INSTITUTIONAL LOCK-IN IN NATURAL RESOURCE MANAGEMENT
The case of water resources in Kerala

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ABSTRACT

The paper shows that the requirement of irrigation was highly overestimated in the State's investment proposals. This demand misrepresentation is another source of inefficiency in addition to the technical and allocative ones. This inefficiency deprives public investment in other sectors, which are more beneficial to the State. It also blocks the value addition of the water resources of Kerala. This is caused mainly by the policy which aimed at self-sufficiency in rice production within the State. The organisational structure, which was created for providing irrigation, and the feedback process lead to the persistence of inefficiency. Thus the paper argues that a lock-in is visible in the institutional framework of the water resource management of Kerala.

JEL Classification : Q28, H4, D73

Keywords : Institutional lock-in, inefficiency, public provision, Kerala, Water Resource Management

Introduction

The phenomenon of 'lock-in' or 'path dependence' has recently attracted the attention of researchers (David, 1985; Arthur, 1989; North, 1991; Cowan and Gunby, 1996; Atkinson and Oleson, 1996). According to them, path dependence causes the emergence and the continued existence of inefficient[1] technology and institutions. The institution and technology chosen at a historical juncture, may drive the economy to an inefficient[2] state at a later period. Moreover, some institutions are unable to correct themselves. This results in the persistent use of inefficient technology and institutions.

Thus, the process of the selection of technology or the institutional framework assumes importance. Arthur (1989) has noted that even historical small-events can lead to the selection of a particular technology

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1 There are different levels of inefficiency. The use of inappropriate combination of inputs like labour and capital, and the use of more inputs than required given the present technological knowledge are the two commonly understood forms of productive inefficiency. However, there is another source of inefficiency in public projects. This is due to the discrepancy in the decision on what is required for the region or the beneficiaries. Thus a technology or project selected may not be necessary to meet the actual requirements.

2 Inefficiency of the economy arises out of two processes. First, the present state is sub-optimal compared to the one that would have been reached, had the decision taken earlier, been a different one. Secondly, the economy is in a position by which it cannot adopt to the new realities. For a discussion of efficiency in institutional terms see, Rutherford (1994).

over the other competing ones. North (1991) has indicated the potential role of ideology, and wrong perceptions of reality, in the selection of an institutional framework. However, the documented evidence for technological and institutional path dependence is scanty.

This study uses the framework of path dependence to explain the issues of water resource management in Kerala. The central argument is that the ideology of self-sufficiency led to the selection of a particular resource development framework, which resulted in the gross inefficiency of public investment, and blocked the value addition of the water resources of the State. The study also provides evidence that the existing institutional framework is not capable of evolving into an efficiency-enhancing one.

The paper is organised as follows: First section examines the demand for irrigation in Kerala and the inefficiency of large surface-irrigation projects caused by demand misrepresentation. The implications of this inefficiency are discussed in the second section. The elaboration of the institutional framework which results in the inefficiency is done in the third section. It also includes a brief exposition of the political economy of the development of water resources in the state. The discussion of the factors which lead to the persistence of inefficiency in this sector is given in the fourth section. The last section provides the summary and policy implications.

I Demand for Irrigation in Kerala

A number of studies have showed that there exists no clear evidence that irrigation projects have significantly benefited Kerala's agriculture (George and Nair, 1982; Narayana and Nair, 1983; Kannan and Pushpangadan, 1989). Issues such as improper financial planning, cost escalation, inordinate delay in construction, etc., in irrigation sector have also been critically analyzed (Netto, 1990; KSSP, 1988). In a couple of notes, prepared for the State Planning Board, K.N.S. Nair has questioned the emphasis on, and the focus of, irrigation in this humid-tropical state, given its specific agro-climatic characteristics[3].

Santhakumar et al. (1995) have analyzed the technological planning of Kerala's irrigation projects. This study showed that the planning of irrigation projects has the following limitations: a realistic estimate of the requirement of irrigation water was not made; data on local water resources was not collected and analyzed; the possibility of using different scales of operation in irrigation, sources of water and technological solutions was not explored; and the planning was not broad enough to examine the possibility of having a cropping pattern which would consume less water.

However, no systematic effort has been made to assess the demand for irrigation in Kerala. This is mainly due to the fact that the planners have been following the 'requirement approach' in forecasting the demand for irrigation. In this approach, the quantity of irrigation required for each crop, the future cropping pattern of the area, the total irrigation requirement, etc., were calculated on the basis of certain assumptions. This approach has two problems. The first one is, as noted by Ruttan (1965:17), the implicit assumption that 'resource combinations are inelastic with respect to changes in the prices of resource inputs relative to each other'. Secondly, this approach gives a high degree of autonomy to the planners to decide the nature of the resource development projects, which provides greater scope for demand misrepresentation.

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[3] This refers to the discussion notes, such as **Some irrigation policy issues relevant to enhancing agricultural production** and **Rational development and use of water resources of Kerala**, State Planning Board, Trivandrum.

Since the provision of irrigation has been traditionally considered to be the responsibility of the Government, the 'demand for irrigation' is not taken as a price-based, economic demand. The decision on, how much water is to be provided through irrigation projects, is based on some estimates of 'physical demand'. This 'physical demand' is an estimation of water to be provided, in addition to the quantity available locally, to cultivate a particular crop in a specific season. Physical demand (PD) can be defined as follows:

Physical Demand = Total water needed for the crop for the season
- (Direct Rainfall+ Residual Water)

Thus the irrigation demand for a particular region depends on the following factors: Rainfall; Residual Moisture; and the cropping system that will be adopted after the provision of irrigation. There are reasonably reliable methods of assessing the total water required for a crop. Similarly there are reliable estimates of rainfall. However the reliability of the estimates of residual moisture depends on the topographic and climatic features of the region. There is considerable degree of variation in the quantum of residual moisture available at different levels of the small watersheds of Kerala because of its undulating topography. The decision on the cropping system 'to be adopted in the command area', has been mainly based on the value judgements of the (technical as well as political) planners.

The assumptions in the calculation of physical demand, become evident through the following brief analysis of the different methods of calculation of irrigation requirement employed in Kerala.

1.1 Engineer's Assessment: Earlier Phase

When irrigation planning started in Kerala, the objective of the planners and engineers was to convert most of the agricultural land of

Kerala into three-cropped paddy fields (Santhakumar, et al., 1995). This objective influenced the calculation of irrigation requirement, estimated by the early engineers. They had somewhat reliable estimates of rainfall of the different regions of Kerala and assumed that only fifty per cent of the rainfall can be used for cultivation and the rest will flow out as unusable runoff. This assumption is not so unrealistic, given their objective of converting the whole command areas into paddy fields. However, their basic objective of expanding paddy cultivation was grossly unrealistic. The current cropping pattern of Kerala, marked by the steady decrease in the area under rice, itself is sufficient to show the unrealistic nature of the objective of the early engineers. The initial plans of almost all the irrigation projects of Kerala were based on this unrealistic objective. Table 1 summarizes the features of the requirement assessment at this stage.

Table 1: Features of the Early Engineers' Assessment of Irrigation Requirement

Rainfall	Assumed that only fifty per cent is usable
Residual Moisture	Neglected
Cropping System	Paddy Alone

1.2 Engineer's Assessment : After Late Seventies

Since the Central Water Commission and other funding agencies insisted on the revision of proposals to increase their benefit-cost ratio, engineers were forced to consider crops other than paddy for the provision of irrigation in Kerala. In doing so, as shown by Santhakumar et al. (1995), they have tried to show that the construction of previously planned projects, is necessary for supporting a new cropping system. In this new system, only those crops, which require large amounts of water were selected and those requiring less or no irrigation were not considered.

For example, rubber was omitted or neglected under the proposed cropping patterns of both Kallada and Vamanapuram Irrigation Projects, whose command areas support large areas of rubber plantations today.

Requirement assessment at this phase was based on more realistic assumptions in terms of rainfall and residual moisture. Engineers had taken into account the availability of water in the streams adjoining paddy fields. Thus the revised estimate of water requirement during monsoon period is significantly less than that of the figures estimated at the first phase. In the second phase, it was assumed that only 50 per cent of the irrigation requirement need be provided from the project and the rest can be met from the small streams of the command area. Table 2 summarizes the features of assessment carried out in this phase.

Table 2: Features of Assessing Requirement After the Late Seventies

Rainfall	Reliable Estimates
Residual Moisture /Locally Available Water	Considered; Assumed that only 50 per cent of the demand during monsoons need to be provided from the reservoir
Recommended Cropping System	Three crops of paddy in wet land and other irrigation needed crops in dry land

1.3 Assessment of Requirement by Micro-watershed Studies

The limitations of irrigation planning in Kerala led to a feeling among water resource planners that a much more detailed assessment of the availability of water resources should be made at micro level or at the level of micro-watersheds. Scientific organisations like CWRDM (Centre for Water Resources Development and Management) have made such watershed studies in several parts of Kerala.

These watershed studies have brought out more information on the availability of water in the micro-watersheds of Kerala. Table 3 provides the estimates of irrigation required for different crops for different seasons, and the sources of irrigation suggested by a watershed study conducted by CWRDM, in the mid-land of Calicut district.

Table 3: Irrigation Requirement of Chevayur Watershed as shown by CWRDM study

Period	Crop(s)	Quantity of Irrigation Required (mcm)	Suggested Source of irrigation
May-Aug	Paddy	Nil	
May-Aug	Plantations	0.15	Local Runoff (Estimate : 6.64 mcm)
Sep-Dec	Paddy	0.721	Local Runoff (Estimate : 3.4 7mcm)
Sep-Dec	Plantations	0.40	Local Runoff (Estimate: 3.47 mcm)
Jan-Apr	Plantations	1.305	Ground Water through ponds and\ wells (Estimate : (0.1*0.3* Rainfall) - Present Use = 3.43 mcm
Jan-Apr	Paddy	0.941	Storage within the micro- watershed

Source: CWRDM (1987)

The following major conclusions emerge from these studies.

(1) There exists sufficient water locally to irrigate two crops of paddy. Even if there is shortage at the farm-level, water management with effective utilization of local streams would be sufficient to meet the requirement.

(2) There is also an undertapped ground water potential in these micro-watersheds. Even safer estimates of this ground water potential are shown to be sufficient for irrigating garden crops.

(3) If a third crop of paddy has to be cultivated, medium size reservoirs would be necessary within and outside the watershed.

With the aim of having the third crop of paddy, these watershed planning exercises too have gone for designing reservoirs in micro-watersheds. In essence, the assessment done by the micro-watershed studies have shown the need for large canal-based irrigation only for cultivating the third crop of paddy. Table 4 lists the features of assessment made by the micro-watershed studies.

Table 4: Features of Assessing the Requirement by Micro-Watershed Studies

Rainfall	Measured locally
Residual or Locally Available Water	Measured
Recommended Cropping System	Plantation crops requiring irrigation in dry land; three crops of paddy in wet land

All these methods, described above, assessed the water availability using hydrological measurements with varying degrees of accuracy. Then, a future cropping pattern, which was considered ideal by the planners, was visualized. In all such projected cropping patterns, increasing paddy production was an important strategy. That is why, 'three crops of paddy' was suggested in the case of both the revised irrigation planning and micro-watershed studies, even though these approaches have abandoned the 'paddy alone' attitude of the early irrigation engineers. With the estimates of the availability or supply of water, the planners calculated the quantity of surplus water to be provided for achieving the 'ideal cropping pattern'. This exercise was based on a crucial assumption that the people would move easily or (it could be easy to induce people to move) towards the cropping pattern envisaged by the planners.

1.4 The Need for Demand-based Assessment

The assumption that the farmers easily adapt the 'projected cropping pattern' need not be true and is evident clearly from the failure of the completed irrigation projects in checking the reduction of area under paddy cultivation. The adoption of a cropping pattern need not be decisively influenced by the presence of an irrigation facility. If the 'cropping pattern' recommended by the planners is not an adequate basis for estimating the 'demand for irrigation', then efforts should be made to assess the other parameters determining demand.

A discussion of such parameters can be seen in Ruttan (1965). He uses three models: a productivity model - to incorporate current levels of resource productivity; a demand model - to determine the future output levels (of crops); and an equilibrium model - to determine output levels simultaneously with the factor input levels. These models tried to estimate the following parameters:

- A crop production function with irrigated land as an input;

- Marginal value product functions for irrigated land;

- Relating marginal value product (of an input) with the average cost (of that input);

- The future output (of the crop) at the national level based on population and per-capita income;

- The changes in the regional contribution to the national output .

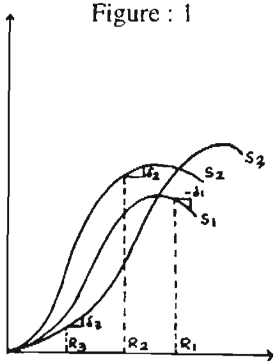
While using the essential features of these models, one can see that the demand for irrigation depends on the marginal product of water, the past and future trends in cropping pattern, the contribution of the region to the national production of the particular crop.

A formal estimation of these parameters is not envisaged here. However, an attempt is made here to make indirect assessments to ascertain some of their impact on the demand for irrigation in Kerala.

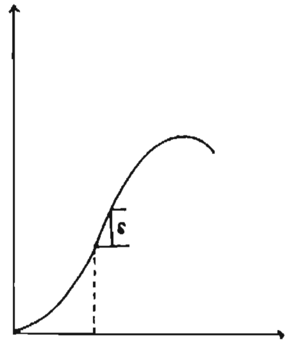
1.5 The Productivity of Water in Kerala

Though a precise estimate of productivity is not aimed at here, data on evapo-transpiration requirement provide some understanding on the seasonal variation in the productivity of water. The seasonal irrigation water requirement in a typical Kerala watershed is given in Table 3 and a demonstrative sketch showing the agricultural production function of water for different seasons is given in Figure 1. During the period between June and November, the marginal product of an additional unit of water is negative, since there is excess water from rainfall. The marginal product of water during summer is also lower due to the high temperature between December to May. We can compare this situation of humid-tropical Kerala, with that of an arid-tropical State like Tamilnadu where 5,20,000 hec. of area under paddy receive two months of rainfall, and 1,490,000 hec. receive it for less than two months (Srinivasan, 1985).The marginal product of water in Tamilnadu is much

Figure : 1



(a) Production function of water in a wet tropical region like Kerala



(b) Production function of water in a semi-arid tropical region like Tamilnadu during a single non-summer season.

S_1 – First Season	R_1 – Rainfall during First Season (S-W Monsoon) (High Rainfall) δ_1 – Margin Product of Irrigation during first season which is negative because of high rainfall.
S_2 – Second Season	R_2 – Rainfall during Second Season (N–E Monsoon) (Moderate Rainfall) δ_2 – Marginal Production of Irrigation during second is positive but small
S_3 – Third Season (summer)	R_3 – Extremely low δ_3 – Rainfall during third season seems positive but small because each unit increase in product require more units of water due to high temperature regime.

Thus $(-\delta_1) + \delta_2 + \delta_3 < \delta$

The sum of the values of Marginal Product of Irrigation for three seasons in Kerala is less than the Marginal Product of Irrigation in Tamilnadu for a single season.

higher during the non-summer periods when the temperature regime is also modest[4]. Thus even if summer months are avoided for cultivation, the annual value of the contribution of irrigation is much higher in Tamilnadu compared to Kerala.

Regarding the regional contribution to national agricultural production, Kerala's share, which accounted for 1.31 percentage of total rice production in India in the late eighties, is declining steadily. This is a reflection of the shift in cropping pattern in Kerala towards high value crops. The provision of irrigation per se will not reverse this trend. One can estimate the irrigation requirement for paddy in Kerala, with an assumption that the present area under paddy may continue without much change (which itself is a highly optimistic assumption).

An attempt is made in the following section to make a preliminary analysis of the requirement for irrigation based on the current land-use pattern of the command areas of two major irrigation projects - one nearing completion and the other proposed but yet to start construction. The block level data of the current cropping pattern of the command areas are given in Table 5 and 6[5].

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[4] The temperature regime in Tamil Nadu is 25-30°C, at least for one season.

[5] Data is from the unpublished documents of the Department of Economics and Statistics.

Table 5: Cropping pattern of the Command Area of Kallada Irrigation Project in the Nineties

Block	A	WL %	Paddy % of WL		Other Crops in WL a	p	FI %	X	Y	DL %	CM %	RB %
Ithikkara	18	12	s1	35	2	31	32			88	84	4
			s2	39	1	31	29					
			s3	0	7	31	62	37	4.4			
Mukhthala	11	15	s1	30	2	43	25			85	85	
			s2	32	3	43	22					
			s3	0	4	43	53	33	4.9			
K. Pally	9	34	s1	16	3	53	27			66	66	
			s2	21	4	53	22					
			s3	0	14	53	33	18	6.1			
Ochira	6	53	s1	10	6	58	26			47	47	
			s2	13	9	58	20					
			s3	0	6	58	24	11	5.8			
Kottaraka	17	14	s1	70	7	13	10			86	61	25
			s2	73	11	13	3					
			s3	0	7	13	66	74	10.4			
Vettikkav	20	16	s1	59	14	17	10			84	59	45
			s2	62	14	17	7					
			s3	0	14	17	62	66	10.6			
Anchal	19	10	s1	62	10	24	4			90	48	42
			s2	63	11	24	2					
			s3	0	10	24	68	70	7			

Note:

A- Percentage of area under cultivation of each block, out of total command area;

a - seasonal crops; p - perennial crops

WL - Wet land;

S1 - Ist Season (June - August);

S2 - 2nd Season (September-December)

S3 - 3rd Season (January - April)

DL - Dry Land;

CM - Area under Coconut and other mixed crops;

X - Percentage of the wet land in the taluk requiring irrigation in summer (method of calculation described in the text);

RB - Area Under Rubber;

Y - Percentage of total area of the taluk requiring irrigation for paddy in summer

FL Fallow

Table 6: Current Cropping Pattern of the Command Area of The Proposed Vamanapuram Irrigation Project during the Nineties

Block	A	WL %	Paddy % of WL		Other Crops in WL a	p	Fl %	X	Y	DL %	CM %	RB %
Nedu.gd	21	10	s1	32	21	41	6			90	43	
			s2	32	19	41	8					
			s3	0	31	41	28	38	3.8			47
Velland	22	10	s1	35	16	44	5			90	24	
			S2	34	13	44	9					
			s3	0	19	44	37	42	4.2			66
Vamapm	23	10	s1	56	15	21	8			90	42	
			s2	55	15	21	9					
			s3	0	28	21	51	57	5.7			58
Kazhkm	22	15	s1	36	13	42	9			85	82	
			s2	36	11	42	11					
			s3	0	28	42	30	35	5.3			3
Chikl	12	17	s1	44	0	49	7			83	77	
			s2	46	0	49	5					
			s3	0	8	49	43	42	7.1			6

Note: Abbreviations used are as same as for Table 5.

1.6 Recalculating the Irrigation Requirement based on the Present Cropping Pattern

It can be seen that only about one-third of the wet lands of the command area are used for paddy cultivation. The rest is used for other seasonal crops and perennial crops. Since there is more water, and lesser area is under paddy during the first season than the second, it is wrong to assume that the provision of water will increase area under paddy during the first season. (In VIP [Vamanapuram Irrigation Project], there is a slight reduction in the wet-land area under cultivation during second season.) The lower area of the first season is an indication of the problem of excess water. Since the problem of excess water disappears in second season, it leads to a slight increase in area under paddy. This slight increase is due to the extension of paddy cultivation to a part of the seasonal fallow of the first season. It is not rational to assume that the area used for cultivating non-paddy crops during first season, will come under paddy during second season, if irrigation is provided. This is because of the fact that it is not the absence of water, which resulted in the cultivation of non-paddy crops in the first season. This again indicates that the provision of irrigation will not further increase the area in the second season. The next question is whether there is shortage of water to cultivate the current area under paddy. This is unlikely for two reasons. From a demand point of view, if water scarcity is there to any significant extent (at which yield levels are affected), then people would have converted that area for the cultivation of less-water needed and more profitable crops. This option is clearly available to them, as evident from the use of nearly 40% of area for the cultivation of such crops during first and second seasons. Thus the non-exercise of such an option in the area which is currently under paddy can be taken as an indication of adequate water availability. Secondly, the information on supply, made available by the watershed studies, also point to the availabilityof water locally to meet the contingent needs of the second season. Thus the need for bringing water from distant projects is not there during the second season.

In the third season, there is an increase in fallow area and this can be taken as due to the lack of irrigation. If irrigation can be provided during third season, this additional part of the seasonal fallow may come under cultivation. The whole fallow area of third season will not come under cultivation, because of the fact that one part remained fallow even during the other seasons when water scarcity was not a problem. Thus, one can assume that the non-cultivation in this part is due to reasons other than water scarcity. Hence this part of the fallow of third season may not come under cultivation, even if irrigation is provided. Thus, it is logical to assume that the provision of water during summer may benefit an area, which is equal to the difference between the maximum and minimum values of the seasonal fallow. In essence, the argument here is that the demand for irrigation from distant source for paddy is limited to the third season, and, that too, for an area of 30 to 50 per cent of the wet lands.

Another question is whether the wet-land crops other than paddy, which are cultivated in the third season require irrigation for enhancing its productivity. Among these crops, there are both perennial crops like coconut and seasonal ones. Coconut cultivated, in converted wet lands do not require irrigation, as the trees could use the moisture available in the deeper portions of these valleys. However seasonal ones do require irrigation in certain localities. It can be seen that the area under annual crops (in wet lands) increase during the third season. This itself is an indication of the moisture availability. Moreover, the water requirement of these annual crops like pulses is much lesser than that of paddy. Thus in the recalculation, attempted in this paper, it is assumed that water requirement for annual crops is equal to that of cultivating paddy in areas equal to half of that under annual crops currently in the third season. Thus, the total area requiring irrigation in wet land (in summer) is taken as the difference between the maximum and minimum values of seasonal fallow, plus half of the area that is under seasonal crops (other than paddy) during the third season. This part of wet land is written in Tables 5 and 6 as X values. The percentage of this area in the total cultivated area of each block is noted as Y values. The sum of the products of A (i.e., percentage of the total cultivated area in each block) and Y would give the percentage of wet land in the whole command area, which require irrigation in summer. This area comes to 7.45% and 5.05% of the total command areas of KIP and VIP respectively.

Regarding the dry land part of the command areas, a major part of it has already been converted into rubber plantations. Around 18% the command area of KIP and 37% of that of VIP are under rubber cultivation. This is in contrast to the negligible areas (around 0.2 %) earmarked for rubber cultivation in the cropping patterns, in the project proposals prepared by the Irrigation Department. Since rubber cultivation is more profitable than crops requiring higher levels of irrigation (than rubber), the provision of irrigation will not reduce the area under rubber to the level envisaged by the irrigation planners.

Thus, one can recalculate the total irrigation requirements of these two projects, based on the following assumptions.

(1) Only 7.45% and 5.05% of the commands of KIP and VIP require irrigation for paddy, (or for annual crops which is equivalent to these areas under paddy in terms of water requirement) in summer.

(2) The area under rubber (i.e., 18% and 37% respectively) do not require much irrigation.

(3) There is no need to provide irrigation from a distant source between June and November.

Such a recalculation is attempted in Tables 7 and 8.

Table 7: Recalculation of the Irrigation Requirement in Vamanapuram Project

	Dryland	Wetland
Area proposed to irrigate	6978 ha	2540 ha
Estimated irrigation requirement as percentage of storage	50	50
Area under rubber (37% of total are)	3522 ha	
Area that may require irrigation during summer (5.05% of total area)		481 ha
Reduction in irrigation need	50%	81%
Total Reduction in the requirement of storage	65.5%	

Table 8: Recalculation of the Irrigation Requirement in the Kallada Project

Area Proposed to irrigate	46400 ha	20800 ha
Estimated irrigation requirement as percentage of storage		
in monsoon months	2.7	29.0
in summer	43.5	24.8
Area under rubber (18% of total area)	12096 ha	

Area that may require irrigation during summer (7.45% of total area)	5006 ha	
Reduction in irrigation requirement		
in monsoon	2.7 %	29.0 %
in summer	11.6 (due to rubber)	18.6
Total Reduction in requirement (according to our assumptions)	61.9	

It can be seen from the Tables (7&8) that the requirement for irrigation from reservoirs is reduced by nearly two-third in both the projects. Only one-third of the storage is necessary or the average benefit per unit of water will decrease nearly by three times. Since the cost of per-hectare irrigation is already high in Kerala, this reduction in demand would drastically reduce the economic viability of the projects.

A major part of this irrigation requirement is for irrigating coconut and mixed crops. The area under coconut and mixed crops varies significantly. For example, within the command area of Kallada project, it varies from 50 to 100 per cent of the total dry land. In the areas closer to the coast, most of the dry land is under coconut and mixed crops, while in hilly areas, nearly fifty per cent of the dry land is used for rubber. This pattern also varies from basin to basin. In the case of Vamanapuram, the coconut and mixed crops occupies only a smaller portion of the dry land even in areas closer to the coast. The rubber cultivation has penetrated even to these areas, and nearly 55 to 65 per cent of the high-lands have been used for rubber cultivation. Still, coconut and mixed crops form a substantial part of the command areas in non-hilly areas and there is a theoretical requirement for irrigating these crops.

1.7 On Irrigating Coconut and Mixed Crops

Though there is 'theoretical requirement' for irrigating coconut, one has to analyze whether this will translate into an economic demand. The issue is whether farmers will be ready to bear a substantial part of the investment for irrigation. Irrigating coconut in Kerala requires a major investment at the farm level, even if water is provided free of charge from the canals. If economic demand is not there, then farm-level investment may not take place, cost sharing of irrigation will not materialize, and the farmers will not be motivated to use water efficiently through the use of proper water management practices. This is important when we consider the availability of a number of technologies which can partly substitute water with capital in water management (for example, sprinkler and drip systems). Thus the nature of economic demand has crucial implications on the efficiency and sustainability of economic investment and natural resource utilization.

The translation of physical demand into economic demand depends on a number of factors. Understanding the economic conditions and 'preferences' of the farmers who cultivate coconut may provide some insights into this problem. Their readiness to use irrigation may depend on a number of factors such as the size of the holding, dependence on agriculture as the major source of income, and so on. Some observations can be made from the data of a survey, in 881 households situated in three panchayaths of the proposed command area of the Vamanapuram Irrigation Project. These panchayaths were situated at the lower reaches of the proposed canal system. Lower reach panchayaths were selected with a purpose. Upper reach panchayaths have lower percentages of wet lands and larger areas under rubber cultivation. Thus the 'need' for irrigation is not that pronounced in these areas as in the case of lower reaches. Around 25 per cent of the households in two wards of these three panchayaths were surveyed. Table 9 summarizes a few results.

Table 9: A few Summary Features of the Land-holding Status of Three Panchayaths of the Command Area of Vamanapuram Project.

Panchayath Topography	Andoorkonam Near Coast	Pothankod Mid-land	Manickal Mid- and High land
Surveyed households	301	287	293
Percentage of Rubber cultivators among the households	4.6	30.3	41
Rubber cultivators among those having more than 50 cents of land (%)	11.5	67	79
Rubber cultivators having less than 50 cents of land	1	6.9	15
Average size of the coconut-cum-mixed crop farm	44	42	40

Following are the major observations from the above table.

1. A large number of farmers having more than 50 cents in the mid-land (and high land) part of command area of VIP have become rubber growers. The percentage of rubber growers among those who hold less than 50 cents (of dry land) and the percentage of non-rubber farmers among those who hold more than 50 cents are extremely low in such areas. It shows that in this area, those who have reasonable size of agricultural land have become rubber cultivators.

2. Those who hold less than 50 cents continue to nurture a mixed crop system dominated by coconut. Most of such small holders are coconut growers. The average size of a coconut farm is around 42 cents in command area of VIP.

What are the implications of these observations? These small-holders may be less willing to make any substantial investment in their land for agricultural development including the provision of irrigation. This is due to the fact that these families have to devote substantial 'time' and 'investment' for other income generating activities.

However, there can be some errors in this observation. First of all, the provision of water through canals might change their calculations of the cost of irrigation and then more people may be ready to irrigate. The assessment of their willingness in the absence of any such provision may be incorrect. Second error is due to the phenomenon that small holders of coconut may take more effort (per tree) to nurture their coconut farms. A part of their leisure time and luxury investment (for household self-sufficiency in coconut, quality food, gardening) might flow towards the nurturing of coconut gardens.

However, the extreme small-holding nature of coconut growers in the command area gives an impression that these farmers may not be ready to make a substantial investment towards irrigating coconut. Even if water is provided through canal, substantial investment by the farmer is required to bring water to his farm and to provide it to the trees, given the topography, distribution of land-holding and other features of Kerala. This investment may not be made by the extreme small holders due to the fact, as noted by Narayana, et al. (1991), that they are not in a position to use the benefit of economy of scale. The reduction in coconut yield associated with irregular irrigation may also prevent farmers from doing so, unless they are sure of the high reliability of the source of irrigation.

In brief, one can say that even the physical demand for irrigating coconut need not ultimately become a viable economic demand. Thus the real demand for irrigation may be much lower than the quantity calculated in Tables 7 and 8.

2. Economic Implications

The planning based on the overestimation of irrigation requirement is another source of inefficiency. The literature which deals with the efficiency of public sector enterprises has generally stressed the assessment of allocative and technical efficiencies[6]. Thus using Farrel Efficiency Measurement, overall efficiency is taken as the product of technical and allocative efficiency. The technical inefficiency is clearly visible in State's irrigation projects in its cost escalation. The incurring of huge administrative expenditures without actually starting the project, and the necessity to repair the ill-constructed structures, and so on, point to the fact that the expenditure is much more than what is actually required, using the selected technology.

However, the fact that the demand for irrigation is much lower than the estimated ones, leads to other levels of inefficiency. The mere production of irrigation in excess to the 'actual demand' is wasteful. In addition to this, a major implication of the demand misrepresentation is that it affects the choice of technology. This is illustrated as follows.

Assume that there are three technologies, T1, T2 and T3 and costs of producing Q output using these technologies are given by CT1(Q), CT2(Q), CT3(Q). Then the economic cost function is Min [CT1(Q), CT2(Q), CT3(Q)]. Suppose that the planner assumed the demand as

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[6] For a recent exposition of the assessment of efficiency in public sector, see Ganley and Cubbin (1992).

Q=100. Then a particular cost will be the least one from the above function and the corresponding technology, the least cost one. Assume that the real demand is only 10. In that case, the technology chosen for producing 100 may not be the least cost one for producing 10. Thus there is a case of over expenditure due to the choice of technology.

This issue of wrong technological (project) choice is evident in Kerala. There may be more appropriate or cost-effective ways of meeting the reduced demand for irrigation. These options are left unexamined due to the presumption that the demand is higher.

The implication of this gross inefficiency is that the use of excess public resources in irrigation, deprives other sectors which require public resources. Thus the basic efficiency criteria by the Government that it should allocate resource outlays so that the gains, from the expenditure of an incremental unit, are the same in every direction (including tax reduction), is violated.

There is yet another inefficiency in irrigation sector, and that is with respect to the economic use of this natural resource, i.e., water. Since attempt is made (albeit unsuccessfully) to consume more water than the State really requires for irrigation, it blocks the value addition of water resources through other potential uses. An attempt is made in the following paragraphs to quickly survey the other potential uses of water resources of the State. (A detailed survey of this aspect is not within the purview of this paper.)

Water resources can either be used within the State or outside the State. Within the State, the major uses are for irrigation, and domestic and industrial uses. Since water is presently being used for the domestic and industrial uses of the State, this cannot be considered as a potential source of further value addition within the State. The use for hydro-electric power production does not decrease the stock of the resource.

Moreover there has not been much conflict between irrigation and energy production within Kerala, except in a few projects[7].

The domestic and industrial uses will increase in Kerala in the near future. In fact, though water distribution through canals has not increased agricultural production in several command areas, it has enhanced the drinking water availability during summer. Of course, providing drinking water through this means is highly inefficient, and this could have been done through other resource-saving means. Moreover, the overall water requirement for domestic and industrial purposes may not increase beyond one-tenth of the resources available in the State (considering the rainfall pattern of Kerala). Thus the potential for further value addition of water within the State is negligible in the near future.

However, there exists scope for value addition outside the State. The discussion on productivity of water, given above, showed the marginal benefit that can be derived from one unit of water in the neighbouring State of Tamilnadu is significantly higher than that in Kerala. Moreover, the demand in Tamilnadu is presently more than the supply available in the State and this unmet demand is estimated to increase nearly to 1 MHM (10 Km^3) by 2000 AD (Palaniswami, 1995). The industrial and domestic uses in Tamilnadu have already contributed a significant share of the total water demand of the State, and this is expected to go up to 25 per cent in the near future. The prices for the

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[7] Power production in major irrigation projects such as Malampuzha, Peechi, Neyyar, Walayar, Wazhani, Kallada, etc., is nil or of very small quantities to the tune of 4 to 5 MW. It is in Chalakkudy that tail-end water of a hydro-electric project is used for irrigation. In this case, irrigation is a secondary activity. A project to use the tail end-water of the biggest hydro-electric project namely Idukki, is yet to be implemented.

end-user (for non-agricultural uses) is of the order of Rs. 17.5 per 1000 litres (in 1995 prices). Because of the increase in demand for and price of water for non-agricultural uses, farmers, who receive irrigation, cultivate less-water-needed crops and sell water to other users. Such farmers gain 50 per cent more than those who use water for high-water-needed crops. The water demand situation in the State of Tamilnadu points to the fact that there exists a large scope for value addition of the water resources of Kerala outside the State.

However, there are hurdles for an inter-state water trade. First of all, there is a need for cost-effective water transfer systems, which take into account the cost to be incurred for reducing the environmental impact of the transfer projects. Secondly, appropriate institutional mechanisms are lacking in India today which aid water transfer between states and which ensure that benefits flow towards both the partners of exchange and that there will be no violations of the contract in future. However, if one takes the view that appropriate technology and trade mechanisms will evolve in a conducive environment, then the present situation marked by the lack of water trade may be the major bottleneck for the evolution of cost-effective technology (i.e., transfer projects) and acceptable trade mechanisms.

One can only speculate on a few alternative water resource management strategies for Kerala. One possible strategy could have been to have more water reservoirs in Kerala which can be made use for cultivation in Tamilnadu during monsoon period and for storing water to release during summer to the rivers in Kerala. Thus the water filling the reservoirs at the early stages of the South-West monsoon can be made use of economically for cultivation outside theState, while that at the later stages of monsoon can be used within the State. The 'selling of water' during monsoon may be able to generate adequate resources to have a large number of reservoirs in Kerala to reduce summer shortage and for other uses. (The water release, if made to Tamilnadu, can also be made use for tapping hydro-electric energy). There could have been a conjunctive water use strategy within Kerala with reservoirs storing water for summer and enriching the ground water sources and wells. There could have been a strategy which uses the drainage channels to distribute water during summer instead of digging canals. There could have been more investments for taking water from the recharged ground source and distributing it (efficiently) to trees and other crops. The need for efficient distribution mechanisms are important for crops like coconut, rubber, banana, pepper, tea, coffee, etc.. At this stage, one can only say that the gross inefficiency of Kerala's irrigation and its persistence have retarded the development of other potentially efficient water resource management strategies in the State.

In essence, the unsuccessful and costly attempt to use more water for irrigation within Kerala, block the value addition of this water resource both inside and outside the State.

While saying that the demand for irrigation is low, one question that normally arises, especially in a developing country situation, is whether the provision of irrigation by itself, will increase the demand in future. This question can be answered by noting the historical experience of Kerala, where the provision of irrigation has been able neither to increase the cultivation of high-water needed crops, as envisaged, nor to reduce the shift in cropping pattern away from such crops. Thus the assumption of the 'supply-induced demand' has been proved wrong by the historical experience in Kerala.

Second question is related to the equity. More specifically, even though, the demand for irrigation and the potential value addition of water in Kerala are low, if the provision of irrigation has better distributive consequences, then the equity concern should justify the projects. This concern was there in the provision of irrigation for paddy in the State, since paddy cultivation provided the maximum agricultural employment opportunities. However, again the historical experience shows that the provision of irrigation could not increase paddy cultivation in the State and thus the objective of increasing employment opportunities could not be achieved. Because of the inability to achieve this objective, further spending on irrigation with this objective cannot be justified on equity concern.

One can also argue that the increase in employment opportunities for the construction of projects would have been beneficial in an underemployment situation. The concern here is whether the Government has analyzed the potentials of alternative employment-providing avenues which ultimately generate socially useful assets. The ample scope for such alternative avenues, does not justify the public investment in a sector merely for providing employment. Because of the high opportunity cost of the public resources, one cannot justify the over-investment in irrigation, on the basis of non-targeted social benefits. The scarce public resources can be invested in other sectors where social benefits are higher than that in irrigation. Moreover, there is no justification for limiting the value addition of a natural resource. The surplus accrued (by the State) from this value addition process can be effectively used to increase social benefits.

The paper shows that there exists high level of inefficiency in Kerala's water resource sector due to demand misrepresentation and the blocking of value addition of this resource. What is the institutional framework that causes this high level of inefficiency? The following is an attempt to describe this framework.

3. Institutional Framework and Inefficiency

Taking the definition of institution from North (1991), as the rule of game, the prevalent rule in Kerala is the free provision of irrigation by the State. Kerala was not alone in assuming the role that irrigation has to be provided (almost freely) by the State. The pro-active developing strategies followed by the Third World countries after their independence, the socialist planning strategies, the strategies of public investment to increase aggregate demand, and all such influences of the mid-twentieth century were for the State-sponsored construction of irrigation projects. This role assumed by the State, gave it the right to decide what is the quantity and quality of irrigation to be provided. This decision in the present framework is based on (incomplete) scientific assessments, political judgements on the nature of resource development and ideology. The notions that 'Kerala can increase food production significantly through irrigation', that 'the farmers will continue with paddy cultivation', that 'achieving food-self sufficiency at the State level is a necessary virtue', etc., have shaped the decision on how much irrigation was to be provided in the State. As shown by Santhakumar et al. (1995), this was based on the neglect of the agro-climatic features as well as the misunderstanding of the ability of the State to influence the cropping pattern.

Within the framework of free State provision, a technical organization has evolved to plan, implement and maintain irrigation projects. The feed back provided by this organization promotes further development of major irrigation within the State. The organization has also developed further technical capability to construct more irrigation projects, and this organizational learning has also helped in the continuation of the institutional framework.

Using this institutional framework, one can explain the inefficiency in irrigation with a 'rational' perspective. This perspective assumes that the current level of inefficiency is due to the rational action of some actors. Thus from the point of view of those actors, the investment would be efficient, even though it is not effective in meeting the projected targets. Such a rational perspective will naturally focus on the political economy of irrigation. Following is a brief analysis of the incentive structure of the political economy, which result in the inefficient policies in irrigation.

3.1 The Incentive Structure of the Political Process

A substantial part of financial resources for irrigation was provided by the Central Government. Its policies were shaped by the requirement of semi-arid regions, where irrigation is necessary as well as productive. The characteristics of the small humid-tropical State of Kerala cannot really reflect in the policies of the Government of India. When financial allocation is there at the national level to construct irrigation projects, the State planners will try to bring a part of that allocation to the State. It is at the insistence of the nodal organization of the Central Government, i.e., Central Water Commission, that the State irrigation department made changes in irrigation planning to be more realistic and enhance the benefit-cost ratio. However, such strategies of the Central Government were not sufficient to instil a real economic criteria on the part of the State planners. Thus the sectoral allocation for irrigation at the national level, provided a strong incentive for State planners to invest in irrigation, neglecting its real benefits. When such a national allocation is there, it is 'better' for a region to ask for a part of it, even if it does not require the targeted-outcome of the investment.

This is true for a constituency or a small region within the State.For a constituency or smaller region, it is presently better to ask for an irrigation project even if the region does not need irrigation. This is because the project is an opportunity to bring in a part of public budget to the constituency which gains benefits other than irrigation. This is indicated by the authors' analysis of the attitude of the elected representatives of the Vamanapuram project area (Santhakumar et al., 1995). This discrepancy arises due to the present structure of allocation of budgets to different regions. Similarly, aid agencies, who provide large funds for centrally conceived programmes can also have the same effect. In fact, the intervention of the international aid agency made some changes in the structure of the irrigation planning. In the case of Kallada Irrigation Project, World Bank insisted on the inclusion of crops other than paddy and also the redesign of the field distribution system. However, such intervention has not helped in the overall correction of the irrigation planning to make it appropriate to the demand characteristics. Thus the changes made in the planning process on the advice of aid agency turned out to be of cosmetic nature.

In the relation between the technical department and the political decision-makers, one can see several structural reasons for inefficiency. First of all, political leadership depend fully on the technical departments for the planning of projects. There is an inevitable 'underspecification' in the communication of the requirements of the political system. Technical department has higher level of information, which they can use according to their self-interest.

Political system also has no incentive to demand for an efficient solution, if it will reduce the budgetary requirement. This is especially so in the case of coalition governments like that of Kerala, where departments like irrigation will be allotted to single-minister parties. These ministers do not want to reduce the 'activity spectrum' of their departments.

These brief remarks point to the need for a detailed and a rigorous understanding of the political economy for explaining the persistence of the inefficiencies in water resource planning.

What is visible from this brief analysis of the political economy of irrigation is that there is no incentive for adopting a better approach of project planning. This is not due to the absence of techniques or methods or inter-disciplinary skills. The central problem is that the incentive structure of the planning framework is such that there exist no demand for the use of such methods and skills.

The next section seeks whether there is any possibility of change in the institutional framework in the near future.

4. Institutional Lock-in and the Persistence of Inefficiency

In order to analyze institutional change or persistence, the analysis of the linkage between ideology, institutions and organizations are important. The studies of technological and institutional lock-in (Arthur, 1989; David, 1985; North, 1991) indicate that institutions emerged in certain situations can continue to influence the choices made in future. This is mainly because the feedback from the organizations, which came into existence within the particular framework, is not suitable for changing the institutional framework according to the emerging economic scene.

One can also apply this approach to explain the persistence of inefficiencies in Kerala's water resource planning. There seems to be an institutional lock-in in the water resource management of the State. Only one instance is cited here and more research is needed to identify other sources of institutional lock-in. The food shortage experienced from the early forties and the restrictions on grain movement between the states led to the emergence of strategies for achieving rice self-sufficiency in

Kerala. This may be due to the genuine assumption on the part of the planners that the construction of irrigation projects would enhance the production of rice in the State. Moreover, at that time the planners did not have much information on the other factors which limit the expansion of rice cultivation in the State. Thus the framework of food-self sufficiency policy with emphasis on irrigation and its free provision, was adopted on the basis of justifiable assumptions in the fifties and continued in the sixties.

A large organizational set up emerged within this institutional framework. The resultant organization evolved to take advantage of the opportunities and, as noted by North, there is no implication that the skills acquired will necessarily result in increased social efficiency. The feedback from organizational set up is to strengthen the old institutional framework. This was visible in the strategy change of the irrigation department of Kerala. The justification of irrigation schemes (which were planned in self-sufficiency framework) as necessary for supporting a water hungry cropping pattern in the eighties (Santhakumar, et al. 1995), can be cited as an example of this self-reinforcing feedback.

The institutional paths can also be shaped by the subjective models of actors or ideology. For example, food self-sufficiency did not remain as a strategy but evolved as an ideology. It is interesting to note that food self-sufficiency has not been completely abandoned at the policy level, but similar themes are recurring now and then. In essence, choices made at historical junctures, due to either objective situations or ideologies, can continue to influence the future choices. The self-sufficiency policy, emphasis on irrigation and its free provision, resource availability at the national and other levels for the construction of irrigation, sunk investments in projects which have not been commissioned, and the self-reinforcing mechanisms of the irrigation department, and the inability of the political system to shed the self-sufficiency policy in spite of known impossibility, etc., are all creating an institutional lock-in and leading to the persistence of inefficiency in the water resource management of Kerala.

5. Summary and Policy Implications

The analysis of the different methods of assessing the requirement of irrigation employed in Kerala showed the need for a demand-based approach. This approach is necessary to see that the irrigation system is finally utilized by the beneficiaries, and they are ready to share a part of the investment.

An indirect assessment of the demand for irrigation based on the existing land-use pattern in the command areas of Kallada and Vamanapuram projects showed that the projected demands are 62 per cent and 65 per cent excess of the respective potential demands. Even this potential demand need not fully arise, when we consider the percentage of dry-land owned by extremely small holders. Thus Kerala's irrigation projects are highly inefficient not only due to technical and allocative reasons, as noted by other studies, but also due to the excessive demand misrepresentation.

The second implication is that since Kerala keeps more water than required for irrigation purposes, it blocks the value addition of water resources of the State. The paper identified a number of opportunities within and outside the State, in which the water resources of the State could have generated more returns. The institutional blocking of the value addition of water resources is another source of inefficiency.

These inefficiencies were mainly due to the existing institutional framework for the development of water resources of the State. The ideological and organizational characteristics of this framework include the food self-sufficiency objective, free provision of irrigation by the State, the self-reinforcing mechanisms of the State irrigation department, the national allocation of resources for irrigation, etc.. This framework does not seem to be conducive to generate a proper feed back, which can induce changes to achieve higher level efficiency.

In spite of the apparent reluctance to change, it may be useful to record some suggestions for the improvement of irrigation investment in Kerala.

1. A close analysis of the current demand pattern of all the existing projects should be done. This demand should not only include that for irrigation but also for other needs such as drinking water. Then there have to be structural and organizational changes to meet this real demand. In order to institute these changes, at least part of the resources should be recovered from the beneficiaries who actually use the water. The assumption here is that since they use water, they should be ready to participate in cost-sharing to enhance quality and reliability of irrigation. Proper safeguards have to be built-in to help the economically backward sections.

2. New projects should not start construction, unless and until, there exist clear evidence to show the real need for the project. For example, as shown by the rough calculation of this paper, it is doubtful whether Vamanapuram Irrigation Project. is really required. However, the need for further and closer assessments is not preempted here. What is argued here is that projects should start only with the supporting evidence for the demand for the project.

3. A dispassionate reassessment of the water resource development strategy is required in Kerala. It has to be accepted that achieving

food self-sufficiency is almost an impossible task. The shift in Kerala's cropping pattern towards less-water needed crops cannot be avoided through the construction of irrigation projects. However, the need for drinking water and other uses is increasing in the State. Based on a reassessment of supply and demand for resources, a policy that allows value addition of water resources of Kerala, both within and outside the State, should be formulated.

REFERENCES:

Arthur, W.B. (1989) "Competing Technologies, Increasing Returns, and Lock-in by Historical Events," *Economic Journal*, 99, 116-131

Atkinson, G. and Oleson, T. (1996) "Urban Sprawl as a Path Dependent Process," *Journal of Economic Issues*, 30, 2, 609-615

CWRDM (1987) "Integrated Management of Micro-watersheds: A Study of Chethukadavu and Chevayur Watersheds," mimeo. Calicut

Cowan, Robin and Gunby, Philip, 1996, "Sprayed to Death: Path Dependence, Lock-in and Pest Control Strategies." *Economic Journal*, Vol.106, pp.521-542

David, P. (1985) "Clio and Economics of QWERTY," *American Economic Review*, 75, 332-337.

Ganley, J.A and Cubbin, J.G. (1992) "Public Sector EfficiencyMeasurement: Applications of Data Envelope Analysis," Amsterdam: North-Holland.

George, M.V. and Nair N.G. (1982) "Irrigation and Agricultural Development in Kerala," in Pillai, P.P.(ed.), 'Agricultural Development in Kerala', Agricole Publishing Company, New Delhi.

Kannan, K.P. and Pushpangadan, K. (1989) "Agricultural Stagnation and Irrigation in Kerala," *Economic and Political Weekly*, 24, 19, 1067.

KSSP (1988) (Malayalam) "Eighth Plan of Kerala: A Preface to the Discussions," Trichur

Narayana, D. and Nair, K.N. (1983) "Linking Irrigation with Development," *Economic and Political Weekly*, 18, 45&46, 1935-1939.

Narayana, D. et al. (1991) "Coconut Development in Kerala: Ex-Post Evaluation," Trivandrum: Centre for Development Studies

Netto, N. (1990) "Public Investments in Irrigation Projects in Kerala: An Analysis of Cost and Organisational Structure," Unpublished M.Phil. Thesis, Centre for Development Studies, Trivandrum.

North, C.D. (1991) "Institutions, Institutional Change and Economic Performance," Cambridge: Cambridge University Press.

Palanisami, K. (1995) "Sustainability of Water Supply in South Asia: Impact of Growing Competition between Agricultural and Non-Agricultural Sectors." Proc. of the International Conference on 'The Political Economy of Water in South Asia: Rural and Urban Action and Interactions', Madras, January

Ruttan, Vernon (1965) "The Economic Demand for Irrigated Acreage," Baltimore: The John Hopkins Press.

Rutherford, M. (1994) "Institutions in Economics: The Old and New Institutionalism," Cambridge: Cambridge University Press

Santhakumar, V. et al.(1995) "Planning Kerala's Irrigation Projects: Technological Prejudice and Politics of Hope." *Economic and Political Weekly*, 28,14, 586-594.

Srinivasan, P.S. (1985) "Agro-Climatology of Rice in India," in Jaiswal, P.L. (ed.), 'Rice Research in India', New Delhi: Indian Council of Agricultural Research, 203-230.