Water Market and Energy in Bhavani Basin, Tamil Nadu, Tamil Nadu

Ayyanan Malaisamy, Assistant professor
Department of Agricultural Economics, Centre for Agricultural and Rural Development Studies,
Tamil Nadu Agricultural University
Email: agri_malai@yahoo.co.in

Settings

In terms of water sources, India is endowed with vast water and land resources. The geographical area of India is about 329 million hectare (m.ha) with a wide range of physiographical and climatic variations. India is among the foremost countries in the world in exploiting its river water resource. India's has an excellent network of river systems, which have been categorized into 20 major river basins. There are 12 major river basins that are Inter-State in nature, with a combined catchment area of 256 m. ha, 46 medium basins of catchment sizes varying from 20 to 200 m. ha. covering an area of about 25 m. ha, and other water bodies including tanks and ponds draining a total area of 7 m. ha. The total water resources (surface and ground water) have been estimated at about 2300 Billion Cubic Meters (BCM), of which the surface water resources are estimated by the Central Water Commission as 1870 BCM, and the ground water potential assessed by the Central Ground Water Board to be about 431 BCM. The total utilizable flow is estimated as 1086 BCM (surface water 690.03 BCM and 395.6 BCM. of groundwater), of which 37 per cent surface water and 38 per cent ground water have been utilized so far.

The increasing demand over supply of water, the worked out supply-demand gap based on the growth rates of irrigated crops is 2.12 m.ha.m (44.72 per cent). The gap based on National Commission on Agriculture's estimate is 0.48 m.ha.m. (10.12 per cent) (Palanisami, Paramasivam and Rajagopal, 1995). In India, average food grain consumption at present (1999 estimate) is 550 gram per capita per day whereas the corresponding figures in China and USA are 980 g and 2850 g respectively. Present annual requirement on the basis of present consumption level (550 g) for the country is about 200 million tonnes (MT). A moderate rise in consumption level of 750 g per capita per day is considered to be realistic for assessment of future needs. The annual food grain requirement of the country thus works out to be 450 MT by the year 2050. The real challenge is providing additional irrigation water to increase food production while satisfying the rising demand for water from other competing sectors. Since irrigation sector being the largest consumer of water, greater attention in water management is needed in this sector. That is, almost all the utilizable potential will have to be harnessed to meet the demand for agriculture, industry, energy generation and domestic consumption. Even among the user sectors, the consumption of water in India is highly skewed. (Ministry of Water Resources, Govt. of India, in 1998).

The National Water Policy (2002) gives overriding priority to drinking water over other uses. The policy states that all water resources development projects should invariably include a drinking water component. Wherever there are no alternative sources of drinking water, needs of human beings and animals should be the first priority of any available water.

Theoretically, only the consumptive use can be taken as urban requirement. It is generally accepted that consumptive use should be only about 20 per cent of the gross demand. The demands of mega cities, metropolitan cities and smaller urban agglomerations differ. However, taking an average of 200 liters per capita per day (lpcd), the urban demand for water for population of 1000 million (2002 estimate) would be 73.17 billion cubic metre (BCM) of which consumptive use should only be 14.63 BCM (20%). A quantity of 14.63 BCM is too small compared to the total potential to pose any problem of supply. Losses between source and treatment plant, in the distribution system, at the domestic level and above all lack of wastewater management put the demand as a high of 60 BCM instead of the low 14.63 BCM, the minimum need (Ministry of Water Resources,2000).

It is estimated that by 2050, India's population would be around 1.64 billion and 50 per cent of them would live in rural areas. Domestic water demand of this 820 Million (M) rural population (taking into consideration ever increasing aspirations for more water including piped water supply system even in rural areas) shall be at the rate of 100 liters per capita per day. As such the rural drinking water demand by 2050 shall be 29 BCM per year, whereas the present (1998 estimate) drinking requirement at the rate of 40 lpcd is 10 BCM. (Census of India, 2001).

Problem focus

Demand for Water in Tamil Nadu

Tamil Nadu specifically, has a geographical area of 130069 km^2 divided into 17 river basins. The average annual rainfall of the State is 945 mm. In Tamil Nadu in terms of water sources, there are about 60 reservoirs irrigating about 1 Mha. There are 39,000 irrigation tanks having a command area of about 0.8 M ha. More than 1.6 M wells are available irrigating about 1.2 Mha. The recent estimate had indicated that the utilizable groundwater recharge will be about 2.24 MHM. Thus, in any case the total water potential of Tamil Nadu would be about 4.74 MHM i.e., 2.50 MHM from surface water and 2.24 MHM from groundwater sources. (Working Group on the Estimation of Groundwater Resource, 2000). The entire surface water and more than 60 per cent of the replenisible ground water is harvested and utilized. More than 90 per cent of the water is used for agriculture and the demand is still increasing responding to the need to produce more food for the growing population. Irrigation in the State has traditionally been the largest consumer of water and continues to be so. It consumes about 85 per cent of the available water resources at present and much attention should be given on the agricultural water need, its present and future utilization pattern etc. The State's endowed irrigation potential in per capita terms only about 0.08 hectare compared to all - India average of 0.17 hectare (Season and Crop Report, 2002).

At the same time, the water demand for industries and municipal purposes are also increasing every day. The domestic and industrial uses of water at present claim a share about 15 per cent in the total resources and this share is likely to be about 25 per cent in the year 2025 AD with increased industrialization, urbanization and growing needs of rural areas for improved facilities for drinking water.

Limited groundwater replenishment along with heavy power cuts has characterized groundwater use during years of poor rainfall. Additionally, private exploitation of groundwater by numerous individual farmers has tended to result in the indiscriminate and unregulated proliferation of wells and, consequently, a decreased water table in several regions of the State. Since the available water supply is constant, it has to be shared by various users in an optimal way and this has assumed very significance at present in the state (Indian Water Resources Society, (IWRS), 2000). However, with the growth of population, improved economy, increased urbanization, high degree of industrialization and most importantly the need for sustainable environmental and ecological management, there is multiple and serious competition for water from high value non-agriculture sectors. Therefore, the rapidly growing urban and industrial water demands will need to be met increasingly from water transfers out of irrigated agriculture. This inter-sectoral transfer of water is now one of the major water issues in Tamil Nadu.

The Bhavani Basin is one of the important basins in the State both in terms of agricultural and industrial development, intersectoral water transfer are prevalent in a large scale in urban and rural/industrial use. In addition, as urban areas and non-agricultural economy grow, water is allocated to high value. This rapid expansion reflects increasing signs of over-development of well irrigation and large-scale extraction of groundwater leading to overdraft coupled due to favorable government policies with respect to free electricity.

Methodology

Sampling Method

To find out the water transfer at farm level, random sampling procedure was adopted in the study representing Head, Middle and Tail regions of canal based on the location with respect to the distance from the Bhavanisagar reservoir (Table 1). From each each region, 50 farmers were selected using random sampling procedure. Thus the total size of sample was 150, consisting of 50 farmers in Head region, 50 farmers in Middle region and 50 farmers in Tail region.

Table 1 Region wise Distributions of Sample Framers

Sl.No	Region	Sample Size (Number of Farmers)
1	Head	50
2	Middle	50
3	Tail End	50
Total		150

Period of Study

The data collected were pertaining to the agricultural year 2001-02 ,field enquiries were made between June June 2002 and December 2003 and analysis of work were completed and submitted for Ph.D in May 2004.

Method of Data Collection

A reconnaissance survey for each region (Head, Middle and Tail end0 was undertaken with a view to assess the nature and extent of water transfer and productivity of water by such water transfer. To collect the required information an interview schedule was prepared, pre-tested and then used.

Results and Discussion

The existing rights are such that farmers are not restrictive for their water transfer. Competition for limited water resources increasingly occurs between different stakeholders and at different levels (Figure1) between farmers within an irrigation system; between irrigation systems in the same river basin; between the agricultural sector and other rural uses, such as fisheries or domestic water supply and drinking water; and more and more between agricultural and urban and industrial users and uses. The increase in demand will be higher for urban and industrial uses than for agriculture. Therefore, the rapidly growing urban and industrial water demands will need to be met increasingly from water transfers out of irrigated agriculture.

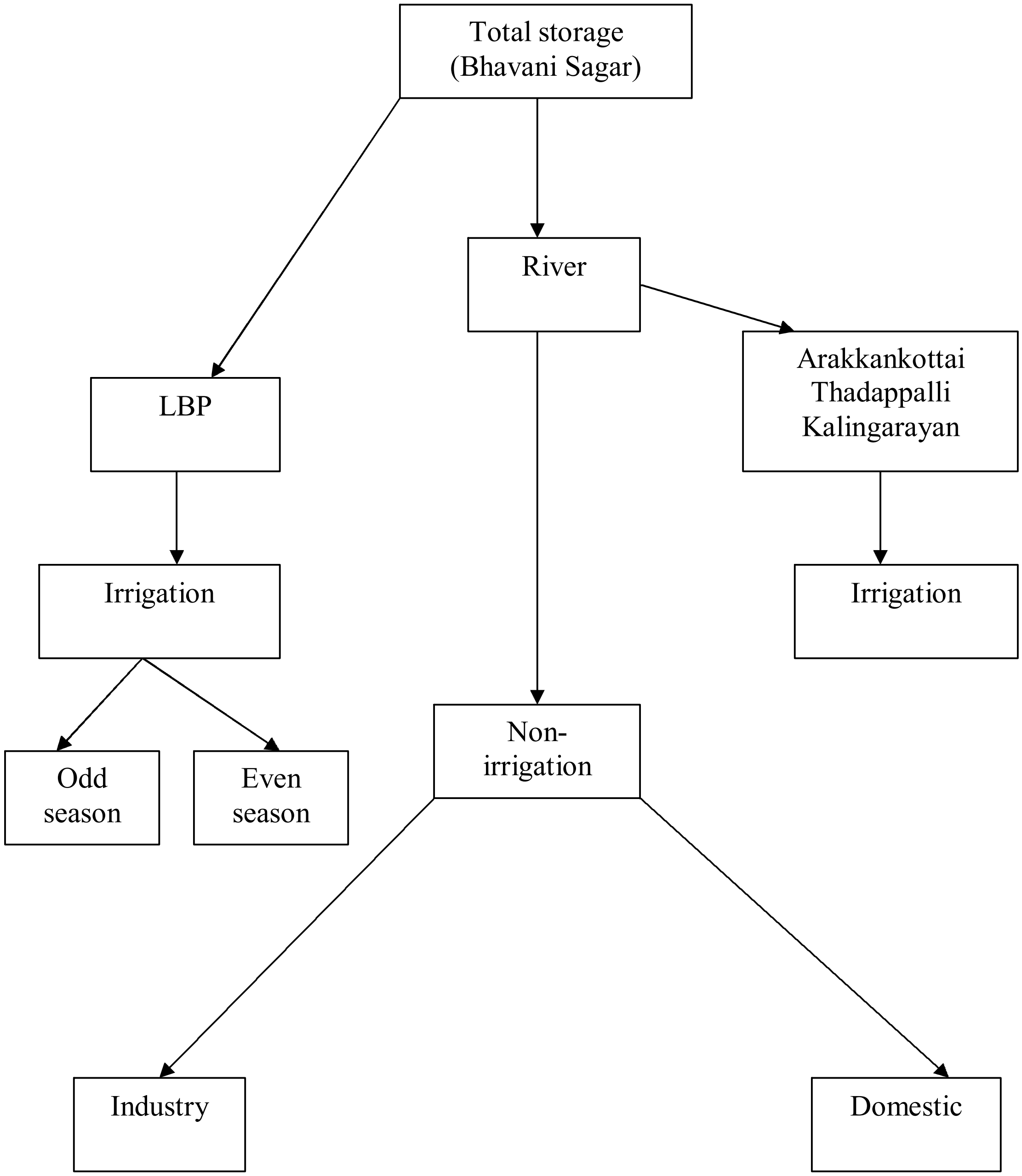

Figure 1: Flow of Water in the Lower Bhavani Basin

1. Surface Water in the Lower Bhavani Basin

The different source of the surface water schemes, water release in different canals and water availability of Bhavani basin are given in Tables 2. It could be noted from the table that the surface water quantity of all sources in the Lower Bhavani basin is 1516.12 MCM.

Table 2 Surface Water Resources of the Lower Bhavani Basin

Scheme / Canal	Ayacut area (ha)	Water availability* (MCM)
Old Ayacut		
Arakkankottai canal and Thadapalli canal	9800	599.97
Kalingarayan canal	6300	181.52
Ground Water Pumping scheme	8228***	**
Tanks	1984	12.97
New Ayacut		
LBP canal	83505	721.66
Total	101589	1516.12

Source: Executive Engineer, Erode and Bhavanisagar 2002.

Notes: 1. * Figures furnished for three old canal systems and LBP are 2001-02.

2. **Water availability under water pumping scheme reported here considers the direct water lifting from the rivers and canals and quantum of water available is not reported separately. It is included in the old ayacut canal system itself.

3. ***It irrigate non-ayacut area. So, not included in the total.

2. Groundwater Sources

The details of the ground water sources of the Bhavani basin are depicted in Table 3. The ground water sources indicated that number of electrified well has more at all level i.e. black, basin and non-command area level and its gross irrigated area was also large than diesel and without power wells.

Table 3 Sources of Ground Water Extraction at Different Levels

Particulars		Command area level	Non-command area level	Total
1.	Total no. of wells	52053	29260	81313
	a) Electrified	**43898**	**25055**	**68953**
	b) diesel engine	7744	3910	11654
	c) without power	411	295	706
2.	Net area irrigated (ha.)	41837	23739	65576
3.	Gross area irrigated (ha)	69675	35049	104724

Source: Calculated on the basis of figures provided by Assistant Directors of Statistics of Coimbatore and Erode.

3. Different Sectors Demand and Supply of Water in Bhavani Basin

The details of different sectoral water demand and supply are presented in Table 4. It could be seen from the table that in all the sectors water demand is higher than the supply except in inter basin domestic water supply (30.03MCM).

Table 4 Different Sectors Water Demand and Supply in Bhavani Basin (MCM)

Sl.No	Sectors	Demand*	Supply	Gap
1	Agriculture (MCM)	3283.56	2006.97	-1276.59
2	Domestic			
	(a) Intra basin	93.68	51.01	-42.67
	(b) Inter basin	92.54	133.25	+30.03
3	Industry (MCM)	39.15	39.15	0.00

*** 40 per cent irrigation efficiency level**

4. Water Market

Large numbers of farmers, who have their land along with the Bhavani river course are engaged in lifting water from the river. In some cases, farmers who have lands far away from the river also are engaged in water lifting. These farmers owning cultivated lands in far off locations from the river course, buy small pieces of land usually around five to ten cents nearby the river in which they dig wells, lay pipelines to their holdings and pump water. Farmers lift water either directly from the river or from dug wells established by them in the river side. If lands are located near the river bank, they will set pumpsets individually. If lands are located within a reasonable distance, then they will jointly engage in lifting water, because of high establishment and running costs. This practice is illegal, because wells within 200 m of the river are considered to be recharged directly from the river. Thus, pumping from these wells diverts water to which the pump owner has no rights. The pucca well constructions are made with reinforced concrete and conduits are laid from them to the interior fields. PVC, GI, and HDPE pipes of large dimensions are used. Farmers use both electric motors and diesel engines to lift water. In most cases farmers use diesel pump sets in these types of operations, although some use electricity by transferring their existing electric connections to the new wells. This practice further compounds the illegality of river pumping: Selling water from pumps that use electrical power is prohibited because electricity is provided free for direct agricultural purposes only. Despite the illegality of the practice, farmers/pumpers often simply pay the necessary penalties and continue the water selling business, which generates more than adequate revenues to cover the modest fine.

This lift irrigation exists both in upstream (Mettupalayam taluk of Coimbatore district) and downstream (Erode district) of Bhavanisagar. In the case of electric pump sets, the horse power used to lift water varies from 5 to 15. Most of the farmers use 5 HP electric motors. In the case of diesel engines, it varies from 2.5 to 10 HP. Most farmers use 5 and 10 HP diesel engines.

In 1990, water pumping from river was allowed as authorized activity. The authorization was given to patta land owner. These patta landowner paid water charge (Rs 150 for wet crops) to revenue department like others and was not needed to give any extra rupee to revenue department for water pumping activity. Due to non-extra payment to authorization pumping, every landowner wanted to take water from river and got authorization (G.O.3339/12/12/1962). Now, in the upstream of Bhavanisagar, the authorized 845 farmers lift water with the help of electric motors and diesel engines to irrigate 1023 ha land. In the downstream of Bhavanisagar, the authorized 1012 farmers in Sathiyamangalam, Gobichettipalayam and Bhavani taluks set diesel engines and electric motors to lift water. By the water pumping in downstream irrigation they irrigate 2691 ha land. The total authorized river-pumping irrigation 3714 ha and quantity of water pumped 31.38 MCM.

The authorization of water pumping activity in head and middle regions of river had affected the tail end farmers resulting in government stopping the authorization process. Hence, unauthorized river water pumping arisen. The details of numbers, area under irrigation through authorized and unauthorized driver pumping and quantity of water pumped from river are indicated in Table . From the table, it can be seen that 2921 numbers lift water directly from river by authorized or unauthorized and 49.36 MCM of water was lifted. Hence, 8228 ha is irrigated in non-command area in the basin by river water pumping.

Table 5 Number and Area under Legally Approved and Unapproved Pumping

Sl. No.	Nature of Water Pumping	Number of farms	Area Covered (ha)	Quantity of Water Pumped (MCM)
1	Legally Approved Ground Water pumping	1,857	3714	31.38
2	Legally Unapproved Ground Water Pumping	1,064	4514	17.91
	Total	2921	8228	49.36

Source: PWD Department, Erode, Survey data.

5. Cost of Water in Agricultural Sector

In agricultural sector, there are cases i.e. water pumping in field itself or pumping from 1-3 km distance from river by authorized or unauthorized. The cost difference between these two cases was in pipe cost (water transfer to long distance) and well cost. The cost of pumping of one kilo liter of water is given in Tables 6. It could be seen from the tables that in case of water pumping from long distance of river, the cost of pipe for 1 km distance was Rs. 122500 at Rs.35 per feet and well cost Rs.41000 was incurred and these two costs in the case of field itself water pumping, water transfer pipe cost was nil and well cost was Rs.95500 (Tables 6). The average cost of 1 KL of water was Rs.3.54 in pumping scheme from to river and Rs.2.53 in water pumping.

Table 6 Cost Analysis of 1 Kilo Liter Water pumping from 1 km Distance from River

Sl.No		Amount
1	Well (200 ft) at 70 /ft cost Rs.	14000
2	Pipe for 200 ft well at Rs.35/ft	7000
3	Wiring and labour fitting cost	20000
4	Pipe for 1 Km distance field Rs.35/ft	122500
5	Total Cost of well (Rs.)	163500
6	Land value of 5 cent near to river at Rs.3000 / cent	15000
7	Average life of wells (Years)	30
8	Assumed land duration (Years)	100
9	Average life of electric motors (Years)	15
10	Age of well/electric motor (2003-year of construction)	1
11	Interest rate @ 12 per cent	0.12
12	Cost of Electric motor and accessories (Rs.)	24000
13	Electric motor and accessories (hp)	5
14	Compounded cost of well (Rs.)	183120
15	Compounded cost of land	16800
16	Compounded cost of motor & accessories (Rs./year)	26880
17	Annualised cost of well (Rs./year)	22733.19
18	Annualised cost of land (Rs/year)	2016.024
19	Annualised cost of motors (Rs./year)	3946.636
20	Total annualised cost (Rs./year)	28695.85
21	Total hours of pumping(hrs/day for 300 days)	1200
22	Energy consumption (kwh)	4476
23	Quantity of water pumped M3	15120
24	Labour cost in rupees per year(@Rs.70/day)	10500
25	Maintenance cost (Rs/year)	480
26	Electricity cost (Rs.3.1/kwh/year)	13875.6
27	Total irrigation cost (Rs.3.1/kwh/year) case	53551.45
28	Total cost in field itself case	51535.42
29	Cost of water pumping scheme (Rs./M3 of water)	3.54

Assumptions

Interest rate is 12 per cent

Amortized cost of well = [(Capital cost of well) $*(1+i)^{AL} * i] \div [(1+i)^{AL}-1]$

Where

AL = Average life of wells

Constructed during 2002 I.e. age of well is 1 year

6. Cost and Profits of Different Operator in Water Market

The details of the profits and cost of different type of operators in the inter-sectoral water transfer are given in Table 7. It could be observed from the table that Bullock operators got profit Rs.75 per kilo liter than other operators in normal period and it was doubled during peak demand.

Table 7 Cost and Profits of Different Type of Operators in the Inter-Sectoral Water Transfer

Sl.No	Operators	Incurred Cost Rs / 1000 liters Water	Net Profits Rs / 1000 liters Water
1	Farmers	6.68	8.15
2	Tankers	15	39.85
3	Barrel	60	40.74
4	Bullock	100	75.00

The total water transfer in Bhavani basin in different forms is given in the following Table 8. Inter state water transfer from Bhavani to Kerela at Mukkali is in progress. It is not approved by Cauvery basin authority in which Bhavani basin comes under.

Table 8 Total Water Transfer in Bhavani Basin in 2002-03

Sl.No	Activites	MCM
1	Water Transfer by Government Schemes for Drinking	184.26
2	Water Market by farmers domestic /industries a)Lean season b)peak season	 17.24 54.18
3	Industrial Transfer by authorized owner	39.15
4	Authorized and Unauthorized Water lifting to agricultural	49.36
5	Inter state transfer *	30.35
6	Total Water Transfer	309.73 or 346.67

*to be transfer in future at Mukkali, Kerala

Source: PWD, Bhavanisagar dam, PWD,Erode and other records

It could be seen from the table that the total water transfer is 309.73 MCM in lean season and 346.67 MCM in peak season. This water transfer from the river and canal to other purposes of ayacuts and non-ayacut is equal to one year water release to

Kalingarayan water (283.13 MCM) or one dry season water release in LBP (340 MCM). So, one season crop production quantity of yield was zero. It will affect in terms of income and livelihood of the farmers.

7. Energy Use as Free in Agriculture

In Tamil Nadu, Government gives electricity as free to farmers. In Bhavani basin the number of electrified wells is 43,898. The well failure is common in Tamil Nadu. Assume that 40 per cent of the well is only functioning in the basin then the total number of well benefited by the free electricity policy is 17559. Average horse power water pumping motor using is 5 Hp. Average working of pumping hours per day is 4 hours. The average working days of well in a season (90 days based on paddy duration) is 10 days. The details of the free energy units given by government to farmers for agriculture are given in Table 9.

Table 9 Energy Use as Free in Agriculture

(Units/Season/Basin)

Sl.No	Particulars	
1	Total no of wells	43898
2	40% Well functioning	17559
3	Hp	5
4	Average Working Hours / day	4
5	KWH as free/well/day	15
6	Average working days/well / season	10
7	Average energy use as free/well/season	150
8	Average energy use as free / basin/season (M . Unit KWH)	2.63

It could be observed from the table that per well per season free energy consumption units are 150. The total energy units as subsidy are 2.63 M units as free of electricity.

8. Energy Use as Free in Water Market in Bhavani Basin

Farmers or individuals transferred water from farm wells to domestic sectors. The number of tanker trips on a given day depends upon the price of water as well as demand.

Farmers sold water for Rs.15 per 1000 liters and Rs. 200 per tanker (13500 liters), and tankers would sell it for about Rs.60 per 1000 liters and Rs 800 per load. One kwh power in 5 minutes was needed to fill the 1000 liters. Farmers incurred cost in electricity to pump water is Zero due to government policy (Table 10). Depending upon demand, farmers may increase their rates during some seasons to Rs.40 per 1000 liters and Rs. 540 per load. Because farmers own both the land and the well, they face no authorized constraint in pumping out well water to sell, and, the government does not interfere in the process. The details of energy used as free are presented in Table 5.16 and Figure 5.4.1. It could be seen from the table that 1,74,33.0 kwh and 2,75,53.7 kwh of electricity gives as free in lean and peak respectively.

Table 10 Energy Used as Free in Water Market in Bhavani Basin

Sl.No		MCM	MLD	Liter	KWH
1	Authorized and Unauthorized Water Transfer to Non Ayacut	49.36	127.10	12709711	12709.7
2	Water Market Lean Season	17.24	47.23	4723333	4723.3
3	Water Market in Peak Season	54.18	148.43	14843978	14844.0
Total					17433.0 or 27553.7

9. Water Vs Energy Crops in the Basin

The water productivity was calculated in energy crops based on the number of irrigations and depth of irrigation for energy crops at 40 per cent efficiency level. This was also compared with the water market profit per 1000 litre (Tables 11).

Table 11 Water Productivity in Energy Crops in the Basin

Sl.No	Crops	Yield Kg/ha	Water used (mm/ha)*	Average Productivity of water (kg/mm)
1	Sugarcane	150000	6250	24.00
2	Jatropa	3750	3000	1.25

* 40 per cent efficiency level

It could be seen from the table that the sugarcane yield was 2.4 kg/ 1000 litre. The yield of jatropa in the 3rd year was 0.13 kg / 1000 litre. Therefore, the gross income was Rs 2.60 and Rs 0.65 at the rate of Rs 1.10 and Rs 5 per kg of government support price of sugar cane and jatropa respectively. Jatropa crop 4 kg seed yields 1 kg of oil. It gives gross profit 25 from oil and Rs 12 from cake. Hence, total gross profit Rs 37 from 4 kg of seeds for that farmer incurs Rs 26. The net profit only Rs 11after 3 years. This is reason for farmer not ready to grow energy crops in water scarcity. But in water market in the area, farmer got net profit Rs 8.15 per 1000 litre in 1 hour.

10. Consequences of water Transfer in the Lower Bhavani Basin

The cropping pattern depends mostly on a host of factors like soil characteristics, irrigation, rainfall distribution etc. Farmers changed their water intensive crop to dry crop due to water scarcity through water transfer. The details of substitute crop in sample farms were given in Tables 12.

Table 12 New Cropping Pattern in Lower Bhavani Basin

Sl.No	Crop	Area in 1990 (ha)	Present Area (ha)	% Change
1	Paddy	29807.48	25188	-18.34
2	Sugar cane	7750.89	6300	-23.03
3	Banana	948.5811	933	-01.67
4	Turmeric	4847.271	3331	-45.52
5	Groundnut	8063.91	10304	21.74
6	Cotton	1747.53	3360	47.99
7	Pulse	1599.88	1702	06.00
8	Gingelly	5286.9	3000	-76.23
9	Tapioca	805.9275	2205	63.45
10	Maize	3313.44	2496	-32.75
11	Chollam	3856.8	3000	-28.56
12	Coconut	6254.675	5150	-21.45
13	Others	41055.86	34620	-18.59
Gross Cropped Area		115339.10	101589	-13.54

Source: Joint Director of Agriculture, Coimbatore and Erode.

It could be seen from the table that there was marked difference between last 10 years in terms of percentage area under varies crops. V. puthupalayam village in Kodumudi block, Karattatipalayam village in Gobi block and Koombupalam village in sathy block of old ayacut areas were grown only one season of paddy instead two seasons due to water scarcity. It could be seen from the table that in all blocks tapioca (63.45 %) and cotton (47.99 %) was substituted for water intensive crops such as paddy (-18.34 %), sugarcane (-23.03%) and Banana (-1.67).

11. Consequences on Well Ownership in Lower Bhavani Basin

The details of well ownership of the three regions are presented in the in Table 13.

Table 13 Pattern of Well Ownership in Sample Farms of the Basin

(No. of wells/farm)

Regions	1990-91			2001-02		
	Open well	Dug cum Bore	Bore well	Open well	Dug cum Bore	Bore well
Head	1	0	1	1	1	2
Middle	2	1	1	2	1	2
Tail end	1	1	1	1	2	3

It could be seen from the table that the average number of open wells owned was 1, 2 and 1 respectively for Head Middle and Tail end regions farmers during 1990-91 and also same for Head, Middle and Tail end during 2000-2001. Because open well without bore was not viable to irrigate in water scarcity period. It is interesting to note that the number of bore wells owned by all regions of farmers has increased over a decade (from 1, 1, 1 respectively for Head, Middle and Tail end to 2, 2 and 3 respectively Head, Middle and Tail end). Declining groundwater table due to over exploitation of groundwater force the farmers to go for installation of new bore wells.

12. Effects on Well Working Hours and Depth in Middle and Tail End Region

The details of well average depth; horsepower and working hours per day were presented in Table 14.

Table 14 Average Depth of Wells and Pump Horsepower of Sample Farmers in Middle and Tail End

Particulars	1990-91			2001-02		
	Average depth (ft)	Hp	Working hrs /day	Average depth (ft)	Hp	Working hrs /day
Open well	75	5	24	85	10	18
Dug cum Bore	100	5	20	165	12	10
Bore well	200	5	22	450	7.5	7

It could be seen from the table that the power of electric pump is generally dictated by two factors such as what horsepower is available (the minimum pump size is 3 HP) and what is needed to draw groundwater to the surface. For instance, Middle and Tail end may be forced to install a larger pump than is economically justified by the area they do cultivate, but larger horsepower of pumps may be a necessity in areas where water table is too deep. It is evidenced that the average size of horsepower of electric motors has significantly increased over the periods in Middle and Tail end. In case of Head region there was negligible change happened in the same periods. Working hours of pump per day was decreased from 22 hours to 7 hours.

13. Average Water Use in the Sample Farms

The water use was calculated based on the number of irrigations and depth of irrigation for various crops. This was also compared with the experimental station results (Tables 15)

Table 15 Water Use of Different crops in the basin

Sl.No	Crops	Experimental Water Use(m)	Farmers Water Use (m)		
			H	M	T
1	Paddy	1.3	1.4	1.2	0.9
2	Sugarcane	2.1	2.4	2.0	1.7
3	Turmeric	1.5	1.7	1.5	1.4
4	Groundnut	0.6	0.7	0.6	0.4
5	Maize	0.4	0.6	0.6	0.4
6	Cotton	0.6	0.7	0.8	0.5

Among the different regions of the basin, the shortage was more fell in the tail region. It is seen from the table the water use has been reduced by 30% for rice, 19% for sugarcane and 6% for turmeric indicating the serious of the water shortage.

Summary and Policy Conclusion

1. Due to free energy of government policy and absence of supply chain in biofuel, farmers is not ready to cultivate biofuel crops in this basin.

2. The decline of water table and the increase in depth of wells were relatively higher in this basin. This is of significant importance in the sense that if the present rate of exploitation of ground water then the present kind of farming practiced may not be sustainable in terms of ground water availability. The constraint of limited water availability in their wells with farmers in tail end forced them to reduce the number of irrigation.

3. On the effect of water withdrawal side, study found that there was considerable reduction in crop area, crop yield and agricultural income per hectare due to water scarcity and hence the government has to play a decisive role in water allocation of ayacut area by elimination of unauthorized water withdrawal and put charges for energy consumed in agriculture.

Reference

Malaisamy,A,” Water Rights, Present and Future Water Demand and Consequence of water Transfer in Bhavani Basin, Ph.D thesis submitted to the department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore,2004

Ministry of Water Resources, Govt. of India, **The Standing Sub-committee**, 1998

IWRS, **“ Human Issues Income in Water Resource Development’** Theme Paper, Water Resource Day, Indian Water Resources Society,2000

IWRS, **“Management of Floods and Drought”,** Theme Paper, Water Resource Day, Indian Water Resources Society

Palanisami, K. and N.Murali, "Allocation of Water Among Competing Users – Interaction Between Agricultural and Non-Agricultural Sectors" in K.Palanisami, Nagarajan Murali and A.Mohamed Ali (Ed.), "**Economics of Irrigation Planning – Application of Simulation Models**", TNAU-WTC-SARP Publication, September, 1995.

Season and Crop Report, Government of Tamil Nadu, 2002.