Alternative Gravity flow PVC pipe water distribution in the command of irrigation project, for Improvement of water use efficiency

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ABSTRACT: (9 pt)
Volumetric water supply is the one of the basic principles of the Maharashtra Management of irrigation sector by the Farmers Act 2005 and rules 2006. With the conventional gravity flow irrigation net work it is difficult to supply irrigation water on volumetric basis to each individual farmer. There are significant losses in the conventional gravity flow irrigation net work. On the other hand, volumetric water supply to an individual farmer as per his water rights can be done easily by switch over to PVC pipe distribution net work **PDN**. The PDN is economical, water saver, and very easy for operation and maintenance as compare with gravity flow open channel irrigation net work. There are various water user associations situated in different parts of Maharashtra where equitable water distribution on volumetric basis are being practiced with the use of Gravity flow PVC pipe water distribution PDN. In this paper few pioneering case studies of volumetric irrigation water supply with Gravity flow PVC pipe water distribution PDN are disused.

INTRODUCTION

The water resources, reservoirs, distribution systems etc. are the property of the Government. They are wholly governed by the Government. 83% of the store water is used in irrigation sector. The water harvested is released as per the availability and demand of the beneficiaries. In general open channel gravity flow water distribution is used to supply irrigation water. The conveyance losses in these systems are significant and are increasing day by day. Poor maintenance is one of the major causes. These systems have inherent losses too. It is a need of time to reduce these losses and increase the water use efficiency. Lining to the inner surface of the open channel is a solution to reduce the conveyance losses. It is costly, cannot be adapted economically to the secondary and tertiary networks. It is not a perfect way. Now a day's PVC pipe of various diameters are available everywhere. In Maharashtra few Water User Associations **WUA** has replaced the open channel water distribution network by gravity flow PVC pipe network and achieved zero conveyance losses and high water use efficiency **WUE**. With adoption of the new techniques, area irrigated is manifold as compare to previous conventional open channel gravity flow water distribution network.

Problems in Conventional open channel gravity flow water distribution network

Few of the general problems in Conventional open channel gravity flow water distribution network are given below.

- Difficult to maintain judicious water supply. The command area automatically gets divided in to head, middle and tail reaches. The head reach farmers draw more water and tail Enders is deprived of water.
- There is uncertainty in water supply, Water cannot be supplied as and when needed, the quantities and rotation period is fluctuates.
- Disparity in the demand and supply.
- Since water is charged on area basis, inefficient use of water.
- Volumetric water supply is fundamental requirement to improve water use efficiency; volumetric water supply to an individual is not possible.
- There are no incentives to the farmers for efficient water use.
- The rotation of water supply schedule is difficult to implement.
- The beneficiaries will try to tap as much water as possible, when their turn is on.
- The field channels are not well maintained as the farmers are not organized to share the water as their responsibility.
- It is very difficult to regulate the flow rate in the channel.
- All above features drives the farmers mind to apply maximum irrigation water.
- Beneficiaries are reluctant for the regular maintenance and operation of the system.
- Land under the distribution network becomes unproductive. Farmers are unwilling to provided land, thus land acquisition is not easy.

Innovative PVC pipe distribution technique

All the above problems discussed above are easily solved by the PVC pipe water distribution network. As managerial staff is less as compare to the command area under their charge, it is difficult for them to maintain and keep watch on each and every field. Thus Maharashtra Government has decided to hand over the command area to the beneficiaries for efficient water management. The WUA are now formed. The command area is being handed over to the WUA. In some cases the formalities are completed. Water will be released to them on volumetric basis. Overall distribution, controlling and management of irrigation, maintenance is done by water user association. Few of them have adapted innovative PVC pipe distribution net work **PDN** in lieu of conventional gravity flow open channel water distribution net work and achieved higher water use efficiency, high water productivity, and sustainable water use. Conflicts as compare to conventional water distribution network is made inbuilt zero. Few of them are enumerate below.

Volumetric irrigation water supply with PDN in the command of Jai Malhar Lift irrigation Scheme.

Indore village is situated 25 Kilometers away from the district head quarter Nasik, Maharashtra (India). A minor irrigation tank is constructed on the upstream of the village. The storage capacity of the tank is 0.89 Million cubic meter **Mcum**. A jack well is constructed inside the reservoir. A main distribution chamber is constructed on a higher ground near the dam. Two submersible pumps of 25 HP each are installed inside the jack well. The discharging capacity of each pump is 50 lps. A rising main pipe of 315 mm diameter and 120 meter length is laid. It carries the water lifted by the two pumps, and delivers inside the main distribution chamber. The diameter of the distribution chamber is 3 meter and the depth is kept as 2 meter, 115 no. Total 115 no share holders are registered. PVC pipe pieces of 63

mm diameter and 300 mm in length are fixed over the vertical wall of the chamber. They are fixed exactly at one level. They work as out lets. There number is equal to the number of share holders. The water delivered inside the chamber is divided equally among the all 115 pipes and flows out. Group of three to seven farmers are formed.

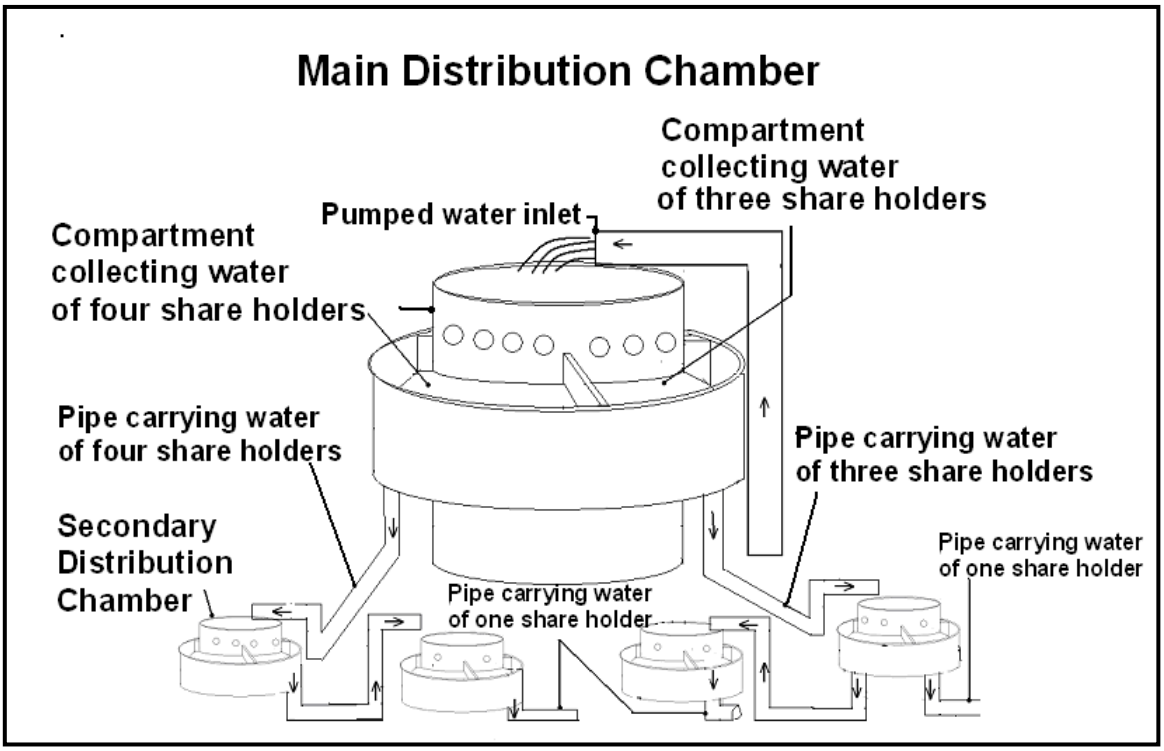

Fig 1

			
Indore MI Tank	Main Distribution Chamber	Peripheral Compartment On Main Distribution Chamber	Secondary Distribution chamber

Water lifted by the pumps gets collected in to the main distribution chamber. This water immediately and equally divided and runs outside from the outlets, fixed on the peripheral vertical wall. Peripheral chamber is divided into small compartments. The number of outlets letting water in to a peripheral compartment is dependent upon the number of farmers in that group. All peripheral compartments

receive water at the same time. The water collected in the compartment is then carried through a pipe line of that group, up to the secondary distribution chamber constructed at a suitable location near the head of their farms. Water collected in this secondary distribution chamber is again divided in to a number equal to the members in that group. The water coming out from each out let is then conveyed to the individual's field. Thus all the share holders will get equal quantum of water at the same time. As the total discharge of the two pumps is 100 liter per second **lps**, then it is equally divided in to 115 members, and each of them will get nearly one lps discharge over the running period. In the existing and conventional flow irrigation systems in similar command, lot of conflicts arises. There are no head, middle and tail Enders as occurs in conventional gravity flow irrigation net work. The discharge of the pump multiplied by the running time of the system will give the quantum of water lifted by the WUA. And the total quantum of water divided by the member's number (115) will give volume of water supplied to each individual member. Thus without using any flow measuring device the water will supplied on volumetric basis and judiciously.

Volumetric water supply with PDN in the command of Wavi Harsh Adivasi Upasa Sinchan Water User Association WUA, Dist Nasik

It is a lift irrigation scheme established to lift water from the Vaitarana Major Project, Situated in Nasik District of Maharashtra. A jack well is constructed on the upstream side of the dam. The command area of the WUA is 371 ha. It is divided in to 20 small chaks. Area of each chak is approximately 20 ha. Individual electric pumps are designed for irrigation water supply to each chak. Water supply at the rate of 1 **lps** per hectare is decided for selection of the appropriate type of the pump and the main pipe line conveying water from jack well to the chak head. 20 submersible pumps have been set up in the jack well. A control room is constructed over the top of the jack well. All the starters and switches of pumps are fixed over a single controlling panel placed vertically in the control room. Chak numbers are painted on the respective delivery pipe and the starters of pumps. Discharge measuring meters are installed one on each delivery pipe line. The G.I. delivery pipe extended in to the main PVC line, conveys water from jack well to the chak head. A water distribution chamber is constructed at the head of the chak. Depending upon the cultivable command area under the chak, its distance from the Jack well and its elevation, the diameter of conveyance main pipe line, and the pump are designed. A small distribution chamber is constructed near the chak head. Water conveyed from the PVC main is first delivered in to this distribution chamber. One pipe out let for one ha area is fixed over the vertical wall of the distribution chamber. The diameter of the PVC Pipe out lets is 90 mm. If an owner has 3 ha Cultivable land then discharge from three pipes out let i.e. 3 lps will be given to him. His water share is collected in to the peripheral chamber and then carried to his farm head with separate pipe line. The running time of the pump/running time of the pipe out let multiplied by the total discharge received by the farmer gives the volume of water supplied to that farmer.

Volumetric water supply with PDN in the command of Chandrabhaga Medium Project

Chandrabhaga Medium Project is lies in the Tapi river basin, situated in Amaravati District of Maharashtra State. It consists of composite dam across the river Chandrabhaga. Open channel gravity flow irrigation network up to the Minors were completed and pipe out lets were installed over the Minor as per conventional practices. The discharging capacity of the pipe out let is kept as 30 lps. The water distribution net work below these outlets is setup in gravity flow PDN instead of conventional open field channel net work. The PVC pipes in PDN terminate in to a turnout. The turnout supplies water to an area of 3 to 5 ha; Called as a Chak. A small distribution chamber of size 1.5 m x

1.5m x 1.5m is constructed below the Pipe out let. The water delivered in to the distribution chamber, by the outlet on the Minor, is then conveyed by the PVC pipe network up to the chak head. The diameter of the various components of the PVC network are so calculated that the turnouts will deliver the discharge proportional to the CCA under that turnout i.e. area of the chak. Water allowance is taken as 1 lps. Thus if the command of a turnout is 5 ha then the discharge of the pipe turnout will be 5 lps. Accordingly the diameter of the turnout pipe is decided. The running time of the every turnout will be same as that of the running time of the outlet. Turnout discharge multiplied by the running time will give the volume of water supplied to an individual. Thus without installation of any measuring device, water is distributed among the beneficiaries on volumetric basis, equitably and judiciously. Water and Land Management Institute **WALMI**, Aurangabad, Maharashtra, India has designed the PDN on request of the project authority.

The elevation difference between the supply level and the farm level is used to convey the water through pipeline.

Table showing turnout wise CCA, Discharge, Head available and the diameter of the PVC pipe

Chak no	Lateral		Area in ha	**Discharge in cum	*Head available in m	Designed inner diameter of pipe in cm	Outer diameter of pipe in mm
	for Turnout no	length in meter					
Outlet 1	TO1	5	4.88	23.87	0.4	6.20	75
	TO2	5	4.38	21.42	0.3	6.30	75
	TO3	5	5.43	26.57	0.3	6.85	75
	Sub main1	200	4.88	23.87	1.7	9.81	110
	Sub main2	75	9.26	45.29	0.3	14.62	160
	Sub main3	5	14.69	71.86	0.4	9.42	110

* Elevation difference between the start and end of the pipe

**water allowance x area x 3.6

Following steps have taken in the design.

1. Cultivable command area of a chak **CCA** in the conventional water distribution net work generally ranges from 20 to 30 ha; is subdivided in to a group 3 to 5 ha.
2. Contour lines at an interval of 0.5 m are marked over the command plan of the chak area under consideration.
3. The main pipe line is aligned along the ridge.
4. A turnout at the head of each group (small chak) is located in such a way that all the area in that group can be easily irrigated with the water flow from the turnout.
5. Water allowance is worked out. It comes to 1.358 lps; as per the project planning.
6. Discharge of each turnout is worked out by multiplying the command area of the turnout and the water allowance at the rate of 1.358 lps.
7. Independent laterals for supplying water to each turn out are designed by using Hezan and Willames Equation. The elevation difference between the starting and end points is assumed

to over the frictional head loss in the PVC pipe and thus the diameter of the pipe is decided. The pipe available to the nearest diameter in the market is recommended for the use. On the same principal the sub sub main, sub main and the main pipe diameter is calculated. Different component of the pipe, its length, discharge and diameter are shown in the table below.

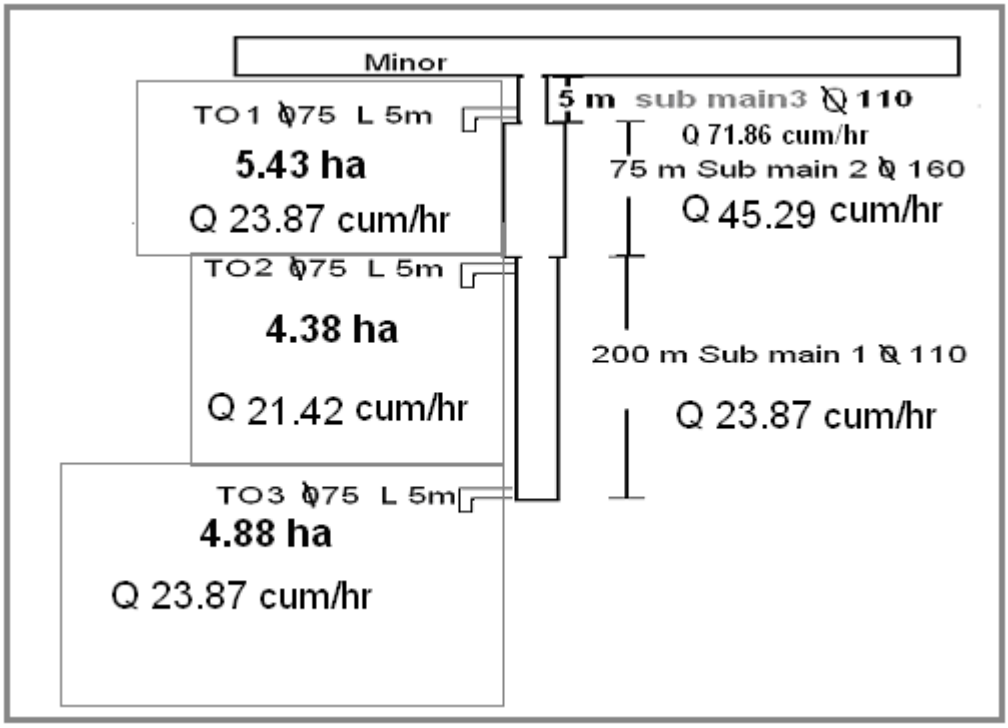

Figure showing the PVC pipe network in a chak

A pilot scheme has installed on the field as per the designed and layout given by the WALMI. After observing it's easy practical operation and usefulness; the project authority has decided to adopt it, not only in Chandrabhaga Medium Project but also in the command of Purna Medium Project and Chargad Minor irrigation project. The total are to be covered with the PDN as discussed above is 15310 ha. Out of which it is implemented and tested over 800 ha.

conclusion:

Adoption of precisely designed PVC pipe distribution network helps to increasing water use efficiency for water and food security, water management is made easy, water can be delivered to the user at right time, right place and right quantity. it is adoptable, judicious water distribution, easy to maintain water rights, low cost, low repair and maintenance cost, no chance for malpractice, Transparency, improves PIM, Volumetric and equitable and efficient water use,. It radically improves the water use efficiency and water productivity. The conventional open field channel network of the chaks situated in the command of old irrigation project shall be converted in to Gravity flow pipe distribution net work, as soon as possible as a first step and then the canal network in stages.

REFERENCES

1. Bhalage P S (2011), Vavi Harsha LIS, Periodical Maharashtra Sinchan Vikas, DIRD, Pune, Maharashtra.
2. Bhalge P S & Holsambre D G(2009), Efficient Management of Water Resources through PVC Pipe Distribution Network and Participatory Irrigation Management – A success case study, 5th Asian Regional Conference,ICID-CIID & INCID, 8-11 December 2009, New Delhi, India.
3. Government of Maharashtra, Water Resources Department,(2002), http://www.mahawrd.org/pdf/ofd_man.pdf.
4. Patil E B , Belsare Sanjai (2012), Reforms In Water Resources sector In Maharashtra State, India Water Week 2012 – Water, Energy and Food Security : Call for Solutions, 10-14 April 2012, New Delhi, India.
5. Sodal S.V.(2007): Reforms Initiatives in Water Resources Sector in Maharashtra State, India, The International Environmental Law Research Centre (IELRC), workshop on Legal Aspects of Water Sector Reforms , 20-21 April 2007, Geneva.