena, P. B. 1994. Groundwater Uutilization for Crop Production – Project Terminal Report, Field Crops Research and Development Institute, Mahailluppallama.

Dharmasena, P. B. 1998. Resource Management Studies on Agro-well Farming in the Dry Zone of Sri Lanka – Project Terminal Report, Field Crops Research and Development Institute, Mahailluppallama.

Gunasena, H. P. M.; Sangakkara U. R. (Eds.). 1999. Agro Forestry Research in Sri Lanka, Peradeniya: University of Peradeniya, Sri Lanka.

Gunawardena, E. R. N. (Ed.). 1990. Irrigation and Water resources, Faculty of Agriculture, Peradeniya, Sri Lanka.

Hitinayake, H. M. G. S. B. (Ed.). 2003. Progress in Agriculture and Forestry, Eco- forestry Pvt. Ltd, Colombo.

International Water Management Institute (IWMI). 2001. Innovations in Groundwater Recharge, Colombo, Sri Lanka: International Water Management Institute (IWMI).

Madduma Bandara C. M. 1979. A Study of the Practice of Well Irrigation in the Country around Vavuniya in Northern Sri Lanka. *Sri Lanka Journal of Social Sciences* Vol-2-No.2.

Nadarajah, S.; Gamage, H. (Eds.). 1997. Groundwater Utilization for Crop Production in the Dry Zone of Sri Lanka. M.R.M. Centre, Peradeniya: Natural Resource Management Center/Department of Agriculture.

Nair, P. K. R. 1990. Classification of Agro Forestry Systems. In *Agroforestry: Classification and Management*, eds. K. G. MacDicken and N. T.Vergara. New York, USA: John Wiley and Sons.

Panabokke, C. R. 2002. The Small Tank Cascade Systems of the Rajarata, Mahaweli Authority, Colombo, Sri Lanka. Internet web sites. http://; http://www.unl.edu/nac/agroforestry.html