# Sorjan cultivation system for improving agricultural productivity of marginal low-lying coastal areas in the Southwest of Sri Lanka: A model

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## Abstract

*A sizeable extent of paddy lands in coastal low-lying areas in the Wet Zone of Sri Lanka are now abandoned or have become marginal due to complex and unfavourable hydrologic conditions, and the farmers in those areas have to face considerable hardships. The need for developing new sustainable farming systems has been greatly recognised to make these lands suitable for agricultural purposes, and to ensure some economic benefits to the farmers.*

*A study conducted in a low-lying marginal land of Bangkok in Thailand (model) has shown that by the adoption of "Sorjan Farming System" it would be possible to make these lands favourable for agricultural purposes. The study revealed that new land use system is agronomically and economically more productive, environmental friendly and well suited to the social environment of the area.*

*Appropriate species and varieties, time of planting, management and protection of crop and fish components, which suit the prevailing soil, water, climate and biota present at the sites have to be determined. Institutional support for construction of alternate bed and sink profile as well as for the extension of necessary knowledge of management is vital in developing and popularising the proposed model.*

**Keywords:** Coastal low-lying areas, wet zone, sorjan farming system, bio-diversity, by-product utilization

## Introduction

The southwest coastal low-lying areas in the Wet Zone of Sri Lanka, extending from Negombo to Matara districts are subjected to complex and unfavourable hydrologic conditions. This area consists of mainly low-lying flood plains of river streams, back swamps, filled up lagoons and depressions, tidal marshes and swamps. Paddy cultivation is the only use of these lands, covering 25 to 50 per cent of the paddy lands in Colombo, Kalutara, Galle and Matara districts. Problems of flooding (sometimes several times a year), drought, poor drainage and water logging with their associated agronomic problems beset these areas (Wickramanayake, 1996). Because of the problems of rice cultivation, which are common to all these areas, paddy lands in these areas are now abandoned or considered marginal and the farmers have to face some hardships. The need for develop new sustainable farming systems has been greatly recognised to convert these lands suitable for agricultural purposes and to ensure some economic benefits to the farmers.

## Sorjan Farming System

The adoption of a new land use system called "Sorjan Farming System" would help to achieve the above objectives. This system would be able to make these lands suitable for agricultural purposes, by preventing further degradation as well as regeneration of the diminished natural eco-system of the coastal low-lying areas. Further, it would be able to provide the people with a variety of food and additional cash income, which would help to maintain active involvement of the people in return.

Sorjan farming is an integrated system of crop and fish cultivation in parallel beds and sinks. Lowland crops and fish are cultivated in sinks and upland crops on beds (Fig.1).

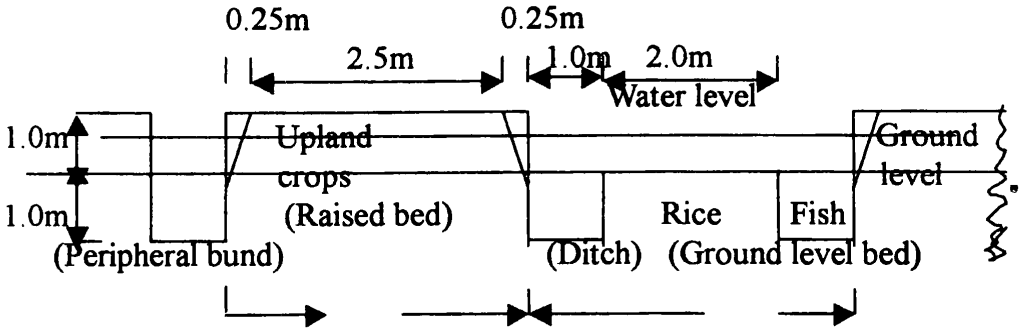


**Fig. 1: Cross Section of Proposed Sorjan System**

The soil obtained by digging the ditches is used to construct raised beds. The land allocation ratio of the system varied depending on the farmer's necessity, and it is 1.5:1:1.5:: Ditches: Ground level beds: Raised beds as shown in Figure 1.

Table 1 shows several potential crops and fish, which can be cultivated in various niches of the proposed Sorjan cultivation system and it suggests that the system is able to restore bio-diversity of the environment up to a satisfactory level.

**Table 1. Potential crops for Sorjan system**

| Raised beds(Upland crops) | Sinks | |
|---|---|---|
| | Ground level beds(Lowland crops) | Ditches(Fish) |
| Vegetables, Fruits, Coconut | Rice, Allocasia, Aquatic vegetables | Fin fish, Shrimp |

Further, maintaining the water level few centimetres above ground level allows fish to swim freely over ground level beds for grazing and thus fish can depend on natural biota present in ground level beds too, besides ditches (Fig 1).

Mud in ditches revitalise vegetable beds. Chopped crop residues and waste vegetables could be used as fish feed as well as manure for raised beds and sinks. Water in ditches provides more assured and ready supply of irrigation water for upland crops and refuge for fish, especially during dry spell.

Sorjan cultivation system basically functions with the integration of agriculture and aquaculture. Aquaculture provides a better opportunity to utilize agricultural wastes. Additionally, this type of system may have the following beneficial attributes.

a. More intensified use of land and water in a sustainable manner
b. Relies considerably on nutrient recycling through by-product utilization and biological diversification (Fig 2 and Table 2)
c. Ability to recycle energy continuously, while producing little wastes
d. Increased resources productivity as well as farmer's income
e. Reduced fertilizer requirement and external dependence
f. Ability to restore and maintain degraded ecological balance
g. Ability to produce a variety of food and often a reasonable marketable surplus

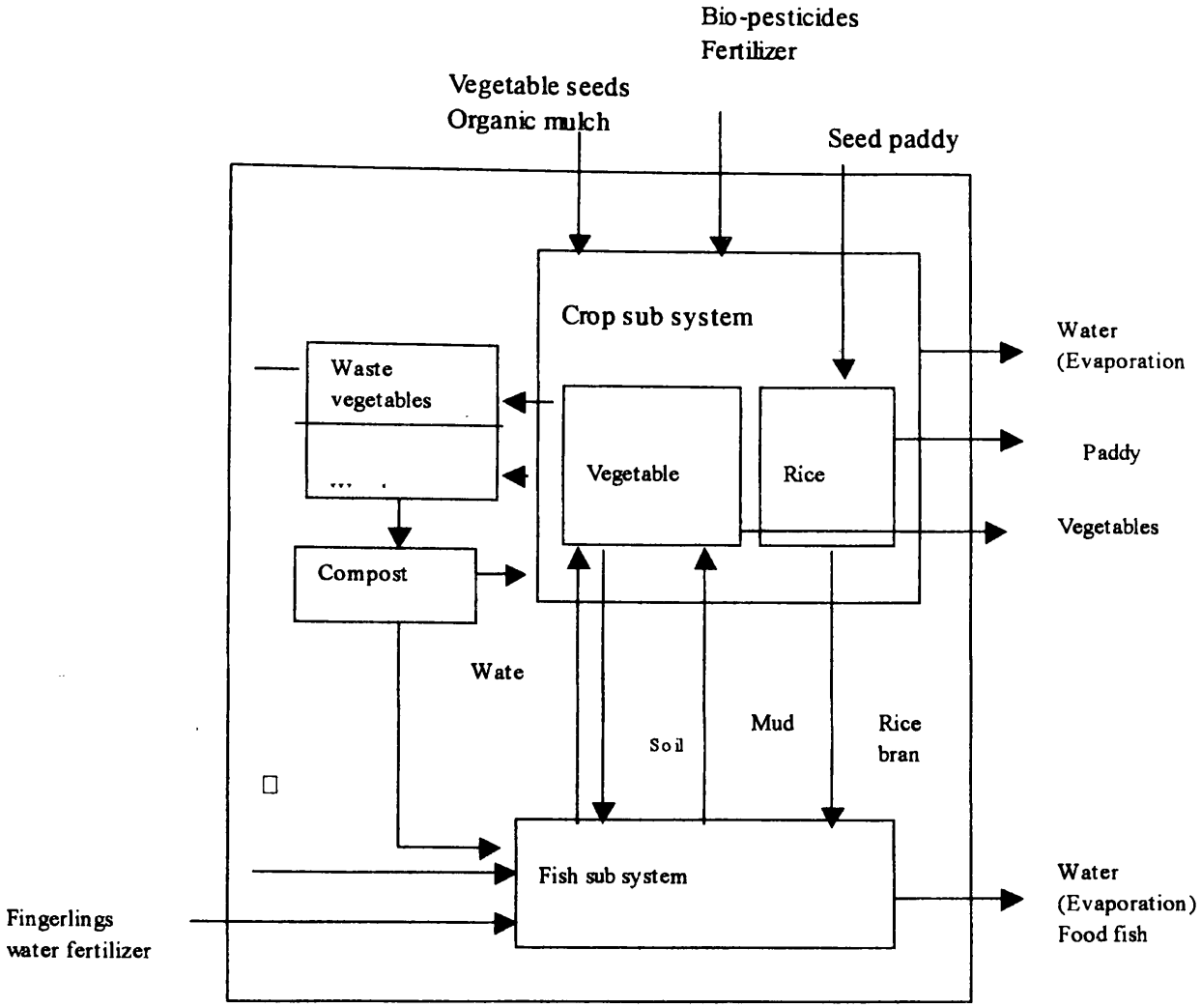


**Fig. 2: Integration of diversified rice-fish production system**

This type of farming system would be compatible with the socio-economic environment of the farmers in these areas who have limited farm area and poor resources.

**Selection Criteria of Crops and Fish Species for the System**

For successful development of the proposed system throughout the low-lying areas, continuous attraction and easy adaptation of people to the system is more important. Therefore, criteria to select the components for the system should be in accordance with the socio-economic set-up and environmental conditions of the location.

In this connection, it may be useful to focus attention on the following factors:

a. The need for a low capital investment
b. The ability to produce a reasonable amount of food for family consumption and a continuous cash income
c. The ability to fulfil family consumer preference
d. The adaptation of crops and fish to the local environment
e. The potential to generate organic matter
f. Compatibility with other crops and animal species of the system.

## Materials and Methods

### Location of the experiment

A study was conducted in a marginal land of Bangkok plain in Thailand, to develop sustainable farming technology by improving conventional rice farming technology, to increase agricultural production. Comparisons were made using data on crops and animal species, inputs, by-products and outputs of two systems

### Soil of the experimental site

Soil has been classified as heavy, alluvial clay with a very fine texture and low fertility. It also has been characterised by a deep soil profile with an extremely acidic reaction (soil pH of 4.5). During heavy rains, water logging usually occurs due to poor drainage. During dry spell, the field dries out very quickly, creating cracks deeper than 50 cm. Hence the physical and chemical properties of the soil make it unfavourable for agricultural use.

Land allocation ratio of the Sorjan cultivation system was maintained as; Raised beds: ground level beds: Ditches:: 1.75:1:1.25

Crops and animals included in the Sorjan cultivation system are given in Table 2.

**Table 2. Crops and animals in the Sorjan cultivation system**

| Raised beds(Upland crops) | Sink | |
|---|---|---|
| | Ground level beds(Lowland crops) | Ditch(Fish) |
| Cabbage, Mung bean, Sweet potato | Rice | Tilapia, Common carp, Puntius |

Crops and fish species used in the conventional rice-fish cultivation system were similar to the species present in sinks of the Sorjan cultivation system.

### Experimental management

Clearing of grasses, bushes and land preparation for raised and ground level beds was done manually. Ditches were cleared and desilted. Removed mud and weeds were placed on raised and ground level beds. Edges of raised and ground level beds as well as peripheral bunds were strengthened by plastering with the mud removed from ditches. Rice and upland crops were planted and managed as recommended. Manual land clearing and preparation was done in the conventional rice-fish culturing system and rice crop was planted and managed as recommended. Manual harvesting and processing of crops were done at the correct stage of maturity. Large fingerlings of Tilapia, Common carp and Puntius, in the proportion of 3:2:1 were stocked in both systems for poly culturing at a stocking density of 1 fish per 10 $m^2$. (Additional 20 per cent was stocked to maintain anticipated fish stocking density). Chopped weeds and waste vegetables obtained from raised beds were fed to the fish. The field was drained before fish harvesting.

## Results and Discussion

The study showed that the Sorjan Cultivation System was agronomically more productive and well suited to the socio-economic environment of the area than conventional rice-fish cultivation system.

### Regeneration of environment and better yield

Table 3 showed that Sorjan Cultivation System was able to successfully maintain more crops and animal species than the conventional rice-fish cultivation system. The improved bio-diversity of the

Sorjan Cultivation system would be capable of regenerating the environment to a satisfactory level. Due to the increased bio-diversity of the system, pest and disease incidences may be low, requiring a minimum use of chemical pesticides. This situation may create a more favourable environment for the growth of beneficial organisms, establishing biological control within the system. On the other hand, beneficial organisms such as pollinating insects can perform well for a better yield in quality and quantity.

**Table 3. Crops and animals components in two systems**

| | Sorjan Cultivation System | | |
|---|---|---|---|
| Cultivated species | Raised beds (Upland crops) | Sink | |
| | | Ground level beds (Lowland crops) | Ditch (Fish) |
| | Cabbage, Mung bean, Sweet potato | Rice | Tilapia, Common carp, Puntius |
| Wild species | Several grass species | Kangkong, other species | Snake head, other species |
| Number of crop species > 05 | Number of animal species > 04 | | Total number of species > 09 |
| | Conventional rice-fish cultivation system | | |
| Cultivated species | Rice | | Tilapia, Common carp, Puntius |
| Wild species | Several grass species, Kangkong, other species, | | Snake head, other species |
| Number of crop species > 02 | Number of animal species > 04 | | Total number of species > 04 |

**Intensification of natural resources and by-Product use**

In the experiment, Sorjan Cultivation System was able to generate several types of by-products (Table 4). The System itself had the potential to utilise them for different purposes such as mulching, composting, fish feed etc. In a Sorjan Cultivation system, fish can breed naturally. The natural biota present in sinks together with crop wastes can serve as feed for fish. The chemical fertiliser requirement is reduced or not necessary at all, since the system itself may be able to produce organic matter in considerable quantity. The above mentioned facts imply that the Sorjan Cultivation System may be able to function at a low cost, since it can depend on recycled inputs rather than external inputs of high cost, such as hybrids seeds, chemical fertilizer and pesticides, pelleted feeds, irrigation.

**Table 4. By-products generated with in the system and their potential uses**

| Crop | By-products | Rate (kg/ha) | Potential uses | Benefit to the system |
|---|---|---|---|---|
| | | Sorjan Cultivation System | | |
| Rice | Straw | 1791 | Mulch, Manure,Compost | Reduce cost of weeding & watering<br>Improve soil fertility |
| | Husk | * | Compost | Reduce cost of fertilizer |
| | Rice bran | * | Fish feed | |
| Sweet potato | Twigs & leaves | 1690 | Food, Fish feed | |
| | Residues | 177 | Compost | |
| Mung bean | Fresh stubble | 710 | Manure, Compost | |
| | Pod husk | 54 | Compost | |
| Cabbage | Waste leaves | 286 | Fish feed | |
| | Kangkong | * | Food, Fish feed | |
| Weeds | Grasses | * | Mulch, Compost | Protect surface and edges of raised beds from erosion |
| | | Conventional rice-fish cultivation system | | |
| Rice | Straw | 6304 | | |
| | Husk | * | | |
| | Rice bran | * | Fish feed | |
| Weeds | Kangkong | * | Food | |
| | Grasses | * | | |

* Not measured

## Yields of the systems

Table 5 showed the yields of crops and fish obtained from the system. It showed that Sorjan faming system has created more favourable environment for fish farming. The net rice yields suggests that there was a better environment for rice crop in the same system.

**Table 5. Agricultural products generated from the systems**

| Sub-system | Gross yield (kg/ha) | | Yield ratio Sorjan/conventional |
|---|---|---|---|
| | Sorjan | Rice-fish conventional | |
| **Crop Sub-System** | | | |
| Rice* | 1373 | 4192 | 0.33 |
| Cabbage | 2200 | - | |
| Sweet potato | 2174 | - | |
| Mung bean | 97 | - | |
| **Fish Sub-system** | | | |
| Tilapia | 18 | 13 | 1.4 |
| Common | 45 | 27 | 17 |
| Puntius | 41 | 03 | 1307 |
| Total fish | 104 | 43 | 204 |

*Net rice yields (kg/ha) of Sorjan and Conventional systems are 5144 and 4840 respectively

## Low requirement of energy

The construction of alternate beds and ditches discouraged the use of machinery for land preparation and thus fossil fuel energy is not required.

## Generation of employment

The Sorjan Cultivation System being a labour intensive system, can absorb a considerable amount of unemployed and under-employed in a more productive manner. The study showed that it could utilize 99 per cent of available family labour.

## Raise living standards of people

The main objective of implementing the proposed system is to prevent further degradation of the environment. In addition to the above objective, the system may help generate agricultural products, which may partially fulfil the basic food requirements of the family, providing a wide array of food varieties (rice, vegetable, fruit and fish) with increased palatability. This would help reduce the degree of malnutrition prevailing in the area. Moreover, if a surplus does remain after family consumption, an additional cash income can be generated by selling them or giving it to a neighbour that would strengthen the mutual support among them. Farmers have an opportunity to improve their economics by engaging in related agri-business fields such as mushroom culture, selling of large fingerlings to fish farmers. Further, by raring herbivorous fish, minimize of predatory actions on cultured fish and infestation of wild fish into the system and change of crop enterprises would help to improve agronomic and economic productivity of the system.

## Conclusions

The proposed alternate land use system presented in this paper may provide a framework for the scientists to research on the options that could result in the regeneration of the diminished environment of low-lying coastal areas in the Wet Zone of Sri Lanka. Therefore research studies should be undertaken to determine appropriate species and varieties, time of planting, management and protection of crop and fish components, to suit the soil, water, climate and biota present at the site.

The high initial cost that is required to construct the alternate bed and sink profile may be a major bottleneck in developing and popularising the proposed system. Besides, a broad knowledge of

faming is required for successful management of such a system, since the system is much more complex than a monoculture system. Therefore, institutional support during initial stages as well as for the extension of necessary management knowledge is vital.

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