IRRIGATION MANAGEMENT AND ITS EFFECT ON PRODUCTIVITY UNDER PARAMBIKULAM ALIYAR PROJECT IN TAMIL NADU *

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Abstract

While at the national level, area under surface irrigation has been increasing, in Tamil Nadu, it has been declining. There is an increased reliance on groundwater sources of irrigation. This highlights the need for improving quality and reliability of canal irrigation in order to increase net irrigated area and improve water productivity in agriculture. In surface irrigation systems, where scarcity in supply is experienced, conjunctive use of groundwater helps to achieve better yield. However, in larger surface irrigation, which supplies water to dry crops – there is a need to assess the effect of conjunctive use in different segments of the command taking into account several other factors such as climatic conditions, local rainfall and sub surface geology. This is because not all parts of the command area get adequate supply, which in turn leads to poor recharge of wells. The paper looks at conjunctive use for irrigation management in the Parambikulam Aliyar Project in Tamil Nadu.

1. INTRODUCTION

Irrigation continues to draw around 4/5 of the total water available in India. India's net sown area is around 141 million hectares and the net irrigated area is about 55 million hectares. This is nearly 40% of net sown area. Given the acute shortage of land for cultivation, India must concentrate on increasing the area under irrigation to improve land and water productivity. Successive Five Year Plans have played a prominent role in expansion and improvement of irrigation by facilitating direct investment through public sector. During the Nine Five Year Plan periods from 1950-51 to 2001-02, India invested a total of Rs. 1556 billion in irrigation (GoI. PC. X FYP. Vol. II. 894).

Although investment and area under irrigation have increased over time, sustainability across states is questionable. In absolute terms while canal irrigation in India has been gradually increasing, in Tamil Nadu it has been decreasing. In Tamil Nadu, the area irrigated by canals decreased from 8.4 lac hectares during 1950-69 to 7.1 lac hectares during 1990-04. During the same period, area under tank decreased from 8.5 lakh hectares to 5.1 lac hectares. However, in the same period the net area under well irrigation more than doubled from 5.7 lac hectares to 13.7 lac hectares (Table 1). There are no other sources of irrigation in Tamil Nadu. Combining all sources, the total area under irrigation was 26 lac hectares during 1990-04. The share of net irrigated area to net sown area was 39% for all-India, whereas, the same for Tamil Nadu was 48%. More importantly, although Tamil Nadu has reached a higher percentage of net irrigated area to net sown area, it has already reached its maximum potential. Any further increase in the net irrigated area can be possible only through increasing the efficiency of water use, especially in the surface sources.

In Tamil Nadu, the rapid growth and relative importance of groundwater as a source of irrigation demonstrates the progressive improvement in the quality of irrigation in terms of assured, adequate and timely supply of water to crops. Especially in the surface irrigation systems where scarcity in supply is experienced,

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1. The wells located in the poor surface supply region are less reliable than those located under well-fed region.

2. There are numerous studies on the impact of irrigation on land use, cropping and productivity, but they seldom deal with institutional aspects. The available literature is reviewed in Vaidyanathan 1985.

conjunctive use of groundwater helps to achieve better yield. However, in larger surface irrigation, which supplies water to dry crops – there is a need to assess the effect of conjunctive use in different segments of the command taking into account several other factors such as climatic conditions, local rainfall and sub surface geology. This is because not all parts of the command area get adequate supply, which in turn leads to poor recharge of wells[1].

Comprehensive studies of the way surface irrigation systems are managed and the relation between management and productivity are rare[2]. There is good reason to believe that centralized bureaucratic management with little or no user participation leads to inefficient irrigation, which contributes to poor quality of irrigation provided by state run systems. This has long been emphasized in irrigation management literature (see Coward, 1980; Downing and Gibson, 1974). Recent studies underscore this point even more forcefully (see Chambers, 1988; Vaidyanathan, 1991; 2006; Sengupta, 1991; Ostrom, 1992; GoI, 1992; IIMI, 1994, Sivasubramaniyan, 1985, 2007). In India, concrete studies or even descriptions of the way water is managed in different types of surface systems are relatively few. Even few studies are mainly concerned with the institutional aspects and not with systematically exploring variations in management practices across different systems, and what effect management, as distinct from other factors, has on productivity (Vaidyanathan and Janakarajan, 1989).

This paper seeks to get a proper understanding of the impact of canal irrigation on productivity. Its distinctive feature is to provide analytical information on present status and detailed account of the changes that happened in the Parambikulam Aliyar Project (PAP) command and the sample blocks with comparable concepts and schedules as used 20 years ago. The changes are analysed in terms of allocation of supply in different canals, water distribution and management among blocks at field level and changes in cropping pattern and productivity. Such diachronic studies of the same group are rare.

1.1 Study Area and Methodology

The Parambikulam Aliyar Project (PAP) in which the study was undertaken is an inter-state multi-valley and multi-purpose project. It was commissioned in early 1960s and started functioning from mid-1960s with an initial annual command area of 80,000 acres[3] and increased to 4.3 lakhs in the mid 1990s. From 1995-96 onwards the government introduced a four-zone irrigation pattern in the overall command area of 4,31,000 acres served by the PAP. Further, in order to distribute the canal supply fairly in the command a new distribution pattern called the Alternate Sluice Irrigation System (ASIS) was introduced in August 2000. Under the ASIS the command area can get its irrigation supply once in two years by rotation. Further, the PAP follows a cropping system of "irrigated dry crops" which entails irrigation of a larger area with a given quantity of water.

The study of irrigation impact on productivity has been done at three levels. First, by documenting the characteristics of the PAP system and its management as a whole, the way it was designed to work and the way it actually works and the way the deviations have been accommodated. Second, by obtaining a meso-level picture of the working of institutions and water allocation in the 12 selected distributaries of the PAP system (see flow chart). Third, by conducting a micro level enquiry of the entire sample cultivators in the representative sample of 100 blocks served by the selected distributaries.

The paper is organized in five sections. Following the introduction, section II provides detailed information on the methods of water distribution in PAP at farm level across selected distributaries in the latest two spells. Section III briefly discusses the cropping pattern adopted in the PAP command in the last three years preceding the survey. Section IV analyses the outcome of cropping in terms of productivity across zones in spell and non-spell years. Final section provides the summary of the earlier sections.

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[3]. This area increased to 2,40,000 acres in mid-1980s to be irrigated once in 18 months with a three zone irrigation pattern and a further increase of 1.75 lakh acres permitted up to 1994-95. [1]

2. BLOCK LEVEL MANAGEMENT OF WATER DISTRIBUTION

In any irrigation system the final outcome in terms of crop productivity depends upon how best the irrigation system and its distribution networks are maintained and water distribution is effectively managed in all parts of the command. Let us first discuss the distribution of water in the PAP command. The responsibility of water allocation up to main/branch canal is vested with the Public Works Department (PWD). Within each distributary, the right for maintenance of channels and distribution of water solely rests with the Village Water Users Association (VWUA). By taking into account the total command area under all sluices in a distributary the quantum of supply required is decided by the PWD officials and the office bearers of the VWUA. Throughout the length of each distributary, several sluices are located. Each sluice serves many blocks under it. Based on the total command area available in each block and the number of days of water release from the main/branch canals to the distributary, suitable rationing system is followed. Mostly this is based on the number of hours water could be supplied per acre in a day. This could be multiplied by the number of days of water release from the main/branch canal.

In almost all the blocks hour based murai[4] system is followed and adjusted among farmers based on the extent of command area available in each block (Table 2). Within each block, the responsibility for construction and maintenance of field channels and regulation of water distribution rests wholly with farmers. In all distributaries and in all blocks surveyed, there appears to be a well-defined system of field channels for carrying water to individual plots, with more or less fixed alignments. The area under the channels is individually owned and managed. The channels are all unlined. During spell period, all farmers cleaned these channels individually as per their cultivation limit. This process has been working smoothly throughout the PAP.

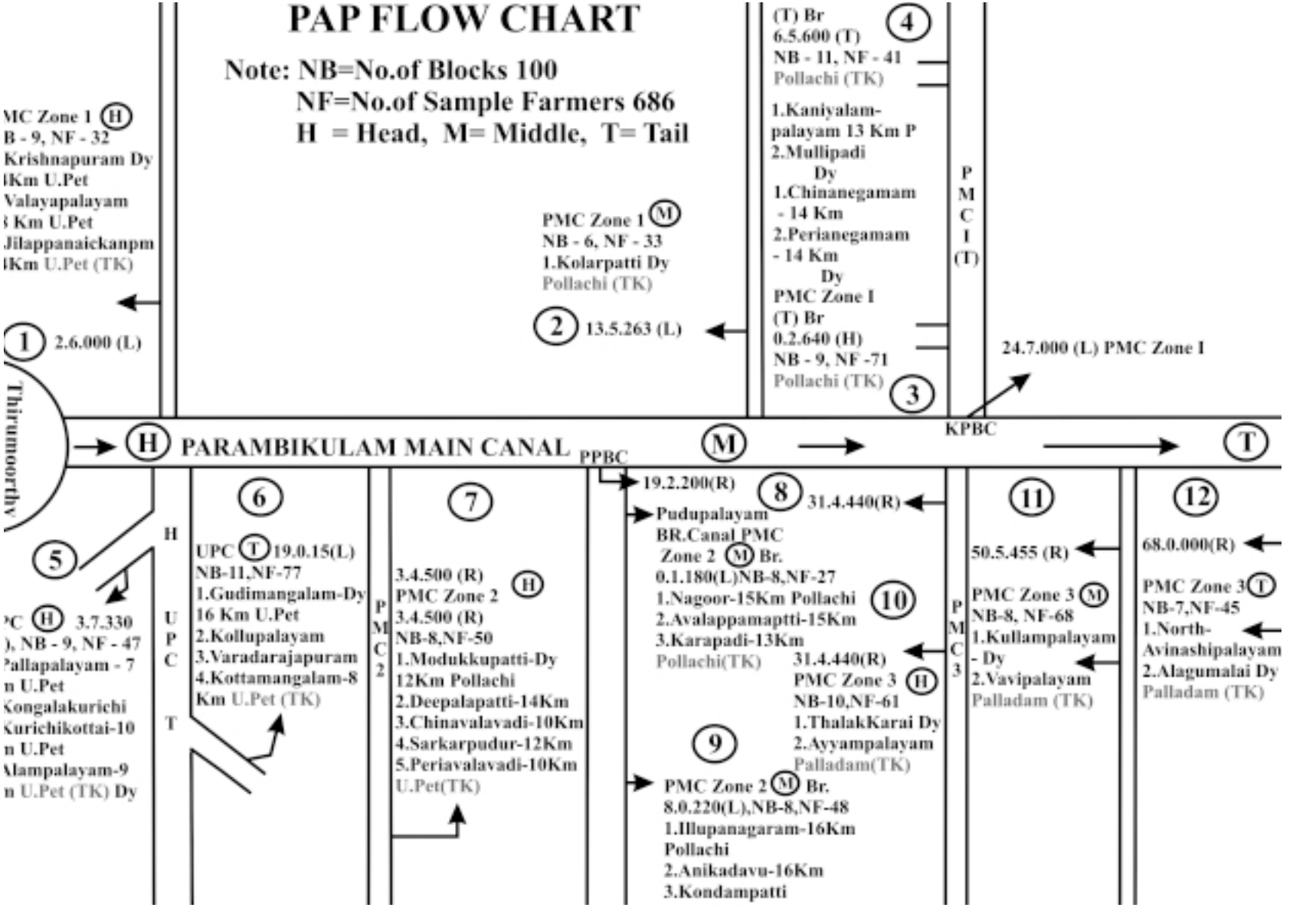
Within the block, one can observe a wide variety of sharing arrangements with specified rules as stipulated by the VWUAs. These are supervised by the Territorial Committee Members (TCMs) as and when required. As shown in Table 2, most distributaries get the canal supply for 7 days in a turn of 21 days duration (7 days supply 14 days off). In a few other distributaries, especially in the Udumalpet canal[5], farmers get 10 days supply but those distributaries are split into two and provide irrigation 5 days each in turn. This arrangement ensures adequate supply to the tail end blocks. This pattern is followed, where the distributary's intake point as well as the breadth and depth is less than the required level. Apart from adopting this general distribution pattern farmers also follow some other pattern.

For instance, the total command area in a block is 21 acres. Water is released for 7 days in the distributary. Hence, supply hours per acre is 8. This is the theoretical calculation. However, in practice the following procedure is adopted for water distribution. As per the turn, each acre is given first 2 hours per day: (a) If a farmer owned only one acre he could use 8 hours supply during the turn. But the actual supply allotment is only 2 hours per day. Hence he can irrigate only (120/480=25 minutes) ¼ an acre during the first round of the turn. (b) If a farmer owned more than one acre of land in the command, say 4 acres, it is easy for him to irrigate 1 acre fully by the allotted time of (4X2) 8 hours supply in the first round. Accordingly, during the first turn of 7 days supply each farmer gets 4 rounds of supply (with 2 hours each). The exact duration of supply given depends upon the possession of holdings in the command area by a farmer. The most important point is, whether the entire area has been irrigated or not depends upon the quantity of supply released in the distributary and the farmers' ability to supplement their well water along with the canal supply.

In a few other blocks of the 3.4.500 distributary, when enough supply was available 6 hours supply per acre per turn was allotted. When deficit supply was reported, the supply was reduced to 4 hours per turn to all farmers. If one round supply was over and still the supply continues a second round of further 2 hours supply per acre was allowed. This turn system facilitates the utilization of well water to irrigate the command in the initial supply period and adjust the PAP supply to provide more water to non-well farmers to crop their land fully initially.

[4] A time bound system of water rationing adopted at block level both in normal and deficit supply periods to share the canal supply either equitably or fairly to all farmers within each block by the direction of VWUA.

[5] This canal takes off from the PMC at mile 0.6.000 and serves about 58,000 acres in 4 zones.


PAP FLOW CHART
Note: NB=No.of Blocks 100
NF=No.of Sample Farmers 686
H = Head, M= Middle, T= Tail
MC Zone 1 H
B - 9, NF - 32
Krishnapuram Dy
Km U.Pet
Valayapalayam
Km U.Pet
Jilappanaickanpm
Km U.Pet (TK)
1
2.6.000 (L)
Thirumoorthy
PMC Zone 1 M
NB - 6, NF - 33
1.Kolarpatti Dy
Pollachi (TK)
2
13.5.263 (L)
(T) Br
6.5.600 (T)
NB - 11, NF - 41
Pollachi (TK)
4
1.Kaniyalam-
palayam 13 Km P
2.Mullipadi
Dy
1.Chinanegamam
- 14 Km
2.Perianegamam
- 14 Km
Dy
PMC Zone I
(T) Br
0.2.640 (H)
NB - 9, NF -71
Pollachi (TK)
3
PMCI (T)
24.7.000 (L) PMC Zone I
KPBC
H
PARAMBIKULAM MAIN CANAL
PPBC
M
T
5
C H 3.7.330
), NB - 9, NF - 47
Pallapalayam - 7
n U.Pet
Kongalakurichi
Kurichikottai-10
n U.Pet
Alampalayam-9
n U.Pet (TK) Dy
H
UPC T
6
UPC T 19.0.15(L)
NB-11,NF-77
1.Gudimangalam-Dy
16 Km U.Pet
2.Kollupalayam
3.Varadarajapuram
4.Kottamangalam-8
Km U.Pet (TK)
PMC2
7
3.4.500 (R)
PMC Zone 2 H
3.4.500 (R)
NB-8,NF-50
1.Modukkupatti-Dy
12Km Pollachi
2.Deepalapatti-14Km
3.Chinavalavadi-10Km
4.Sarkarpudur-12Km
5.Periavalavadi-10Km
U.Pet(TK)
19.2.200(R)
8
31.4.440(R)
Pudupalayam
BR.Canal PMC
Zone 2 M Br.
0.1.180(L)NB-8,NF-27
1.Nagoor-15Km Pollachi
2.Avalappamaptti-15Km
3.Karapadi-13Km
Pollachi(TK)
10
31.4.440(R)
PMC Zone 3 H
NB-10,NF-61
1.ThalakKarai Dy
2.Ayyampalayam
Palladam(TK)
9
PMC Zone 2 M Br.
8.0.220(L),NB-8,NF-48
1.Illupanagaram-16Km
Pollachi
2.Anikadavu-16Km
3.Kondampatti
PMC3
11
50.5.455 (R)
PMC Zone 3 M
NB-8, NF-68
1.Kullampalayam
- Dy
2.Vavipalayam
Palladam (TK)
12
68.0.000(R)
PMC Zone 3 T
NB-7,NF-45
1.North-
Avinashipalayam
2.Alagumalai Dy
Palladam (TK)

It is evident that in almost all distributaries and blocks the farmers follow well-laid criteria and procedures for regulating the sequence and duration of irrigation to farms in the command. The commonly observed aspect is that in almost all distributaries PAP supply was inadequate even to raise dry irrigated crops. The only option is supplementing PAP water with well water wherever possible. Further, in a year, two PAP spells were possible; one in summer and the other in winter. The latter one was always considered favorable due to its coincidence with the northeast monsoon. However, spells given during drought years (between 2002 to 2004) are totally ineffective, including the monsoon spells.

The most interesting aspect of the PAP irrigation is that although each spell is given to a particular command once in two years, the command area farmers are not hesitant to receive the meagre supply lasting for only 30 to 35 days (intermittently) in a spell period of 135 days. This is the success of the PAP irrigation. Another interesting aspect is the conversion of coconut crop from wet to dry crop in the PAP command. This was possible mostly by adopting high-tech drip irrigation, for almost 80 to 90% of the entire coconut area. Only limited head reaches to PMC and farmers located close to main canals did not adopt this drip system.

3. CONDITIONS OF CANAL WATER SUPPLY DURING THE LATEST TWO SPELLS[6]

To understand the actual working of water allocation to the main and branch canals from the dam and its allocation to various distributaries it is necessary to have a look at the number of days of water released to the main and branch canals in each spell. Annually, based on the dam storage, two spells may be possible. The latest spell periods fell in the 12 distributaries under 4 zones during the years were 2004-05 and 2005-06. The last spell periods were 2002-03 and 2003-04. It should be noted that between these two spells the later was severely affected by drought. As a result, the number of days of supply released in the main and branch canals was reduced considerably, to around 30 days less than the normal spell period, which is 135 days (4½ months). In our reference periods, the maximum number of supply days in the latest spell is 94 and the drought spell is 66. Based on this information let us discuss the supply position in each of the selected distributary. The survey information is put down in summary form in Table 3. The conditions of water supply and mechanisms adopted by farmers to overcome the deficit supply in each distributary are given in Table 4.

The ASIS in the PAP is designed to provide canal supply to the lengthy distributaries every year, which have a command area of more than 1000 acres. In those distributaries, the command area is divided into two zones and supply is given to one zone each year. Accordingly, the zones are arranged as 1 and 3; and 2 and 4. For instance, a lengthy distributary is divided into zones 2 and 4, in which zone 2 may get the first spell in a year and zone 4 may get the first spell supply in the next year and vice versa. As a result, canal supply can flow in the distributary every year, which helps to recharge the groundwater through both the canal flow and its irrigation supply. This pattern, as perceived initially when the design was formulated, helps well farmers to sustain their supply throughout the year. However, it may not be feasible for small distributaries, which fall below 1000 acres command, which are classified under one zone and can get the canal supply only alternate year.

3.1 Supply Pattern in the PAP Canals and Distributaries

Since the timing of the spells differs from zone to zone, and the conditions of water supply vary from season to season, the experience of each zone is discussed separately. Annually, two zones get the PAP supply in normal dam storage period. For all 4 zones one spell takes 2 years. Each spell takes 4 ½ months (135 days), which irrigate an approximate command area of 94,000 acres. To better analyze the water supply conditions distributaries can be grouped in the following zones:

3.1.1 PMC zone 1

This zone has three distributaries. The latest spell started on 6 January 2006 and ended on 5 May 2006. The duration of the spell was 119 days, 16 days short of 135 days. However, actual supply days in the PMC

[6] Latest two spells: Latest and Last spells. The former represents the spell years 2004-05 and 2005-06 and the latter represents the spell years 2002-03 and 2003-04. A spell year accounts from June 1 to May 31.

Zone	Distributary sl. nos.	Latest spells	Quantity *	Last spells	Quantity
I	2,3 and 12	2005-06	17.292	2003-04	5.322
II	1,5,6,7, 8,9 and 10.	2004-05	13.200	2002-03	6.844
III	4 and 11.	2004-05	13.200	2002-03	6.844
IV	1,7 and 10.	2005-06	17.292	2003-04	5.322

Note: Distributary sl. nos. as per Table 3.

were 91 days and the same for the three zone 1 distributaries is between 38 and 42 days. 42 days supply, which gives six irrigation supplies during the 135 days period is considered normal. This is roughly based on the calculation of 7 days supply for one half of the zone, another 7 days for remaining half of the zone and next 7 days dam closure for irrigation and recharge of the dam. Except one distributary, which had 38 days supply, other two received normal supply in this spell.

During the 38-year period (1967-68 to 2004-05) the average supply of water released in both PMC and UPC was 13.152 TMCft per annum. If one divides this period into two and counts the average which indicates the first period (1967-68 to 1985-86), supply in both the canals was 12.826 TMCft and in the next period (1986-87 to 2004-05) the average quantum was 13.638 TMCft. Hence, it is probable to take the average of 13 TMCft as the normal supply for both PMC and UPC. Based on this calculation, if one analyses the supply given in the two canals during the latest spell year (2005-06), which indicates that although the supply days were slightly less than normal, because of adequate storage, the quantum of supply released was more than average (17.292 TMCft) which is nearly 4 TMCft more. Whenever the spell coincided with the dry season (January to May) the total supply realized and released may be less than that with the monsoon spell (August to December). Since the latest spell was considered normal, the sample farmers surveyed in all the distributaries expressed some satisfaction on the quantum of supply available. Of the 22 blocks covered in the zone 1 distributaries, 19 blocks got 'regular but not full supply', and 3 blocks got 'neither regular nor full supply'. Amongst the reasons for inadequate supply 8 blocks reported 'excess tapping in the upstream distributary' and 14 blocks revealed 'inadequate storage position' in the dam. Regarding effect on water supply on the crop, only a fourth of the blocks reported to change crop pattern and the remaining blocks 'managed the supply with well water'. This contrast is mainly due to the fact that the supply given to them during the previous spell was much worse. Hence on a comparative basis farmers viewed the supply in this spell as favourable. In addition, the quantum of main canal supply released in the latest spell was 28% more than the average.

The previous spell, 2003-04, which began on 11 December 2003 and ended on 21 January 2004 was, by contrast, a drought spell. Even in the main PMC the supply lasted only 27 days and the selected zone 1 distributaries each received only 12 days supply. Not only this zone, but all the 3 other zones were also severely affected in this previous spell period. The quantum of supply released in this spell year was 5.32 TMCft, (59% less than average). This was mainly due to continuous and severe drought in the entire state including this PAP command.

In zone 1 distributaries, all the 22 blocks reported received 'neither regular nor full supply' and majority of them informed that 'inadequate storage position' was the main reason for poor supply. As of crop effect, half the blocks reported complete crop failure, one third managed with well water and a quarter managed by changing crop pattern and by reducing crop area. More or less same effect was noticed for the other zone distributaries, especially for the last spell period. This effect was evenly distributed throughout the PAP because the dam storage itself dwindled considerably for two consecutive years and monsoon failed totally (for more details see Tables 3 and 4).

* Indicates the quantity of supply in TMCft released in the PMC and UPC. Three lengthy distributaries are divided into two zones each. Long-term average quantum of supply released from the Thirumurthi Dam was 13 TMCft per annum.

3.1.2 PMC zone 2

The latest spell in this zone started on August 20, 2004 and ended on December 31, 2004. This spell lasted 133 days which is only 2 days less than the normal period. Actual number of days supply available in PMC in this spell was 90 and for the Udumalpet canal it was only 71. Both the sample distributaries of UPC are also included in zone 2. Altogether 7 distributaries out of 12 selected come under zone 2. There are, however, significant differences between distributaries in terms of supply days, which are a minimum of 29 days in the tail distributary of PMC to a maximum of 50 days in the head distributary under the PPBC of PMC. In the remaining distributaries the supply days were between 33 and 45 (see Table 3). Although supply to all the distributaries was releazed in the last week of August 2004, the closing dates differed considerably; majority of distributaries were closed in the last week of December 2004, and two others were closed on 10th and 18th December 2004. This difference also makes variation in the total number of days supply given to different distributaries. The quantum of supply released in the PMC & UPC in 2004-05-spell year was 13.200 TMCft, which is close to the long-term average supply.

The location advantage of distributaries in getting supplies is clearly seen in this spell period. Not only the duration of spell was longer in the PMC (90 days) but also in the head reach distributary in the PPBC, which received a maximum of 50 days supply. However, in the same PPBC's tail end distributary received only 35 days supply. Apart from this, in UPC one can notice the location advantage between the head and tail distributaries. In this canal, the former distributary received 45 days supply compared to only 34 days to the latter. It is important to note that after the year 2000, no extension of supply was granted to any distributary. Even during continuous drought years the distribution and allocation mechanism did not change. This shows that the supply system has become rigid now. However, during severe drought years, some supply was released to local tanks for cattle needs and other purpose.

In terms of quantum of water supplied to the distributaries in both the latest and last spells, the data recorded in the respective section offices provide some interesting results. For a clear understanding, the data is modified in terms of the quantum of supply received per acre in the two spells. Of the 7 distributaries coming under zone 2, PMC feeds five and UPC feeds the remaining 2. As per PAP's irrigation pattern one TMCft can irrigate 12 acres of command. By adopting this norm the following points emerge (Table 5).

Even in the latest spell which was considered normal, all distributaries under PMC and the head distributary of UPC received less than the expected supply. Only the tail distributary of UPC received marginally higher quantum. In the latest spell, the percentage of deficit ranged from 25 to 46. It should be noted that the deficit increases steadily when one moves from head to tail distributaries in the PMC. However, this is reverse in the case of UPC. The number of turn supplies given during this latest spell was 5 in majority of the distributaries except in sluice numbers 3, 4 and 7. The latter two distributaries received a supply turn of 6 each and the former one received a maximum turn of 8 in that spell. Due to more turns, the number of days supply given was increased compared to all other distributaries. However, in the tail distributary (31.4.440) of PMC the number of turns given was only 4.

The last spell in zone 2 started on February 1, 2002 and ended on July 31, 2002. This spell was considered unsatisfactory. Since the spell started in summer, it had less number of actual supply days, which is 66 in PMC and 56 in UPC. The supply in this period was erratic. Whenever dam storage improved, supply was released. As a result, all 7 distributaries received only 4 turns. This resulted in poor supply to all distributaries and the deficit ranged from 20% in the head distributary of UPC to around 55% in the PMC distributaries. In one of the PMC distributaries, deficit was as high as 84%; but this was because only a limited number of farmers used the supply. Actual supply released in this spell year in PMC was 6.844 TMCft. This is only half of the average expected supply for a spell. Across distributaries, the number of supply days in this spell ranged from a minimum of 16 to a maximum of 27 under PMC and 27 to 51 under UPC distributaries. In the distributary, which had less number of supply days, farmers stopped receiving PMC supply in the middle of the spell itself and only limited number of farmers cropped the land. Again, in the head reach distributary (3.7.330) of UPC an unusually high number of days of supply were given. This is because in each turn more number of days of supply (which is 13 days) were given. However, the supply position was verified with the responses gathered

from the survey, which indicates that the given supply was neither regular nor full. As a result, majority of farmers reported crop failure. This situation was applicable to other distributaries also. This reveals that the data maintained by the PWD section offices cannot be wholly reliable, especially in the drought spells. This was also noticed in the earlier survey[7].

Due to poor supply given in this spell almost all farmers in all the blocks reported that supply was neither regular nor full. Majority of farmers felt that inadequate storage in the dam was the main reason for this deficit. Some farmers felt that this inadequate supply was caused by excess tapping in the upstream of the distributary. Due to poor supply, around half the respondents reported that their crop failed completely; one third of them managed the crop with well water; and the remaining reduced the crop area and changed the crop pattern.

Although supply was released, the number of turns was accounted, and the quantum of supply taken in a spell in each distributary was noted, it is not clear whether the given supply to all farmers in a particular distributary was enough in either of the spells. This is because the PAP supply was given with a long gap of at least 21 days even in normal spell. During drought spell, like this one, for months together there was no supply. In the block level interviews, all the blocks in all the distributaries in zone 2 reported neither regular nor full supply. This resulted in complete crop failure in most farms including well farms. Effect of wells in supplementing canal supply was also reported to be very poor except in the head distributary (2.6.000) of PMC.

3.1.3 PMC zone 3

The latest spell in this zone started on January 16, 2005 and continued up to May 26, 2005. The spell lasted for 130 days, 5 days short of 135 days. However, the actual number of days of flow available in the main canal was only 64 (see Table 3). In this zone only two sample distributaries exist. The first one is the tail end (6.5.600) of KPBC and the next is the tail distributary (50.4.445) of PMC. While the latter distributary received a supply of 26 days, the former received only 20 days. Although both the distributaries received 5 turns in this spell, the number of days supply in each turn varies widely between 2 and 7 in 6.5.600 and 2 and 10 in 50.4.445 distributary. Only in the first couple of turns, the number of days supply given was normal (7 to 10 days); after that each turn received less than 4 days supply. The other important measure, i.e., the quantum of supply received indicates that while 6.5.600 distributary received only a third of the entitled quantum, the tail distributary (50.4.445) received a little less than a half in the latest spell. As a result, the deficit was more than 50% in both distributaries (Table 6).

The last spell of this zone was even worse, which started on September 9, 2002 and ended on January 12, 2003. Although number of days counted is 125 – a shortfall of 10 days to normal – the actual flow in the main canal was only 57 days. Apart from that, the respective distributaries received the supply only for around 25 days. In each distributary, the number of turns supply was available was 4. However, the number of days supply given was maintained as 6 to 7 in each turn. In terms of quantum of supply received, the share of 6.5.600 distributary was only a fourth of the entitled supply and for 50.4.445 distributary it was 42%. In both distributaries the deficit was over 55%.

Of the 19 blocks surveyed in zone 3, only 3 blocks reported regular but not full supply in the latest spell. In all remaining blocks, the supply was neither regular nor full. All the blocks in the head reach and half the blocks in the tail reach reported excess tapping in the upstream distributary as the main reason for irregular and inadequate supply. Due to poor supply almost half the blocks in both distributaries resorted to reduction in the cropped area. One third of blocks changed cropping pattern and very limited blocks managed the crop by supplementing well irrigation. During the last spell, the pattern had changed dramatically. All the blocks in both the distributaries reported neither regular nor full supply. Majority of the blocks reported that inadequate storage in the dam was the prime reason for deficit supply. All kinds of measures such as reduced crop area, changed crop pattern and resorting to well water, were adopted to save the crop. Hence, it may be clear that none of the spells was useful to provide adequate supply to any of the blocks in both distributaries.

[7]. "According to official records the weekly turn systems was more strictly enforced, with water reportedly supplied on most if not all the days in most of the turns. But one may doubt whether this is true in terms of the quantum of the water supplied" (Vaidyanathan and Janakarajan: 1989: 249-50).[2]

3.1.4 PMC zone 4

This zone has 3 distributaries with 13 blocks out of 27 and the remaining 14 blocks are covered in zone 2. All of them are located in the PMC. The latest spell for this zone started on August 21, 2005 and ended on December 31, 2005 with a period of 132 days. However, the actual flow days in the main canal was only 94, which is the highest flow days compared with all the three other zones. The number of days supply received by each of the three distributaries decreased from head to tail of the PMC, which are 39 days, 38 days and 35 days (see Table 3). Relative to zone 3 distributaries, all the three distributaries of this zone received a little more supply in the latest spell and each one got 5 turns with 7 days supply in each turn. The first turn also got 10 days supply in all the three distributaries. Even then, the quantum of supply received by each one fell short by about 40% (see Table 6).

The block level survey shows that around half the blocks reported received 'regular but not full supply' in the latest spell. The remaining blocks got 'neither regular nor full supply'. The reasons for irregular and inadequate supply were mainly excess tapping in the upstream distributaries and inadequate storage position in the dam. Similar responses were reported across the blocks. Interestingly, the effect on crop shows that none of the blocks let the crop wither in the latest spell. Most farmers managed the short supply by supplementing with well water. In the middle and tail distributaries the farmers in a few blocks also managed the supply by reducing the crop area. However, these responses were completely the opposite when the last spell was considered, where majority of farmers in most blocks let their crop wither and farmers in some blocks reduced their crop area. Only limited blocks had access to well supply (see Table 4).

Last spell for this zone was given from April 1, 2003 to October 17, 2003. Here, the number of days spell covered was 200. However, the number of actual supply days in the main canal was only 53 and in the three distributaries; 13 in the head and middle distributaries and 27 in the tail distributary. The important point is that the dam storage was bare minimum in that spell year. As a result, whenever storage improved, it was released subsequently; hence the gap between the spells was large. Actually, the head and middle distributaries got only 2 turns of supply each with 7 days duration. Between the two turns, the gap was more than 4 months. In the last tail distributary 3 turns were possible, with 13 days supply in the first turn and 7 days supply in the remaining. Even then, the gap between supply was almost the same like the other two distributaries. Due to less number of turns, the quantum of supply received was very less. The deficit ranged from 57% to 80% in all three distributaries.

The above account indicates that the PAP supply even during the normal spell period was inadequate to feed the needs of the cropped area. During drought, the supply totally failed to protect crops, which in turn led to complete crop failure. Even well supply did not help to protect crops. Under this circumstance, let us discuss the role of wells in the PAP command and the type of crops grown by using canal and well supplies.

3.2 Role of Wells in the PAP Command

A noteworthy feature of the PAP command is the existence of wells along with canal irrigation. Almost all the sample distributaries have wells. The wells increased by 51% between 1966-85 and 20% after that. The slowdown of wells in the later period does not mean that the interest in going for wells has decreased. Contrary to this, the field situation indicates that farmers are more interested in installing bore wells. The current situation is that each well has at least one bore to supplement well supply.

According to information collected at block level, 5 out of 100 blocks surveyed do not have wells. A large majority (55%) of wells currently in use were dug even before the advent of the PAP. One-third of total distributaries surveyed have developed wells only after the PAP. Apart from that wells, which are located close to the main canals, have adequate recharge during good monsoon spells. In a few tail end distributaries, well supply was relatively poor even after the monsoon. It was reported that during non-spell summer season wells did not get recharge and most wells were non-functional. As a result, either well supplies or canal supply were adequate to grow even dry irrigated crops. The effect of main and branch canal supply has been realized only by farmers located very close to it. Farther the location of fields from the main or branch canals, lesser the supply and recharge of the wells.

The important feature of PAP wells is the non-existence of water markets. This is mainly because of poor recharge of wells and widespread use of well water to supplement canal supply in the command. Bore well construction took place only in the last 10 to 15 years (Table 7). As per the survey, on an average, every two wells have a bore and its depth ranges from 400 to 1250 feet. The depth of wells is around 100 ft. Most wells, which have depth of less than 50 ft, did not yield supply even during monsoon. Bores are most concentrated in the head reach distributaries and the middle and tail reaches have fewer bores. Majority of wells were reported to have energized pump sets with electrical power, though some wells do use engine oil.

Although wells are widespread in the PAP command, the quantum of supply pumped from these wells was limited, which was not adequate to supplement the canal supplies even during the normal supply period in majority of the distributaries. As per the block level survey, both the supplies – PAP and wells – are inadequate to feed the command. Under this situation, it is necessary to investigate the type of crops grown by the farmers by using the available water supplies in the command and to see how best to optimize yields which are effective in sustaining agriculture in the command.

4. CROP PATTERN IN THE PAP COMMAND

Access to and sources of irrigation have a significant bearing on the cropping pattern. The command areas under PMC and UPC grow a large variety of crops, the more important among them being coconut, maize, cholam, groundnut, vegetables, chilies and onion. For analytical purposes they can be grouped into 5 categories: i) annuals and perennials; ii) makkacholam and cholam; iii) rain-fed crops; iv) fodder and vegetables and v) irrigated dry crops. Except rainfed crops all others require proper irrigation; otherwise yield may retard. Annuals and perennials require yearlong irrigation and how much water it requires depends upon the type of technology used (such as drip irrigation). In the PAP command, only coconut crop gets drip irrigation with 80- 90% coverage.

As noted, PAP was designed to supply water only for irrigated dry crops. However, this policy came into practice only during the last 10 years. Previously paddy was also grown extensively in the command. Perennial crops grown in the command are coconut, mango, perunelli, tamarind and sugarcane. Coconut covered a little more than 50% and all other perennials account for only about 5%. Makkacholam or maize is an important seasonal crop in all distributaries. It is grown both during spell and non-spell periods. Its coverage during the spell period was 30 - 35%. However, its distribution varies across reaches of the command. Other irrigated crops such as cholam, groundnut, onion and vegetables occupy a considerable extent during the spells. Based on the cultivation undertaken by well and non-well farmers in the command area of the selected distributaries the following points are made. Overall summary is given in Table 8.

1. The non-well farmers also raise annual crops in majority of distributaries. This is due to three reasons. (a) Some farmers who do not own wells in a particular block have access to their own well water from adjacent blocks in which they also owned lands; and (b) Farmers who own wells in the non-command area also use their well water in the command. This area is considerably more in the tail distributary (6.5.600) of KPBC. In all other distributaries, the extent of this area is relatively less which ranges from less than an acre in the head distributary (31.4.440) of tail reach in PMC to nearly 19 acres in the head distributary (0.1.180) of middle reach in PPBC. The later distributary farmers did not own wells in any other locality. However, they raised coconut solely depending upon rain. This is possible mainly due to the prevailing black cotton soil. But, the yield of crop is considerably less.
2. In all distributaries, both well and non-well farms, the area devoted for annual and perennial crops remains either constant or in a few cases increases across survey years (2003-04 to 2005-06). This indicates that wells are contributing more to the growth of perennial crops.
3. Maize was the main crop during the spell period. Marketing for this produce was very good since the Suguna Poultry Feed Mill is located in this area and demand for maize is always high. Hence, farmers prefer this crop. Taking all distributaries together, and across reference years, maize cultivation was one-third of total cultivated area among non-well farmers; and one-fourth among well farmers in 2004-05. It

declined to around 15% in both types of farmers in 2005-06 (a non-spell year for many sample distributaries) and it had only about 10% between both categories of farms in 2003-04 (a severe drought year). Hence, PAP supply mostly induced seasonal cropping in the command.

4. During the spell year, area under rain-fed crops raised by well farms decreased considerably. The reduction was half that of the non-spell year, whereas for non-well farms the reduction was only 15%. It may be noted that during spell period wells farmers mostly used available supply for perennial crops hence the rain-fed crops got less importance.
5. Fodder and vegetables as well as irrigated dry crops occupy only around 10% of the total cultivated area in each of the three reference years. There has not been much difference in area under cultivation of these crops between spell and non-spell years. However, drought spells reduces its area across distributaries.

As indicated, based on the availability of assured water source, farmers decided the cropping pattern. Unless well water was supplemented, perennial crops like coconut were not feasible. As an exception, in one of the black cotton soil distributary (0.1.180) some farmers raised coconut without depending on well supply. However, their yield level was very poor. It is important in this context, to see how effective was the cropping intensity and productivity of crops across distributaries and between reference years.

5. CROPPING INTENSITY AND PRODUCTIVITY

The varying conditions of water availability across distributaries and years naturally have an impact on productivity per unit of land. Table 9 presents an estimate of the gross value of output per unit of area held by sample farmers in each selected distributaries. The physical output of each crop as reported by respondents was valued at the average wholesale price prevailing in Coimbatore district during the years 2003-04 to 2005-06. The value of output is estimated per unit of gross cropped area (measured in season acres), and the crop area to the area of plots held by the reporting farmers for each of the distributaries. Productivity per unit of plot area is equal to the product of cropping intensity (CI) and the value of output per unit of gross cropped area.

In 2004-05, which was a spell year for zones 2 and 3 of the PMC and for UPC, the average productivity per acre of plot area was the highest (Rs. 6650) in zone 2, followed by zone 3. In these distributaries the CI is low (1.19) and medium (2.04). This high productivity (compared to all distributaries) in the tail and middle reach distributaries was possible mainly due to cultivation of vegetables like pumpkin, papaya and green chilies by a few farmers. These crops fetch a higher price in the market compared to other crops. This can be called precision farming. Low productivity (Rs. 1032) was found in the tail distributary in zone 3 followed by the middle distributary (0.1.180) in zone 2. Here the CI was 1.84 and 1.72. These two are peculiar distributaries, where the later is located in the black cotton soil. Hence, majority of farmers did not use canal supply but raised only rainfed cholam and Bengal gram. Since monsoon was not favourable, the yield declined considerably. Although a few coconut farmers used the distributary spell supply, the previous years' drought affected the coconut yield and productivity considerably. The former distributary did not get adequate supply from the spell due to its tail end location and coconut was a major crop. Most farmers reported that their crop failed altogether in the spell. Hence, though CI was high, productivity was low. This may be termed as failed cropping or survival farming. In the remaining distributaries in zone 2 and 3, including those located in the UPC, the yield was between the maximum and minimum, which is normal in this area. In these distributaries, the CI ranges from 2.16 to 1.42 but the productivity ranges between Rs. 2776 to Rs. 4949. This shows that CI and productivity are not positively correlated. This is mainly due to poor canal supplies and drought situation during the monsoon.

For zones 2 and 3, 2003-04 and 2005-06 were non-spell years and the former was affected by severe drought hence the well supply was also very poor. However, the latter year experienced a reasonable monsoon. All distributaries (except the tail end one 50.4.445) experienced relatively low productivity in both the years compared to the spell year (2004-05). Between two non-spell years, 2005-06 was better. Although the tail end distributary (50.4.445) in zone 3 was in the non-spell category, the productivity was much better than all other distributaries. This was mainly because of coconut cultivation and good groundwater position, which helped to get more crop yield.

For zones 1 and 4, 2004-05 was a non-spell year. The overall CI of the 6 distributaries falling in these zones ranged from 1.02 to 2.86. However, the productivity ranged from Rs. 1249 to Rs. 4472. Here also one can notice low CI but reasonable productivity. High CI but low productivity was also found in many of the distributaries. This indicates the type of crops (low, high value) grown and the level of output attained by these crops were most important to decide the productivity variations across distributaries. This inference is mainly because in the middle distributary (13.5.263) of zone 1 the entire command was cropped with coconut. All farmers have wells. The CI is the highest among all the distributaries, however the average productivity was only moderate at Rs. 2204. The reverse was the case in the tail distributary (68.0.000) of zone 1, where the CI was the lowest (1.02) but the productivity was high at Rs. 3938. In the former distributary only coconut was grown, whereas in the latter other annual crops like papaya and seasonal crops like onion were grown. These crops also fetch more price than coconut.

Further, the above observation can also be related to the spell year for zones 1 and 4. Since the spell year 2003-04 was drought hit, productivity level was minimal almost in all distributaries in these zones. However, the CI did not change much. This was due to existence of perennial crops such as coconut. The other reasonable spell year for these zones was 2005-06. Here one can notice that all distributaries attained higher productivity and more or less high CI. This shows that spells with adequate supply can enhance productivity to a considerable level than those with poor supply spells. The latter spells invariably led to crop failure resulting in heavy monetary loss.

6. CONCLUSION

In the PAP system, the usual practice of supplying water in each spell for 135 days was erratic and not followed in accordance with the specified rules. The normal practice of 7 days supply in each turn was not followed in any of the distributary in majority of spells. Between normal (mostly in winter) and drought (mostly in summer) spells, the supply pattern was more erratic during the summer spells; and insufficient water availability led to heavy crop loss. Continuous drought led to enormous crop loss to farmers in one of the spells chosen for the survey. It may be attributed to the fact that when the ASIS method was adopted in August 2000, it was remarked in the G.O. that this ASIS is followed on an "experimental basis". Hence, the PWD authorities themselves were not sure on the effectiveness of the new system. Hence, the ASIS is still evolving and the PAP supply pattern is experimental too. Further, it is important to note that the PAP is a "supply" based irrigation system. Hence the farmers demand for adequate water for better cropping if not met.

Generally, the head reach distributaries get relatively more supply – either by way of increase in the quantum of daily supply or by increasing the number of days of turn supply – than the tail end distributaries of either the main or the branch canals. However, this is not always the case for all distributaries. Special features in terms of soil type, proximity to streams, alignment of the canal distributary with reference to its command, and topography make a significant difference in getting water supply. This is clearly captured in our study. Further, canal seepage, the nature of the soil and the geology are most important to determine recharge of wells. During the 20-year period the field level water distribution changed a lot. Previously from dam to field, water was allocated only by the PWD officials. Now, the entire distributary supply is managed by the VWUAs. The PWD's water allocation ends at the main or branch canal itself. This pattern is efficient which is clear from the survey.

Maize is an important crop during dry spells. Since coconut crop was raised in more than half the cultivated area throughout the PAP one can say that well irrigation helps to develop crops for more than 50% in the command and canal irrigation supplements the wells during dry spells. Wells get recharged during monsoon seasons. Maize and coconut occupy nearly three fourths of cultivated area in the PAP command in any given year. Due to erratic supply pattern, the productivity of these crops is below average even in irrigated condition. The effect of irrigation (in terms of productivity) is more in the dry areas than wet areas. In the PAP command, the tail reach distributaries are located in the drought-affected region (Palladam taluk in Coimbatore district). The tail distributaries sluice numbers 10 to 12 are located only in this region. There the productivity and CI are evidently more compared to other distributaries in other reaches.

In many distributaries, non-well farmers also get access to well irrigation, which is a recent phenomenon. Hence, the exact effect of productivity in non-well farms during spell and non-spell periods is difficult to derive from this survey, which requires specific study by separating well and non-well farmers in the PAP command. However, the evidence from the study suggests that cropping intensity and productivity under well farms are relatively more than non-well farms. The PAP system partially helps the command area farmers to reap the benefits of canal irrigation. During normal supply years average productivity was realized and in drought years heavy crop loss was experienced.

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Table 1: Trends in Net Area Irrigated by Sources from 1950-51 to 2004-05 (Area: lac ha.)

Source	1950-51 to 1969-70 area	% to NIA	1970-71 to 1989-90 area	% to NIA	1990-91 to 2004-5 area	% to NIA
INDIA						
Govt. & private canals	101.9	41.6	150.4	39.1	160.7	29.0
Tanks	43.0	17.5	34.0	8.8	22.8	4.1
Wells+ tubewells	76.7	31.3	175.9	45.7	338.3	61.0
Other sources	23.5	9.6	24.6	6.4	32.5	5.9
Total NIA	245.1	100.0	384.9	100.0	554.3	100.0
Net Sown Area	1319.5		1403.2		1413.9	
TAMIL NADU						
Govt. & private canals	8.4 (8.2)	36.5	8.6 (5.7)	33.1	7.1 (4.4)	27.3
Tanks	8.5 (19.7)	36.8	7.3 (21.5)	28.2	5.1 (22.3)	19.5
Wells+ tubewells	5.7 (7.4)	24.9	9.8 (5.6)	37.7	13.7 (4.0)	52.6
Other sources	0.4 (1.8)	1.8	0.3 (1.1)	1.0	0.2 (0.5)	0.6
Total NIA	23.0 (9.4)	100.0	26.0 (6.7)	100.0	26.0 (4.7)	100.0
Net Sown Area	57.4		59.3		54.2	

Source: Indian Agricultural Statistics, 1985-86, 1989-90, Vol.I, Ministry of Agriculture, GoI. New Delhi. www.indiastat.com, Area for all India since 2000-01. GoTN, TN- An Economic Appraisal, various issues.

Note: Figures in brackets indicate source wise percentage compared to India.

Table 2: Methods of Water Distribution within Blocks in the Selected Distributaries in the PAP Command

Sl. No.	Name of distributary/ mileage/ reach/zone	No. of blocks	Min & Max hours of supply per acre/turn	Main features of water distribution within blocks
1.	Krishnapuram 2.6.000 PMC (HH) 2 & 4	9	4.40 - 18.40 hrs in 7 days	In a spell (135 days supply in the main canal) totally 6 turns are possible. A turn system consists of 7 days supply and 15 days off. In each turn 2 wettings are possible for most blocks. Farmers are given a time schedule to follow one by one. Top down supply pattern is followed. VWUA is very active.
2.	Kolarpatti 13.5.263 PMC (HM) 1	6	7.20 - 10.30 hrs in 7 days	The entire commend has been grown with coconut and fully drip system followed. Since half the tail distributary is unlined, the tail blocks always receive poor supply. However, supply was shared fairly and judiciously. Wells are considered most important in this distributary. VWUA is normal.
3.	Negamam 0.2.640 PMC (HT) 1 KPBC	9	3.15 - 7 hrs in 7 days	In this head distributary, water sharing was effective and fair in normal supply period. However, during deficit period, illegal tapping was common. Inclusion of non-ayacut was reported.
4.	Mullupadi 6.5.600 PMC (HT) 3 KPBC	11	4.40 - 7 hrs in 7 days + sole use	In this tail distributary, illegal tapping by upstream farmers during night was common. Disputes are more. Poor supply led to reduction in cropped area by many farmers. Murai system is followed to reduce disputes. VWUA is not effective.
5.	Alampalayam 3.7.330 UPC (H) 2	9	5 - 7 hrs in 5 days + mutual sharing	Fixed and rigid turn system is followed. Due to improper location of head sluice, always deficit supply was available in the distributary. This is inadequate even for dry crops cultivation. The PAP supply has no effect on recharge of wells in summer and even during monsoons with poor rainfall. Groundwater supply is very poor. Functioning of VWUA is poor.
6.	Gudimangalam (19.0.150 UPC (T) 2	11	4 - 6 hrs in 5 days	Top down irrigation method is followed. Turn system is strictly followed. Full (rush) supply is maintained in all five days supply period. Farmers themselves through the direction of VWUA manage the turn system and it is very active. Groundwater supply is inadequate.
7.	Modakkupatti 3.4.500 PMC (MH) 2 & 4	8	4 + 2 or 6 hrs in 7 days	Top down irrigation ensures better supply to tail enders. Strict turn system is followed. Groundwater supply is inadequate even during winter months. Due to location advantage, the head & middle dy farmers get adequate supply whenever the PMC supply is released. VWUA is active.
8.	Poosaripatti 0.1.180 PMC (MM) 2 PPBC	4	5 - 7 hrs in 7 days + liberal use	This dy passes along the block cotton soil and no lining was done. Seepage and percolation is heavy. Since most farmers did not use the PAP supply, the tail enders only use it liberally for their coconut groves. VWUA is normal (average).
9.	C. Nagoor 8.0.220 PMC (MT) 2 PPBC	8	3 - 4 hrs in 6 - 7 days	Two waterings in a turn are possible. Internal adjustment between well and non-well farmers are reported. They mutually cooperate with each other. This helps avert minor disputes & induced farmers to crop entire ayacut. VWUA is active.

Sl. No.	Name of distributary/ mileage/ reach/zone	No. of blocks	Min & Max hours of supply per acre/turn	Main features of water distribution within blocks
10.	Thalakkarai 31.4.440 PMC	10	1 - 2 hrs in 7 days	Majority of farmers raised coconut groves. Hence, 2 hours rotation helps to get 3 to 4 drip supplies or 2 normal supplies are possible in a turn. Minor conflicts arise due to construction of improper field bothies, which led to poor supply to the tail enders. VWUA is active.
11.	Kullampalayam 50.4.445 PMC (TM) 3	8	1.45 - 3 hrs in 7 days + liberal use	Coconut is a major crop (80%). Unlined dy channel affects supply. Also, the elevated ayacut in some blocks detained farmers to use PAP supply. Hence only others are using the supply liberally. Groundwater recharge is very good. VWUA is active.
12.	Alagumalai 68.0.000 PMC (TT) 1	7	4 - 5 hrs in 7 days +sole use	Coconut is limited. Groundwater recharge is favourable due to adjacent location to the PMC. Even non-command wells, supply water to the command. In one block a lone farmer solely utilizes the PAP supply. No competition. VWUA is active.

Source**:** Survey 2006-07

Note: As per turn system 7 days on and 10 days off supply is given in the dy. The main canal is closed for 4 - 5 days to enhance storage from the feeder canal for the next turn. Normally, 5 - 6 turns are possible in a season depending on dam storage.

PMC = Parambikulam Main Canal, UPC = Udumalpet Canal, KPBC = Kovil Palayam Branch Canal, PPBC - Pudupalayam Branch Canal, Reach: H = Head, M = Middle, T = Tail (HH = Head Reach Head Distributary)

Table 3: Number of Days Water Released in the Main Canal and Selected Distributaries

Sl. No.	Distributary mileage & zone	No. of days supply given in the main canal		No. of days supply given in the distributary	
		Latest Spell	Last Spell	Latest Spell	Last Spell
1.	2.6.000 PMC 2 &	90	66	40	23
	Do 4	94	53	39	13
2.	13.5. 263 PMC 1	91	27	39	12
3.	0.2.640 KPBC 1	91	27	38	12
4.	6.5.600 KPBC 3	64	57	20	27
5.	3.7.330 UPC 2	71	56	45	51
6.	18.7.550 UPC 2	71	56	34	27
7.	3.4.500 PMC 2 &	90	66	33	27
	Do 4	94	53	38	14
8.	0.1.180 PPBC 2	90	50	50	16
9.	8.0.220 PPBC 2	90	66	35	22
10.	31.4.440 PMC 2 &	90	53	29	24
	Do 4	94	53	35	27
11.	50.4.445 PMC 3	64	57	26	24
12.	68.0.000 PMC 1	91	27	42	12

Note: 40 to 45 days supply in the distributary and 90 to 95 days supply in the main canals provide a satisfactory normal spell. Below which it is considered drought spell

Source: Office of the Sub-Division, Thirumurthi Dam Section, 2007

Table 4: Water Supply Conditions in the Selected Distributaries

Sl. No.	Distributary & ZONE	No. of Sample Blo-cks	LATEST SPELL PERIOD (2004-05 and 2005-06)										LAST SPELL PERIOD (2002-03 and 2003-04)									
			No. of blocks which received			Reasons for irregular & IA supply		Effect in the Crop					No. of blocks which received			Reasons for irregular & IA supply		Effect in the Crop				
			Regular & Full supply	Regular but not Full supply	Neither regular not Full supply	Excess tapping in the upstream	IA Storage posi-tion	Low yield	Reduced cropped area	Complete crop failure	Crop pattern changed	Managed with well water	Regular & Full supply	Regular but not Full supply	Neither regular not Full supply	Excess tapping in the upstream	IA Storage posi-tion	Low yield	Reduced cropped area	Complete crop failure	Crop pattern changed	Managed with well water
			1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
1.	2.6.000	6	-	4	2	2	4	-	-	-	2	4	-	-	6	2	4	-	-	4	1	4
	PMC 2&4	3	-	2	1	1	2	-	-	-	-	3	-	-	3	-	3	-	-	1	-	2
2.	13.5.263 PMC 1	6	-	6	-	-	6	-	-	-	-	6	-	-	6	-	6	-	-	2	-	4
3.	0.2.640 KPBC 1	9	-	6	3	6	3	-	-	-	4	5	-	-	9	3	6	-	-	6	3	-
4.	6.5.600 KPBC 3	11	-	-	11	11	-	-	6	-	4	1	-	-	11	6	5	-	-	9	-	2
5.	3.7.330 UPC 2	9	-	-	9	6	3	-	3	-	2	4	-	-	9	5	4	-	-	5	4	-
6.	18.7.550 UPC 2	11	-	11	-	-	11	-	3	-	2	6	-	-	11	-	11	-	5	3	-	3
7.	3.4.500	3	-	2	1	1	2	-	2	-	-	1	-	-	3	2	1	-	2	1	-	-
	PMC 2&4	5	-	3	2	2	3	-	3	-	-	2	-	-	5	1	4		1	3		1
8.	0.1.180 PPBC 2	4	-	-	4	-	-	4	-	-	4	-	-	-	4	-	4	-	-	-	4	-
9.	8.0.220 PPBC 2	8	-	8	-	-	8	-	-	-	3	5	-	-	8	-	8	-	3	3	-	2
10.	31.4.440	5	-	4	1	2	3	-	2	-	1	2	-	-	5	2	3	-	2	2	1	-
	PMC 2&4	5	-	3	2	2	3	-	1	-	1	3	-	-	5	2	3	-	2	2	1	-
11.	50.4.445 PMC 3	8	-	3	5	5	3	-	3	-	2	3	-	-	8	3	5	-	2	2	1	3
12.	68.0.000 PMC 1	7	-	7	-	2	5	-	-	-	2	7	-	-	7	2	5	-	2	2	-	3

Note: - indicates nil. **Source:** Survey data 2006-07.

Table 5: Expected and Actual Supply Received by Distributaries under Zone 2

Sl. No.	Distributary Mileage	No.of Sample Blocks	Expected Quantum Mcft/Acre	Quantum of Supply given (Mcft/acre)		Quantum of deficit during latest and last spells (mcft)		% of deficit during latest and last spells	
				Latest Spell	Last Spell	Latest	Last	Latest	Last
PMC 2									
1	2.6.000	6	0.083	0.062	0.035	0.021	0.048	0.25	0.58
2	3.4.500	3	0.083	0.058	0.037	0.025	0.046	0.30	0.55
3	0.1.180	4	0.083	0.058	0.013	0.025	0.070	0.30	0.84
4	8.0.220	8	0.083	0.054	0.034	0.029	0.049	0.35	0.59
5	31.4.440	5	0.083	0.045	0.037	0.038	0.046	0.46	0.55
UPC 2									
6	3.7.330	9	0.083	0.061	0.066	0.022	0.017	0.27	0.20
7	19.0.150	11	0.083	0.088	0.036	-0.005	0.047	-0.06	0.57

Note: Expected supply is 1 mcft for 12 acres.

Source: Derived from the data recorded in respective section offices.

Table 6: Expected and Actual Supply Received by Distributaries under Zone 3 and 4

Sl. No.	Distributary Mileage	No.of Sample Blocks	Expected Quantum Mcft/Acre	Quantum of Supply given (Mcft/acre)		Quantum of deficit during latest and last spells (mcft)		% of deficit during latest and last spells	
				Latest Spell	Last Spell	Latest	Last	Latest	Last
PMC 3									
1	6.5.600	11	0.083	0.029	0.019	0.054	0.064	0.65	0.77
2	50.4.445	8	0.083	0.037	0.035	0.046	0.048	0.55	0.58
PMC 4									
1	2.6.000	3	0.083	0.048	0.017	0.035	0.066	0.42	0.80
2	3.4.500	5	0.083	0.052	0.020	0.031	0.063	0.37	0.76
3	31.4.440	5	0.083	0.047	0.036	0.036	0.047		

Note: Expected supply is 1 mcft for 12 acres.

Source: Derived from the data recorded in respective section offices.

Table 7: Number of Wells Dug and Bores Developed in Different Periods in the PAP Command

Sl. No.	Distributary & Reach	Zone	Canal	Wells Before 1965	Wells 1966-85	Wells After 1985	Total Wells	No. of Bores (since 1995)							Bore Density
								1	2	3	4	5	10	Total	
1	2.6.000 HH	2	PMC	11	2	12	25	6	9	2	1			18	0.72
		4	PMC	7	3	3	13	2	2	1	1			6	0.46
2	13.5.263 HM	1	PMC	24	11	8	43	9	4	2				15	0.35
3	0.2.640 HT	1	PMC	34	11	9	54	10	15	2				27	0.50
4	6.5.600 HT	3	PMC	15	8	6	29	6	3				1	10	0.34
5	3.7.330 HH	2	UPC	23	1	5	29	9	8					17	0.59
6	19.0.150 HT	2	UPC	29	9	8	46	16	4	2				22	0.48
7	3.4.500 MH	2	PMC	10	0	1	11	1	4					5	0.45
		4	PMC	10	2	5	17	6	3		1			10	0.59
8	0.1.180 MM	2	PMC	0	0	1	1	1	1					2	2.00
9	8.0.220 MT	2	PMC	13	18	8	39	2	3		2			7	0.18
10	31.4.440 TH	2	PMC	10	12	1	23	1	15					16	0.70
		4	PMC	10	19	1	30	4	14	2				20	0.67
11	50.5.445 TM	3	PMC	28	15	5	48	13	8	2	2	1		26	0.54
12	68.0.000 TT	1	PMC	21	15	3	39	11	4					15	0.38
	Grand Total			245	126	76	447	97	97	13	7	1	1	216	0.48

Note: Reach indicates the location of distributary from the Thirumurthi Dam.

H = Head. M = Middle. T = Tail. First H, M, T indicates the reach from the Dam. Second H, M, T indicates location of distributary. HH=Head reach Head distributary. MH = Middle reach Head distributary. TH = Tail reach Head distributary.

Source: Field survey 2006-07

Table 8: Summary of Crop Pattern in the PAP Command, 2003-04, 2004-05 & 2005-06 (Area in acres)

Details	W/ NW	2003-04						2004-05						2005-06					
		Annual & Perennial Crops	Macca Cholam & Cholam	Rainfed Crops	Fodder & Vegetables	Irrigated Dry Crops	Total	Annual & Perennial Crops	Macca Cholam & Cholam	Rainfed Crops	Fodder & Vegetables	Irrigated Dry Crops	Total	Annual & Perennial Crops	Macca Cholam & Cholam	Rainfed Crops	Fodder & Vegetables	Irrigated Dry Crops	Total
Grand Total	Nw	132.7	50.5	220.3	11.2	5.5	420.2	134.4	196.6	217.7	26.1	17.8	592.5	134.4	96.0	307.1	37.7	12.9	588.0
	W	1082.1	128.5	148.5	69.7	10.9	1439.7	1095.4	435.6	89.0	148.0	45.0	1813.0	1103.3	240.1	152.7	200.2	79.3	1775.6
	All	1213.0	179.0	368.6	80.9	16.4	1857.9	1227.8	632.1	306.7	174.1	62.8	2403.6	1235.7	335.1	459.8	256.6	94.3	2381.4
% to total	Nw	32	12	52	3	1	100	23	33	37	4	3	100	23	16	52	6	2	100
	W	75	9	10	5	1	100	60	24	5	8	2	100	62	14	9	11	4	100
	All	65	10	20	4	1	100	51	26	13	7	3	100	52	14	19	11	4	100

Note: Perennial and annual crops are counted as season acres. Nw = Non-well. W = Well.
Perennial and annual crops = Mango, Perunelli, Tamarind, Coconut and Sugarcane.Rainfed crops = Bengal gram, black gram, coriander, cumbu, yellow cholam, kollu
Fodder cholam, horse gram, mocchai, fox gram, & Thattai payaru.Irrigated Dry Crops = Cotton, Green gram, Gingelly, Pasi payaru, Onion, Green fodder, Radish.
Source: Field survey 2006-07

Table 9: Cropping Intensity and Productivity, 2003-04, 2004-05 & 2005-06 (Productivity in terms of Rs)

Sl. No	Distri-butary	Zone	Canal	W/ NW	2003-04			2004-05			2005-06			Spell / Non Spell		
					CI	O/GCA	O/PA	CI	O/GCA	O/PA	CI	O/GCA	O/PA			
1	2.6.000 (HH)	2	PMC	Nw	Nil	Nil	Nil	1.00	160	160	1.00	272	272	NS	S	NS
				W	1.33	846	1123	1.84	1546	2849	1.83	1102	2017			
				All	1.29	846	1093	1.82	1526	2776	1.81	1090	1969			
		4	PMC	Nw	1.27	632	802	0.90	392	351	1.00	1636	1630	S	NS	S
				W	1.99	523	1039	1.98	891	1766	1.94	1757	3411			
				All	1.88	534	1004	1.82	855	1557	1.80	1748	3148			
2	13.5.263 (HM)	1	PMC	W	2.84	435	1236	2.86	771	2204	2.88	1162	3353	S	NS	S
				All	2.84	435	1236	2.86	771	2204	2.88	1162	3353			
3	0.2.640 (HT)	1	PMC	Nw	1.33	36	48	2.15	888	1907	2.22	1808	4017	S	NS	S
				W	2.16	340	733	2.20	525	1154	2.24	954	2136			
				All	2.05	315	646	2.19	570	1249	2.24	1061	2373			
4	6.5.600 (HT)	3	PMC	Nw	1.82	124	225	1.99	293	584	2.05	422	863	NS	S	NS
				W	1.68	212	356	1.76	739	1298	1.90	928	1759			
				All	1.73	178	307	1.84	559	1032	1.95	730	1425			
5	3.7.330 (H)	2	UPC	Nw	0.68	1359	921	1.06	3411	3599	0.88	1996	1764	NS	S	NS
				W	1.46	1138	1661	1.60	2214	3540	1.48	1712	2534			
				All	1.22	1175	1436	1.43	2481	3558	1.30	1771	2300			
6	19.0.150 (T)	2	UPC	Nw	0.55	915	506	0.98	3538	3476	0.69	1648	1138	NS	S	NS
				W	1.15	1357	1566	1.57	2471	3874	1.25	2469	3094			
				All	1.00	1295	1295	1.42	2659	3772	1.11	2339	2595			
7	3.4.500 (MH)	2	PMC	Nw	0.88	2375	2083	0.88	4174	3658	0.88	2723	2386	NS	S	NS
				W	2.10	1596	3351	2.26	1620	3667	2.10	2179	4580			
				All	1.71	1724	2945	1.82	2014	3664	1.71	2268	3877			
		4	PMC	Nw	1.06	1312	1385	0.88	1177	1030	0.90	4250	3816	S	NS	S
				W	2.67	1363	3633	2.50	1516	3790	2.62	2173	5692			
				All	2.13	1354	2882	1.96	1465	2868	2.04	2478	5066			
8	0.1.180 (MM)	2	PMC	Nw	1.33	642	851	1.49	801	1198	1.55	976	1511	NS	S	NS
				W	3.00	34	102	3.00	53	158	3.00	81	242			
				All	1.58	469	739	1.72	606	1042	1.76	749	1321			
9	8.0.220 (MT)	2	PMC	Nw	0.44	1025	447	0.96	5888	5648	1.02	3677	3767	NS	S	NS
				W	0.59	2124	1262	1.25	5544	6925	0.94	5786	5419			
				All	0.56	1939	1086	1.19	5604	6650	0.96	5298	5063			
10	31.4.440 (TH)	2	PMC	Nw	0.74	1837	1355	1.18	3774	4447	1.00	2496	2504	NS	S	NS
				W	2.15	1254	2696	2.34	2151	5041	2.36	2143	5054			
				All	1.93	1288	2489	2.16	2288	4949	2.15	2168	4660			
		4	PMC	Nw	1.32	3680	4877	1.40	3965	5561	1.48	10210	15095	S	NS	S
				W	1.95	1590	3095	2.06	2114	4348	2.15	3190	6859			
				All	1.88	1739	3277	1.99	2247	4472	2.08	3697	7698			
11	50.4.445 (TM)	3	PMC	Nw	1.24	1595	1981	1.47	5254	7734	1.57	5470	8566	NS	S	NS
				W	2.04	1063	2166	2.19	1948	4260	2.22	2822	6261			
				All	1.88	1133	2129	2.04	2424	4954	2.09	3218	6722			
12	68.0.000 (TT)	1	PMC	Nw	0.74	1682	1238	0.77	3219	2483	1.28	9151	11669	S	NS	S
				W	0.99	2158	2141	1.08	3942	4241	1.84	5921	10887			
				All	0.95	2094	1985	1.02	3848	3938	1.74	6329	11022			

Note: W = Sample Farmers with Wells; NW = Sample Farmers without Well. CI = Cropping Intensity (adjusted). O = Output; GCA = Gross Cropped Area; PA = Plot Area. NW = Non well. W = Well. Location: H= Head. M = Middle. T = Tail. PMC = Parambikulam Main Canal. UPC = Udumalpet Canal.
Source: Field survey 2006-07

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