HEAD-TAIL DILEMMA OF WATER RE-ALLOCATION:
Productive efficiency-based collective decision on allocating land for sharecropping in in Village Irrigation Systems of Sri Lanka

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Overview:

Reservoirs in Sri Lanka

➢ The reservoir density is about 2.7ha per km^2 of land area (Fernando,1993)

➢ There are four types of reservoirs which are categorised based on their capacity and the functions

i. Large (major) reservoirs

ii. Medium sized reservoirs

iii. Minor perennial reservoirs

iv.Village irrigations system (VISs)

(mainly in low rainfall region)
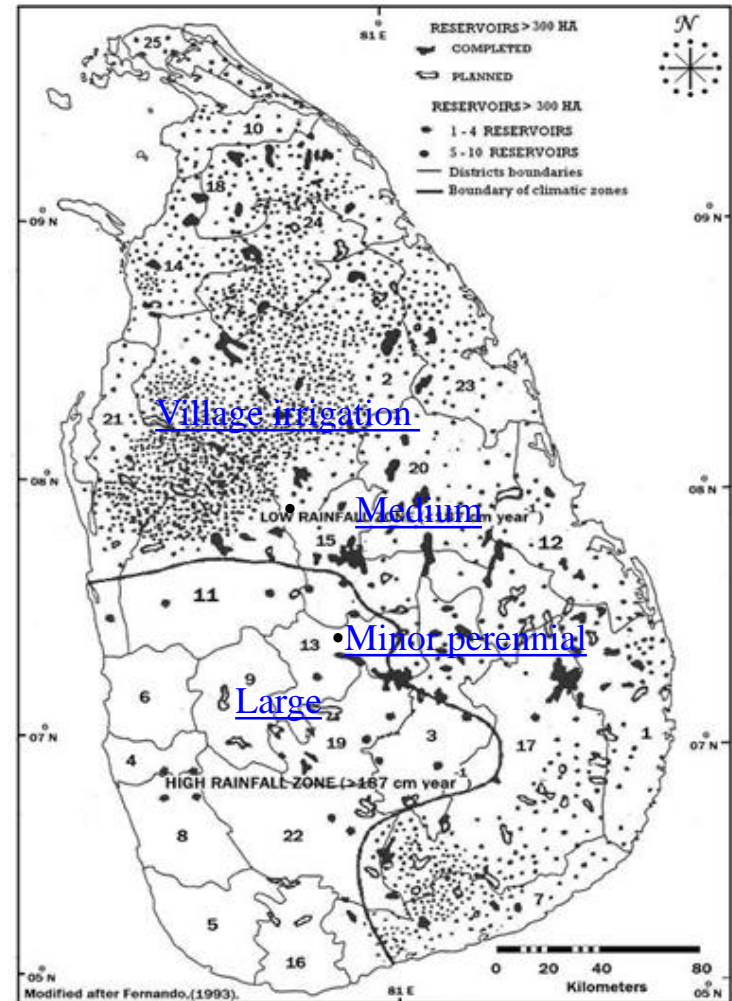
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1. VISs located as a cascade system

Schematic diagram of a Small Tank Cascade system. Scale 1:50,000 (Source: Sakthivadivel 1996).
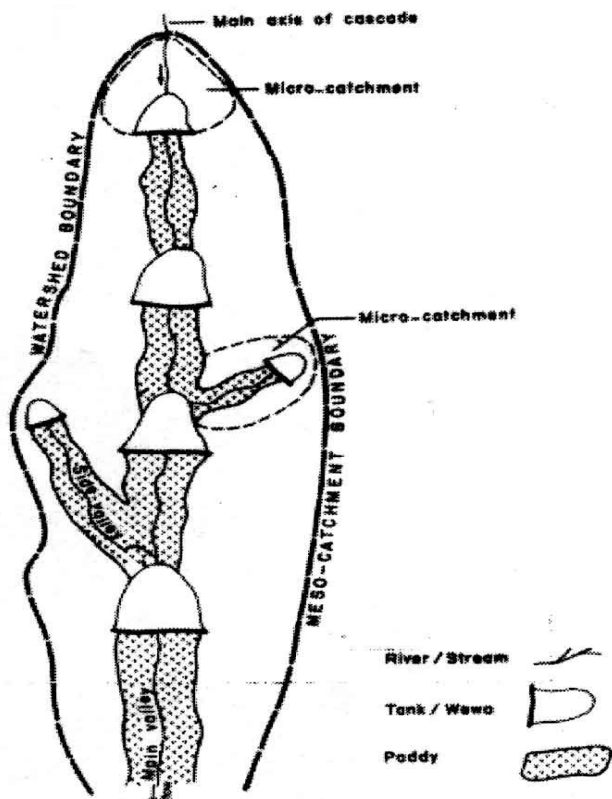
2. VIS associated with a village

Modified after Ulluwishewa, 1995

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fishery
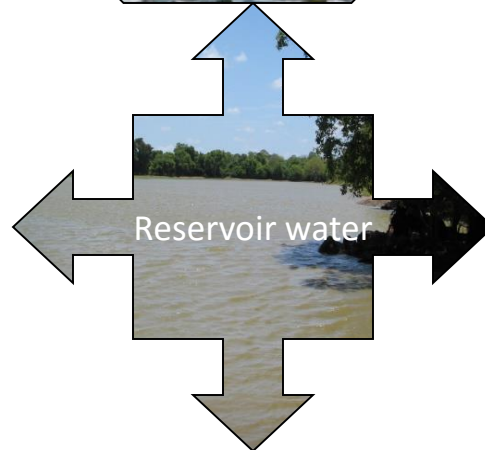
Reservoir water

Two main issues of allocation of water

1. *Inter-sectoral water allocation*

Saving more water for CBF means less water for rice?

Releasing more water for rice means less water for CBF?

2. Intra-sectoral water allocation

Tail-end fields

Middle fields

Head-end fields

Reservoir

Solution for intra-sectoral allocation : Share cropping system (Bethma)

Water is **not sufficient** to cultivate the entire area !

Let's cultivate land in **one part** located at the **head-end**, this will **diminish water losses**, through seepage and percolation !!.

3

Question ?

Is this h*aphazard method of water allocation* (share cropping system or Bethma system) *technically efficient?*

Share cropping system/Bethma ?

1. **Non-cultivation of one or two tail-end zones** in times of water scarcity simply is Bethma (Leach, 1961; Uphoff et al., 1981; Gunaratne & Madduma Bandara, 1989).

2. **The redistribution of land whereby top-end farmers give lands to tail-end farmers**, is a *government intervention* (Leach refers to Bethma as described by Farmer (1957)

3. **Redistribution of land among the farmers whereby top-end farmers indeed give land *voluntarily* to tail end farmers** (Gunasekara, 1981; Abeyatne & Perera, 1986; Perera, 1986; Ekanayake and Groenfeldt ,1987; Murray- Rust & Rao, 1987; Begum, 1987).

4. **The cultivation of a different part of the command area in consecutive years.** Some authors found that some kind of payments to land giving farmers by land receiving farmers (Begum, 1987; Perera, 1986; Murray- Rust & Rao, 1987)

General features of the Bethma

1. **The cultivation of only part of the command area when water is not sufficient to cultivate the entire area**

2. The concentration of the cultivated land in one part to   better control the water and if located at the top end, diminish water losses through seepage and percolation

3. Access to water by both top enders and tail enders

4. Bethma also is a solution for top and tail conflicts of water shearing

Technical efficiency (TE)

➢ In general, *TE is **'the ability of a firm to obtain maximal output from a given set of inputs vector** or **'the ability to minimise input use in the production of a given output vector'*** (Kumbhakar & Lovell, 2000; Coelli et al., 2005).
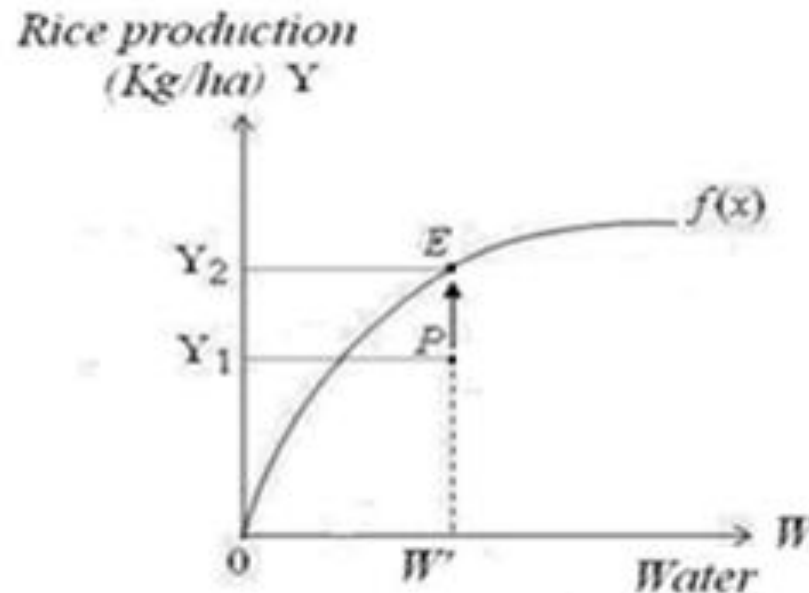
➢ *Technical efficiency (TE) in the context of "Bethma" system is* **the ability of all farmers to obtain maximal output from a available voulume of water In the reservoir.**

Research Methods

1. Data

(i). Secondary data: Digital database of VIS in Sri Lanka (Department of Agrarian Development, 2000)

(ii). Primary data: Collected from a sample survey form 14 villages associates with the VISs, total sample is 460 farmers from three locations in the command area.

2. Sample

Location	Distance from dam (Metres)	No of farmers
Head-end fields	Less than 1000	160
Middle fields	1000 to 2000	152
Tail-end fields	Above 2000	148

3. Data Collection

Face-to-face interview with selected rice farmers using a pre-tested questionnaire

4. Data Analysis

The Stochastic production functions were estimated following a **Simple three steps procedure** for imposing theoretical consistency of the translog production functions (Henningsen & Henning, 2009) .

Model for estimating technical efficiency for rice farming

$$\ln Y_i = \beta_0 + \sum_{i=1}^{5} \beta_i \ln x_{i,k} + \frac{1}{2} \sum_{i=1}^{5} \sum_{k=1}^{5} \beta_{i,k} \ln x_{i,k} \ln x_{i,l,} + v_i - u_i$$

x_{r1} = <u>individual volume of water </u>use by i^{th} farmer (M/ha)

x_{r2} = labour (total operational man days in rice farming)

x_{r3} = mechanical power (minutes)

x_{r4} = irrigating time/total time for irrigating (minutes)

x_{r5} = pesticides (ml)

β_i = the parameters to be estimated

u_i = technical inefficiency

v_i = random error

Inefficiency model

$$U_i = \delta_0 + \sum_{j=1}^{11} \delta_j Z_{ij}$$

Z_1= farmers' age (years)

Z_2 = farmer's education level (years)

Z_3 = participatory rate for activities of Farmer Organisation (FO)

Z_4 = membership of FO (Dummy; 1= yes, 0, otherwise)

Z_5 = paddy field location (Dummy; 1= located at head-end, 0, otherwise)

Z_6 = paddy field location, (Dummy; 1= located at the middle, 0, otherwise)

Z_7 = locational water sharing issue (Dummy; 1 = yes, 0, otherwise)

Z_8 = paddy field ownership (Dummy; 1=own land; 0, otherwise)

Z_9 = use of insecticides (Dummy; 1 =yes, 0, otherwise)

Z_{10} = use of weedicides (Dummy; 1 =yes, 0, otherwise)

Z_{11}= success of field level water management (%)

Results of estimated sectoral *technical inefficiency* models

Inefficiency variables of the models	HEFs	MFs	TEFs
Age of farmer	0.0047	**0.0206****	0.0036
Farmer's education level	-0.0060	0.0241	**0.0572***
Participation rate for FO activities	**-0.0121***	-0.0045	-0.0115
FO membership	**-0.5929****	**-0.3872***	**-0.7195***
Water sharing issues	**0.9149****	**0.3924***	**1.4232***
Land ownership	**0.4594***	-0.0142	-0.1194
Use of insecticides	1.0500**	**0.6648***	2.8940
Use of weedicides	**-0.8458***	0.0826	-3.4103
Success of field level water mgt	**-0.0096****	**-0.0117****	-0.0072

Notes: significance at * 10%, **5%, ***1%.

Results of average productions and the TE scores

Intra-sectoral Average Production and level of Technical Efficiency Levels

Location	Average production (Kg/ha)	Technical efficiency (%)
Head-end fields	1078	**74**
Middle fields	1076	55
Tail-end fields	1409	**80**

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➢ The FO membership, participation rates in FO activities and field level water management are positively influencing TE all three sectors

➢ Water sharing issues is more statistically significant factor which has a negative influence on technical efficiency in MFs and TEFs

➢ The relationship between average production and distance has no negative relationship in the command area as found by Daleus et al. (1989).

➢ Tail-end fields are more productive and efficient in VISs.

➢ Improvement of collective action and individual field level water management, increases in efficiency of intra-sectoral allocation of water.

Reasons for high technical efficiency in HEFs and TEFs.

There are two factors for higher TE in TEFs

(1.) **The length of water retention period and**

water retention days per one water intake

      HEFs   2 days.

      MFs   2-3 days,

      TEFs   4 days.

This is dependent on the soil type, slope and the water management practices of individual farmers.

2**. Soil fertility**

Soil fertility is rich in TEFs with the inundation from the downstream reservoir

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There were three main factors increase soil fertility due to inundation of the TEFs.:

1. **Sedimentation of organic material** due to submergence of TEFs during the high rainfall season (Daleus et al., 1988).

2. **Higher level of ground water and a higher clay content** of the soil (Daleus et al., 1988) due to siltation during the inundated period of the downstream.

3. **The effect of grazing by cattle and water buffalos** in the command area (Seniviratne, Kulasooriya, & Rosswall, 1994).

Policy implications

1. **Improvement of collective action** and individual field level water management can increase efficient intra-sectoral allocation of water by promoting alternative economic activities (i.e. CBF production in VIS).

2. Farmers will be motivated to manage their water demand not only through enforcement of rules, but also through the **development of an understanding of the importance of an efficient water use** in rice farming to increase reservoir water productivity as well as their incomes.

Thank You