Revisiting the Traditional Irrigation System for Sustainability of Farm Production: Evidences from Bihar (India)

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Abstract

The paper aims at to examine the approach of revitalization of the traditional irrigation system in Bihar (India). Although, the system contributes only 12 % irrigation of the total area yet its irrigation potential in 2012 is 15.44 lakh hectors constituting 7 % of the total irrigation potential. The system is self sustained and the people managed. Farming sector in the state contributes 18.12 % to the state gross domestic product in 2012 is the base of the state economy. Traditional irrigation system constitutes primarily of the system of irrigation through "Ahar-Pyne". Ahars are reservoirs and consist of a major embankment across the line of the drainage with two side embankments running backwards up to the line of the drainage gradually losing their heights because of the gradient of the surface. "Ahar" is actually a tank which receives its supply from small rivers through diversion channel called Desiyan (a source of irrigation to ten villages) "pyne". The system was on decline earlier due to mechanisation of irrigation but now it gains its revitalisation due to sustainable contribution in crop production and its rationale of water use efficiency practised by the marginal farmers for enhancing the farm productivity.

Keywords: Traditional, Irrigation, Ahar, Pyne, Agriculture, Productivity, India, Bihar.

JEL Code: Q15, Q 25

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Introduction

Traditional irrigation system in Bihar constitutes primarily of the system of irrigation through "Ahar-Pyne". Ahars are reservoirs and consist of a major embankment across the line of the drainage with two side embankments running backwards up to the line of the drainage gradually losing their heights because of the gradient of the surface. Thus, an ahar resembles a rectangular catchment basin with only three embankments, and the fourth side left open for the drainage water to enter the catchment basin following the natural gradient of the country. These are very different from the regular tanks in that neither their beds are dug out nor do the regular tanks have elevated embankments as do ahars. Water supply for an ahar comes either from natural drainage after rainfall (rainfed ahars) or through pynes where necessary diversion works are carried out. Water for irrigation is drawn out by opening outlets made at different heights in the embankment. Pyne is the local name for the diversion channels. These channels may be of various sizes. The small ones are those found originating in ahars and carrying the water of the ahars to cultivable plots. The large ones have their origins in rivers from which water is diverted through these artificial channels by erecting embankment in the river beds. They are led some way upstream above the level of the land they are intended to irrigate. It is often 3 to 5 kms before the water of the pynes reaches the level of cultivation. Some of the biggest pynes are 16 to 32 kms.

Ahar-pyne system is an indigenous irrigation technology, which continues to irrigate substantial areas even today in South Bihar plains. This system has evolved from an understanding of the particular agro-climatic conditions of the region. An ahar is rectangular embankment-type water harvesting structures i.e. a catchment basin embanked on three sides, the 'fourth' side being the natural gradient of the land itself. Ahar beds were also used to grow a Rabi (winter) crop after draining out the excess water that remained after Kharif (summer) cultivation. Ahars differ from the regular tanks in that the bed of an ahar is not dug and usual tanks do not have the raised embankment of an ahar. While ahars irrigating more than 400 ha are not rare, the average area irrigated by an ahar during early 20th century was said to be 57 ha (Pant, 2004). Water supply for an ahar comes either from natural drainage after rainfall (rainfed ahars) or through pynes where necessary diversion works are carried out. Water for irrigation is drawn out by opening outlets made at different heights in the embankment. Pyne is the local name for the diversion channels. Pynes are artificial channels constructed to

utilise river water in agricultural fields. The paper is based on the research done by the authors in 2010-11. It is designed in to five sections. Section II discusses the present situation of the system with an emphasis on the agriculture as a base of economic growth in Bihar. Since the traditional irrigation system largely depends upon the cooperation among the farmers to maintain found missing. This has caused the decline but the mechanisation of irrigation through tube well did not substitute the former and the small and marginal farmers still looking towards "Aher-Pyne" a major source of irrigation to sustain the productivity analysed in section III; Section IV focuses on the available blend of tools to increase crop production by reducing the input costs through the effective use of existing institutions at the village level in Gaya district. In section V, the concluding observations are drawn. Keeping in view of the nature and extent of ahar and pyne system, the objectives of the paper are the following,

Objective

a. To know the force of change in traditional irrigation system and its impact on sustainable farm productivity in Bihar;

b. To examine the comparative advantages of community participation in traditional irrigation system and productivity;

Data and Methodology

- The study covered Gaya (old) district (presently Gaya, Aurangabad and Nawada) representing the southern region of the state where the influence of traditional irrigation system is still more in enhancing farm productivity.
- The villages covered under the system have been selected for the comprehensive analysis of socio-economic mechanisms to sustain the water bodies.
- In each sample village, ten households belonging to small and marginal farmers were sampled.
- The data have been collected through structured questionnaire from the primary sources. Besides, data from concerned government departments and other sources have also been collected.

2. Traditional Irrigation System and Economic Growth

Traditional irrigation system in Bihar constitutes primarily of the system of irrigation through "Ahar-Pyne". Ahars are reservoirs and consist of a major embankment across the line of the drainage with two side embankments running backwards up to the line of the drainage gradually losing their heights because of the gradient of the surface. Thus, an ahar resembles a rectangular catchment basin with only three embankments, and the fourth side left open for the drainage water to enter the catchment basin following the natural gradient of the country. These are very different from the regular tanks in that neither their beds are dug out nor do the regular tanks have elevated embankments as do ahars. Water supply for an ahar comes either from natural drainage after rainfall (rainfed ahars) or through pynes where necessary diversion works are carried out. Water for irrigation is drawn out by opening outlets made at different heights in the embankment. Pyne is the local name for the diversion channels. These channels may be of various sizes. The small ones are those found originating in ahars and carrying the water of the ahars to cultivable plots. The large ones have their origins in rivers from which water is diverted through these artificial channels by erecting embankment in the river beds. They are led some way upstream above the level of the land they are intended to irrigate. It is often 3 to 5 kms before the water of the pynes reaches the level of cultivation. Some of the biggest pynes are 16 to 32 kms.

Bihar is endowed with fertile land resources. The area under cultivation as a proportion of the total reporting area is as high as 60 per cent, as compared to only 47 per cent for the country as a whole. Land use, cropping and water use patterns are changing, partly as responses to changing demographics and consumption patterns, and partly as responses to changing investment scenarios and economic growth. Despite vast irrigation potential, the availability of irrigation is only 43 percent of net sown area much less in the state. Over the years, it was not increasing either. Again, the fall in net irrigated area by 1.04 lakh hectares for canal, 0.49 lakh hectares for tubewells, 1.62 lakh hectares for other wells and 0.38 lakh hectares for tank/pond irrigation during 1987-2007 was a serious cause of concern and called for necessary policy initiative to reverse such trends (Sharma, 2008). Irrigation intensity was low at 122 percent in the state as against 180 percent in Punjab and 163 percent in Haryana. After bifurcation of the state, the contribution from secondary sector has become less in terms of employment and income generation. The trend in growth rate of Bihar's Gross State Domestic Product during 2004-05 to 2011-12 has been volatile, mainly because of the dominance of the agricultural sector in the state economy. During the 11th Plan, against an

average growth rate of 7.94 percent of the Indian economy, Bihar's average annual growth rate was 12.08 percent at constant prices. This rate of growth of the Bihar's economy was much higher than the rate of growth recorded during the 10th Five Year plan (7.04 percent at constant prices). The recent accelerated economic growth in Bihar, however, has been paid much attention; the average growth rate of per capita gross state domestic product (GSDP) (at constant prices of 2004-05) during the last six years from 2004-05 to 2010-11 was registered at 9.24 per cent, compared to 5.12 per cent between 1999-00 and 2008-09 (at constant prices of 1999-00) (Table 1).

Table 2.1: Growth Rate of Bihar Economy and Sector-wise Contributions

	Annual growth from 1999-00 to 2008-09	**Annual growth from 2004-05 to 2008-09**	**Share in GSDP in 1999-00**	**Contribution to growth (1999-00 to 2008-09)**
Agriculture	3.02	2.67	30.3	13.0
Forestry	4.12	-2.06	1.8	1.1
Fishery	5.28	2.34	1.4	1.0
Mining	-7.11	3.97	0.2	-0.2
Manufacturing	3.26	4.76	7.2	3.3
Construction	26.01	25.55	3.8	14.0
Elec./Water/Gas	2.37	6.83	1.4	0.5
Transport/Storage/Communication	5.18	9.97	7.4	5.4
Trade/Hostel/Restaurant	13.50	19.63	15.0	28.7
Banking/Insurance	7.31	16.51	3.6	3.7
Real Estate/Legal & Business Services	5.1	9.62	4.2	3.0
Public administration	3.88	6.84	7.6	4.2
Other Services	3.69	6.02	16.1	8.4
Total GSDP	**7.06**	**10.93**	**100.0**	**86.1**
Per capita	5.12	9.24		

Source: Calculated by the author, based on data obtained from the Government of Bihar.
Economic Survey 2010-11.

The table also shows the contribution of various sectors to overall economic growth during 1999-00 to 2008-09. The result indicates that the largest contributor was trade/hotels/restaurants (28.7%), followed by construction (14.0%) and agriculture (13.0%). Although the growth rate of agriculture was not so high (3.02%), its contribution became quite substantial because of its large share in the GSDP (30.3%). In other words, due to the importance of the agricultural sector in terms of income sources (more so in terms of employment) in Bihar, even if agriculture grew rather moderately, this would still have a large impact. The state southern part receives less rainfall annually which makes the farming community to store rainfall water and use prudentially. By tradition, they developed the

system of 'Pyne-Aher"(Traditional Irrigation System) which is economically viable and result-oriented.

2.1 Agricultural performance in the state: Agriculture in Bihar is dominated by small and marginal farmers. In rural areas, small and marginal operational holdings constituted 90.44 per cent of the total holdings, accounting for 54.15 percent of the total area operated in 1991-92. During the last decade, Bihar's agricultural sector has been one of the fastest growing in India. Between 1980 and 1992, Bihar's agriculture and allied services sector grew at just 1.6 percent per annum, compared to the national average of 3.1 percent. However, since 1993, growth in Bihar's agricultural gross state domestic product (GSDP) has accelerated. Between 1993 and 2003, the all-India agricultural GDP grew at 2.2 percent per annum. The corresponding figure for Bihar was 2.7 percent, which ranked third to West Bengal and Andhra Pradesh among the major Indian states. Table 2.2 shows the current scenarios of area, production and yield at the national as well as of states. Bihar stands far behind in area than many larger states due to explosive growth of population and the bifurcation of the state in 1999. In terms of area of irrigation, Bihar is comfortable than many states even ahead of national average. Bihar has 5.46 % of production and 5.35 % of area of the country. Many states are far ahead in production. It is due to lack of poor irrigation infrastructure maintenance and almost negligible investment on new irrigation infrastructure development. Bihar's agriculture is still labour intensive and it the shelter of residual labour force also. This gives least scope of further investment due to the marginalized holdings.

Table 2.2: Area, Production and Yield of Food grains during 2010-11 and 2011-12 in major Producing States along with coverage under Irrigation

State	2011-12					Area
	Area	% to All - India	Production	% to All - India	Yield	Under Irrigation (%) 2009-10
1	*2*	*3*	*4*	*5*	*6*	*7*
Uttar Pradesh	20.16	16.12	50.29	19.54	2495	75.8
Punjab	6.53	5.23	28.35	11.01	4339	98.4
Madhya Pradesh	13.50	10.79	19.05	7.40	1411	45.9

Rajasthan	14.41	11.53	18.96	7.37	1316	25.9
Andhra Pradesh	7.29	5.83	18.40	7.15	2525	57.3
Haryana	4.63	3.70	17.96	6.98	3878	89.0
West Bengal	6.09	4.87	16.29	6.33	2675	49.3
Bihar	6.69	5.35	14.05	5.46	2102	64.2
Maharashtra	10.71	8.57	12.32	4.78	1150	17.1
Karnataka	7.45	5.96	12.20	4.74	1637	27.3
Tamil Nadu	3.59	2.87	9.64	3.74	2687	62.4
Gujarat	4.62	3.70	9.07	3.52	1961	41.5
Chhattisgarh	4.84	3.87	6.84	2.66	1415	27.2
Odisha	4.96	3.97	6.43	2.50	1297	33.6
Jharkhand	2.68	2.14	4.66	1.81	1741	5.9
Assam	2.43	1.95	4.19	1.63	1723	6.6
Uttarakhand	0.95	0.76	1.85	0.72	1942	44.4
Others	3.49	2.79	6.88	2.67	@	-
All India	**125.03**	**100.00**	**257.44**	**100.00**	**2059**	**47.8**

@ - Since area / production are low in individual states, yield rate is not worked out.
Note: States have been arranged in descending order of percentage share of production during 2011-12.
Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation.

The growth rate of Bihar's economy was not uniform over the years. During the first five years since 1999-2000, the economy had grown at an annual rate of 3.50 percent. With the economic policies pursued by the state government since 2005-06 which included much higher levels of annual plan outlays, the economy had grown at an annual rate of 10.93 percent during 2004-05 to 2010-11 at constant prices. This is one of the highest among the growth rates of different Indian states.

The gross and net sown area in the State is estimated at 80.26 lakh ha and 56.38 lakh ha, respectively. The intensity of cropping is 1.42%. The principal crops are paddy, wheat, pulses, maize, potato, sugarcane, oil seeds, tobacco and jute. Rice, wheat and maize are the major crops. The average yields of rice and wheat are 1.45 and 2.19 t/ha, respectively, as against the production potential (experimental yields at research farm as well as realized in

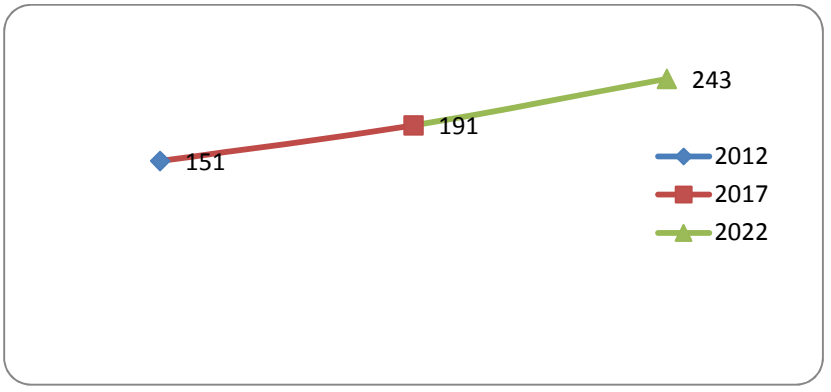
frontline demonstration) of 4.5-5.0 t/ha. Similar, the average of maize yields of the State is about2.38 t/ha as against its yield potential of 5 t/ha. State is rich in soil and water resources, its average yields of Rice, Wheat, and Maize in the state are only about 32, 44 and 40 percents of the potential yields, respectively.

Agriculture productivity in Bihar was much better, compared to other states in fifties which is now much below the national average. In last two years, there has been an appreciable growth, due to improved seeds, technologies and inputs (Table 2.3). The state cropping intensity is rising (Figure 2.1). The rise in cropping intensity is attributed to the investment by the farming households as there is no strong viable alternative in other sectors. The state as well as the private investment did also help and more some programmes like National Agricultural Development Programme.

Table 2.3: Productivity of Major Crops (MT per Ha) in Bihar (2010-11)

Items	Current Productivity	Target 2017	Target 2022
Rice	1.60	3.00	3.50
Wheat	2.30	3.10	3.10
Maize	2.80	4.20	5.20
Pulse	0.80	1.00	1.00
Oilseeds	1.10	1.20	1.50
Fruits	13.50	18.60	20.50
Vegetables	23.62	28.60	30.00

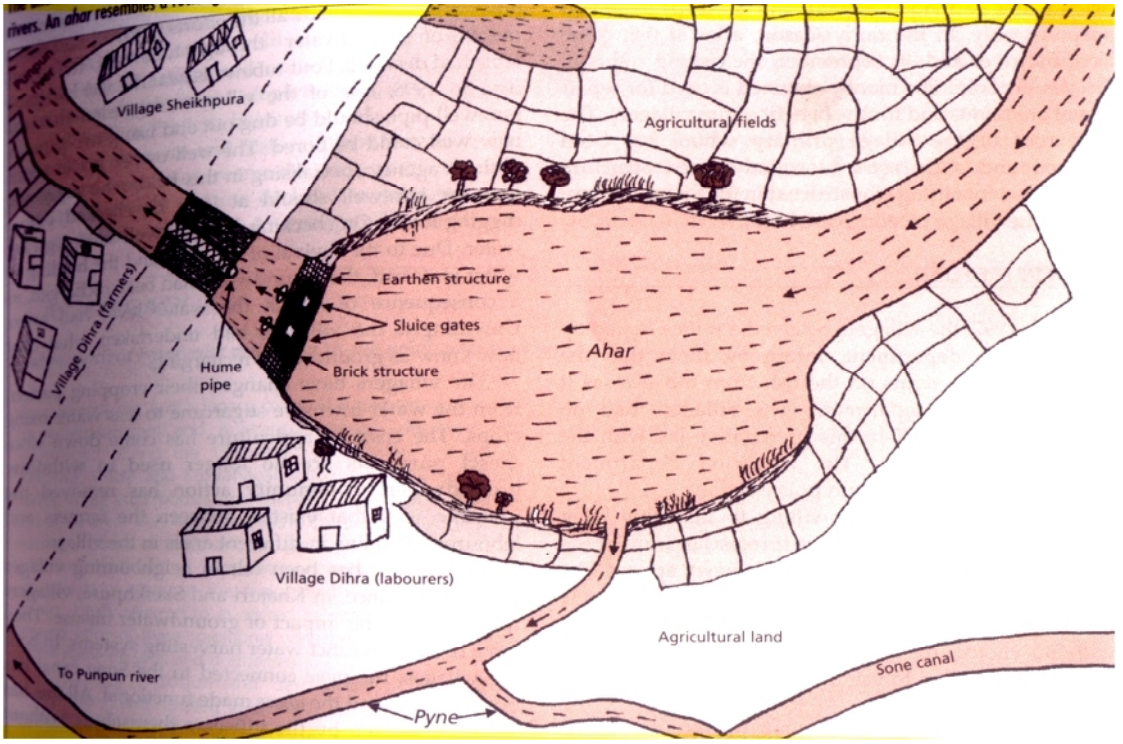
Figure 2.1Cropping Intensity in Bihar (%)



3. Cooperation as a Base of Sustainability for Aher-Pyne System

Bihar is largely agricultural yet it is largely rain-fed agriculture. It has a fair amount of rain as compared to other States yet it has poor irrigational facilities in comparison to many others. The ancestors used to harvest the rainwater, as it would both fulfill the immediate needs for drinking and irrigation. But, more importantly, it would conserve the level of groundwater literally for posterity; for future generations to reap the benefits.

Figure 3.1: Typical Ahar-Pyne System



3.1 Description of ahar- pyne traditional system

Pynes start from rivers, streams, Ahars and also terminate in Ahars (reservoirs) irrigating the command in head, draining in the tail. Series of Ahars & Pynes from upper to lower catchment of streams have been observed. Pynes take flood discharges of rivers and irrigate during high spate of rivers. They divert the flood water for storage in Ahars. Ahars known as Erie/Kanmai in south India also called Bandh/Bandhi in South / Jharkhand. Ahars irrigate during rain deficient period and storages in Ahars indirectly recharge ground water (Figure 3.1 above).

Farmers construct earthen bundhs across the rivers d/s of pynes. It helps divert waters in pynes. With increased discharge earthen bundhs break – pynes get water. Thus the series of ahars & pynes work. There were set rules for operation of ahars & pynes – some mentioned even in "Chanakaya's Arthshashtra". The system mentioned as "Aharyodaka Setu" in this Magnum Opus. Before modern irrigation schemes came, they were backbone of irrigation in South- Central Bihar.

In the modern context, however, consecutive State governments have either been ignorant or chosen to remain so, of the traditional irrigation systems devaluing its promise and denying the people its potential to bring prosperity and make agriculture yields turn their fortunes around. In Bihar, where 75 per cent of its population lives on agriculture, only 50-60 per cent of land is covered by irrigation facilities. There is a heavy dependency on tube-wells, which in turn, are dependent on electricity, which is in short supply. There is also the high cost of diesel for running the tube-wells. It is a vicious circle which makes irrigation, nothing more than a pipe-dream for farmers.

Table 3.1: Irrigated Area by Source in Bihar

Year	Irrigated Area (in '000 hectares)						
	Canal Surface* (Major)	Canal Surface (Minor)	Tank (including Ahar & Pyne)	Tubewell (Private & State)	Other Well (irrigation well)	Other Sources (L.I Barge L.I)	Total irrigated Area
2000-01	1636.31(36.71)	29.22 (0.66)	332.56 (7.46)	2310.06(51.83)	145.84 (3.27)	3.26 (0.07)	4457.25 (100.0)
2005-06	1660.91(34.38)	19.86 (0.41)	332.56 (6.88)	2643.21(54.72)	145.79 (3.02)	28.23 (0.58)	4830.56 (100.0)
2009-10	1202.45(27.07)	17.59 (0.40)	332.56 (7.49)	2726.60 (61.39)	145.79 (3.28)	16.74 (0.38)	4441.73 (100.0)

Source: Department of Minor Irrigation, GoB
Note : * Includes Canal Irrigation for Summer Season also.

3.2 Extent of irrigation

The ahar-pyne system of irrigation was overwhelmingly more important in South of Ganga in Bihar, where it was irrigating about 35 percent of 2.5 mha of cropped land during the first two decades of twentieth century. Compared to it, the irrigation in North Bihar was a mere 3

percent of 3 mha cropped area. During the period 1971-1991, of the 0.98 mha area irrigated by ahar-pyne, 0.88 mha area was irrigated in South Bihar, while only 0.1 mha was irrigated in North Bihar. Today the area irrigated by ahar-pyne system in whole of Bihar has come down to about 0.53 mha constituting about 12 percent of all irrigated sources, compared to about 18 percent in South and North Bihar alone during the first two decades of twentieth Century. The main reasons for the decline of the ahar- pyne system in South Bihar are the abolition of the Zamindari system which had the capital resources and vested interest in maintaining the ahar- pyne system. The second, a large number of alternatives have come before the farmers during the post-independence period in the form of new canal schemes and tube wells. This has been aided by high doses of government subsidies in case of private tube wells. Even in 1970-71, the area irrigated by tube wells in Bihar was about 17 percent, this reached above 48 percent during 1999-2009.

Ahar-pyne system of indigenous irrigation is historically the most important source of irrigation in South Bihar and even today provides a shining example of participatory irrigation management. Ahars, with sides that are more than a km. long, irrigating more than 400 ha are not rare, though smaller ones are more common. However, the average area irrigated per ahar during the early twentieth century was said to be 57.12 ha (Sengupta 1993, 1985). According to O'Malley (1919), this indigenous system is the outcome of the natural conditions and physical configuration of the country, and has been evolved to meet the obstacles which they place in the way of cultivation. However, with the passage of time, the collective institutions of management of the ahar-pyne system have declined. Area irrigated by ahar-pynes is on the decline, accounting for only about 12% of the total irrigated area in Bihar (Table 3.2).

Table 3.2: Area Irrigated by Aher-Pyne System in Bihar

Year	Area Irrigated (mha)	Region Covered
1930	0.94	South Bihar
1971	0.64	South Bihar
1976	055	South Bihar
1997	0.53	Whole of Bihar

Source: Pant (2004)

3.3 Equity in allocation and distribution of water: The Ahar-pyne system had well worked-out institutional mechanisms for sharing of water between farmers. Synchronization of the agricultural operations over the year was achieved by earmarking each 14-day period on the lunar cycle for each agricultural operation (Table 3.3). Buchanan (1939) noted that landlords appointed proper persons to divide the water among the tenantry. According to O'Malley (1919), the parabandi System was used to distribute water among the villages from a common source (usually a pyne). Parabandi derived from the term para (turn) and bandi (fixation) meant fixation of turn. Each village had its fixed turns of so many days and hours to avail the water. These turns were assigned by mutual agreements or ancient customs. A detailed register called lal bahi (red register) maintained in some systems specified the irrigation rights of each village. Usually parabandi arrangements began in the month of Aswin (mid-September), when the demand was acute and supply limited. At other times, all branches of pynes were left open (CSE, 1997). The reliability and timeliness of ahar irrigation is ensured because water is stored in the reservoir and is utilized when pynes do not have any water left and rains are not forthcoming. This is the likely scenario during the hathia period, when water is critically needed by paddy (Pant, 2004). Equity in water allocation was not a granted right but it was in-built in the system.

The total landholding of each individual in a command was highly fragmented. In consequence, every major landholder who could influence the allocation had interests both at the head and the tail regions of the distributary (Sengupta 1993). If water available is not sufficient and does not reach the tail end, a part of the command area remains unirrigated, but everyone suffers. Pynes feed several ahars and several distributaries originate from each ahar.

Table 3.3: Timing of Agriculture Operations in ahar-pyne system

S.l No.	Period	Operation
1.	June 20 to July 5	Seed Bed Sowing
2.	July 18 to August 15	Transplantation
3.	September 12 to September 25	Field water drained out
4.	September 26 to October 7	Fields filled again
5.	October 8 to October 20	Standing water in Fields
6.	October 21 to November 3	Field water Drained out
7.	November 4 to November 15	Harvesting

Source: Aggarwal and Narain (1997)

3.4 Community participation & distribution of responsibilities: In the past community participation was extensive in traditional irrigation management. Community labour for repair, called *kudimarammath* in south India and *goam* in Bihar was an established custom. Ahar-pynes work, particularly the one relating to maintenance and overseeing of water distribution was looked after by three functionaries. These were headman, Barahill (supervisor) and Gudait (watchman). A unique feature of ahar-pyne management system in was that some posts were associated with particulars castes. For instance job of the watchman, the drum- call for *goam* (Collective physical action) used to be made by beating of drums and the drum beatings used to be done by dafalis (Pant, 2004). Some of these indigenous irrigation systems (pynes) were so large that their water conveyance system ran over 30 kms, covering hundreds of villages and irrigating thousands of acres of land. Since the construction of such irrigation works required huge capital investment, only big landlords could do it.

Large pynes were mostly constructed several years ago when larger areas were under the control of the single zamindars (landlords) and their authority to enforce their orders and wishes was more absolute (O'Malley 1919). Repair and Maintenance: The repair and upkeep of the most ahar and its water conveyance system is of two types. The one involves major repairs and the other deals with the minor routine upkeep to make the system work. The responsibility of ahar-pyne construction as well as major repairs was of landlords (Buchanan, 1939; O'Malley, 1919). The amount spent by the estate was later realised from the farmers under the Gilandazi (improvement of irrigation works).

The routine upkeep work involves cleaning and desilting of ahar and pyne and maintaining the water conveyance network, while the system is in operation. As a result, ordinary maintenance such as the periodic clearance of silt, the repair of small branches of the ahars and field channels is done by the cultivators themselves under *goam* system and it starts before the onset of monsoon. Apart from the routine activities, an important task is to keep constant vigil, particularly during monsoon against sudden damage of protective works which may occur due to natural cause or due to man-made reasons. The operational works include cutting and closing embankments for diversion, erection of bandhs or garandis across the pynes, opening and closing of outlets and at times even resorting to manual water lifts to irrigate uplands. *Goam* was and still is very effective in meeting the emergencies. The call for *goam* was made by beating of drums. *Goam* occurs even today every year in hundreds of villages of South Bihar.

3.5 Central control: Steward (1949) and Wittfogel (1957) opine that irrigation management requires a high degree of discipline and that in turn implied central control and an all-powerful bureaucracy. In the ahar-pynes of South Bihar, it is found that a centralised authority in the form of the landlord played an important role in respect of construction of ahar-pynes, their major repairs and allocation of water to different villages. However, landlords did not play any role in determining the mechanism relating to how water was distributed among different individuals in each micro irrigation command and how they maintained the micro water conveyances structures. Further, Buchanan (1939) mentions that there existed some indigenous irrigation works in South Bihar which were constructed and maintained by tenants and that the landlords had no claims of rents against such works. Even where findings do indicate a centralised management in certain matters, it is difficult to assume that high level of participation of cultivators in the irrigation management was a natural consequence of the centralised authority (Pant, 2004).

4. Institutional Arrangement in the Traditional Irrigation System

Traditional water harvesting structures were nicely maintained before independence. Zamindars managed maintenance through labour contribution of farmers: “goam” (a collective effort). They even defrayed expenses on making and maintaining these systems. They enforced ‘parabandi’ for operation and distribution of water. Presently these systems are grossly neglected. Their irrigation potential has vastly reduced due to siltation & lack of maintenance. Detailed Register called “Lal Bahi” contained Water Rights of Farmers.

4.1 Requirements for modernisation of ahar & pyne system

In order to modernize Ahar-Pyne system, there is a need to follow six steps systematically. These steps are (i) Planning, (ii) Designing, (iii) Funding, (iv) Implementation (v) Monitoring and (vi) Evaluation. Some important points for consideration are mentioned below

- Basin planning.
- Hydrological Data
- Hydrological Information System (HIS) for both surface & groundwater.
- Hydrometeorology – rainfall, temp., radiation, humidity, sunshine-hour, wind speed.
- Ground Water Surface hydrology- aquifer character, permeability, transmissibility, porosity, specific yield, spring-level variation.
- River morphology- river behavior, management.

4.2 Overview of institutional arrangement: evidences from the sampled villages

Moratal Pyne irrigates forty villages in Bodh-Gaya and the Manpur Block of Gaya district. When the visit of the origination point of this pyne was made on August 20, 2010, the people were desilting the river "Phalgu" from where it originates. The institutional arrangement of the pyne is continuing since 1949. The MLA of the Mufasil Assembly (now Wazirganj Assembly Constituency) is the President of the society. The election of the President is done by all the forty villages. They used to elect the Secretary also. This is done through the general body meeting held every year called "Aam Sabha". This Aam Sabha is held generally before the start of the rainy season. Besides, every week also, a meeting of executive committee held in the Sikher village. The executive committee consists of two-three villagers from the every village. There is an arrangement to generate some income for the maintenance of the Moretal Pyne.

The income is raised based on the utilization of water from the Pyne on "Paher (4 hours)" basis. The current rate of contribution per Paher is Rs. 900.00 only. The distribution of Paher is done on weekly and the monthly basis among the beneficiary villages. The villagers used to meet once in a week often during the water scarcity/enhanced demand. The decision of the committee is final and binding on all the beneficiary villages. Management of committee adopts always a very rational approach. If a village suffers due to lack of water in river, the committee decides to provide water when water comes in the river. The mechanism of management prudentially lies in the hands of committee. Every member of the committee gets elected every year in "Aam Sabha" by the villagers. Two-third member election is done on the criteria of land area and the population of the village. The socially active, honest and working as well as dedicated persons first elected by the village meeting (Gram-Sabha). After the election, two-three elected persons are included in the Pyne management committee. The term is for one year. There are no criteria like cast, creeds, money and other social factors rather the persons' dedication, pro- activeness and honesty. The villagers reported that arable land has not been cultivated for the last two years due to lack of sufficient rain in catchment area. The farmers suffer this year also due to erratic rain. This institutional arrangement is fully managed by the beneficiaries of the villages within the area without any support from the state. Exceptionally today also, this arrangement is meeting the challenges of maintenance and the operation of the traditional irrigation system. The marginal farming community is the larger beneficiary for the sustenance of their crop production under the pyne-aher system in Bihar. However, this arrangement is i8n need of revisit for effective result of the system in

policy decision. This is self-sustained system of irrigation during the cultivation period and helping to bring about the equity in benefit sharing. Recently, some programme intervention has been made to assist the traditional irrigation system for enhancing the productivity under the participatory management of rainwater.

5. Concluding Observations

Improved irrigation access will increase crop yield and production, and in turn, result in increased farm income, but the less understood issues are how this differential access to irrigation will actually affect the income inequality and poverty status in an irrigation system—and the nature of the feedback effects of this process. From the evidence presented earlier, we conclude that irrigation access is a crucial instrument for reducing (rural) poverty within a region. This is not so much through direct impacts of increased yield and farm returns per se, but more through indirect impacts associated with increased rural employment—especially the scale of economic multipliers operating in the rural economy. The equity aspect of water distribution among individual cultivators which continues even today is obtained because all farmers, rich or poor and big or small, have plots in head and tail positions of the irrigation channel. As a result, adequacy or shortage of irrigation water is equitably shared by all cultivators of the irrigation command (Sharma, 2009). The reliability and timeliness of ahar irrigation is ensured because water is stored in the reservoir and is utilized when pynes do not have water left and rains are not forthcoming. This is the likely scenario during the hathia period, when water is critically needed by paddy. The routine upkeep work involves cleaning and desilting of ahar and pyne and maintaining the water conveyance network, while the system is in operation. Policy intervention is appearing now to revitalise the system under the schemes of rural development. This will help in not only rise in crop production rather rationalisation of water uses also.

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