Chapter 5
Merits and Demerits: The Surface Canal Irrigation System and the Pipeline canal Irrigation System

5.0 Introduction

The canal irrigation system is one of the most important inputs for the crop production in the drought prone area of the country (Jadhav, 2014). In India, the canal irrigation systems have spread in different parts of the country, whereas many of them have totally unlined or partly lined (Bose, 2013). It is the main purpose of any canal irrigation system to utilize the available water resources properly with more area under irrigation. The optimum utilization of the water resource depends on the overall efficiency of the canal irrigation system. In the last chapter SCIS and PCIS have been discussed in detail. To understand the overall efficiency of the system, it is evaluated at the scientific, economical, social, and environmental levels. Therefore, this chapter discusses the merits and the demerits of the under construction SCIS and suggested PCIS.

“Sustainable Modeling of Gravitational Pipeline Irrigation System: A Geographical Focus on Left Command Area of Nilwande Dam in Ahmednagar District”, 184
5.1 Merits of the Left Bank Surface Canal Irrigation System

The surface canal irrigation system is the second most important source of water for agricultural irrigation (Madan, 1989). The Nilwande major irrigation project is one of the paramount important projects in the drought prone region of Ahmednagar and Nashik districts. It is a storage irrigation method, for serving irrigation water for the eight month cropping pattern in the command area. The present open surface canal has some important merits which are discussed in this section.

5.1.1 Ground Water Recharge

The unlined canal seepage is the most important artificial source for ground water recharging (Pujari, 2012, Mirudhulak, 2014). The surface canal seepage helps to raise the ground water table and farmers can pump water to irrigate their crops in the water scarcity period or up to the next rotation of the canal. The left bank main canal has a length of 85 km and minor canal is 67 km in the command area. The recharge of LBC is 4ham. per day/ M.Sq.m of wetted area and the total ground water recharge is 2.66 M. Cum in the command area, which is useful for watering the crop in dry periods. The dry area in the command area assists in availing the domestic water supply through pumping the ground water. Groundwater recharges from the field irrigation also the effective source of recharging the aquifer. It takes recharge from a return flow of irrigation about 30 per cent of the water supply on field head and it is worked out 34.04 M. cum available for ground water recharge in the LBC command area.

5.1.2 Flood Control

The canal irrigation systems are planned to provide a dual purpose in the respective region (Yadav, 2014). They also provide water for agriculture and domestic uses when there is a shortage of water in the command areas. And secondly, during the monsoon flood situation due to excess rain in the catchment area while canal passed flood water into the command
area. The excess water or overflow of the reservoir is used for filling the ponds and minor water storages in scarcity area. Therefore, canal plays a vital role in flood management.

5.1.3 Other merits

The surface canal irrigation system has manifold benefits. The canal network has provided an inspection roads or bank roads. It helps to provide transport and communication facilities in the remote command area. The canal boundary sides acquire sufficient, land for maintenance and has utilized for the tree plantation. Hence, vegetation cover has been increased on the canal sides. In case of indirect benefits, the land values are increasing and lend a hand to the general development of the region.

5.2 Demerits of the Left Bank Surface Canal Irrigation System

The surface canal irrigation system is a widely used system for water convey from the reservoir or river to farms in the command area (Swamee, 2000). In this process the unlined canals have substantial water loss due to the low overall efficiency. Therefore, it is essential to discuss demerits of the system to improve the overall efficiency in future, even though it is the prime source of water convey for irrigation in command.

5.2.1 Seepage and Transit Losses

It is stated in literature review that, many researchers have discussed the seepage losses from the unlined canal, which is one of the major difficulties for the open canal system. As per the Indian standard measurement (1980) the seepage water loss from unlined canals in India is varied between 0.3 to 7.0 m$^3$/s per 106 m$^2$ of wetted surface. According to the United States Bureau of Reclamation (USBR), the seepage loss of unlined canals is 20-30 percentage (Saeed, 2014). In case of the left bank canal of Nilwande irrigation project, it is workout as 4ham/day/M.Sq.m of wetted area throughout the season. That means, 2.66 M. cum (0.09 TMC) water will be lost through the seepage in main canal and branch canals. It resulted to
generate many difficulties in the command area like water logging, depletion of fresh water, salinization, aquifer contamination etc.

The transit losses considered as per the government norms for the left bank unlined canal and observed the of 4.50 cum/ second of wetted surface. It calculates 21 % of arriving the water requirement at canal head. As per the table 4.7 the total requirement of water for drinking and agricultural purpose at canal head is 7.87 TMC that means about 1.23 TMC (21 % to total requirement) is the annual transit loss in the LBC.

5.2.2 Water Logging

The excessive seepage loss from canal resulted into the water logging problems on the both sides of canal in command area. As per literature review many irrigated command have been facing the water logging problem in India and other counties. In India about 5.5 million ha irrigated land facing the water logging problems due to open canal seepages (IDNP, 2002). Pravara left canal is existing canal in the study region, which has created the water logging problems within the alluvial area in the command area (Photo 5.1).

Photo 5.1
 **Pravara Left Bank Canal and Water Logging in the Command Area**
The project conducted (2004) by the Regional Remote Sensing Service Center (RRSSC), Jodhpur of Indian Space Research Organization (ISRO) reported that, the total water logging area in Maharashtra was 426.41 thousand hectare by the various major and minor irrigation projects. Within that 11.31 Th ha area was perennial and remaining 415.10 Ta ha area was seasonally water logged. According to the same report the Bhandardara Major Irrigation Project has 4.78 thousand hectare area under water logging problem, which is an existing project in the study area.

5.2.3 Evaporation Loss

The evaporation loss through the open canal depends on the climatic elements of the region i.e. temperature, wind velocity, humidity, water surface area exposed to the atmosphere and water depth in the canal. It is very difficult to measure the evaporation loss in the relatively large command area, due to differentiation in the temperature, and wind velocity. The water loss depends directly on the exposed water surface and inversely on the water depth. Therefore, the evaporation losses not considered significant.

5.2.4 Soil Degradation

An excessive seepage water is resulted into an increasing soil salinity in the command area. It results to decline the regular crop productivity in the region (Gajja et al, 1997). Natraj (2014), has studied the causes of the soil degradation in the command area of the Pravara left bank canal. According to him, the soil deterioration is growing in the study region due to the over surface irrigation to the crops. It is observed that, in the head and middle parts of the command area, farmers over water their farms because of easy, efficient, and low pricing water availability through open canal which resulted to increase salt that affect soil badly (Photo 5.2). According to the project report of the Regional Remote Sensing Service
Center (RRSSC, 2004) 2.50 Th ha area has been found salt affected in the command area of the Bhandardara irrigation project.

**Photo 5.2**

*Over irrigation in the Pravara Left Bank Canal Command Area*

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**5.2.5 Siltation, Weeds, and Trees in the Unlined Canal**

Deposition of sedimentation on the bed of the open canal affect water transport capacity. The unlined canal banks can be eroded by the heavy rainfall, wind and weathering process that also results into the silatation (Pandey, 2013). The rapid speed of the canal water contributes an erosion of the side bank and empty canal lead to increase the mechanical weathering process. The huge amount of weeds and plant imped the canal flow and increase the maintenance of the unlined canals. It is observed that, the waste material and unwanted grass from agriculture has been thrown into the open canal. In case of the settlement side canal the solid waste also thrown into the open canal.
5.2.6 Uneven distribution of Water

Inequity in water distribution is a key problem in the command area and also all over the country. It is stated by Sharma (1989), Patel (1995), Ballabh (1997), and Solanki (2003) in the literature review that the tail end farmers have always face an injustice in water distribution. There are many motives behind that injustice to the tail end farmers. One of them is the large convey and seepage loss during the long distance water transportation. It is observed in several commands that, when flood comes in the rainy season, the head area farmers divert the canal water toward the tail enders in the command area. Hence, there is a great loss of crops and land despite the low rainfall in the area. Inversely, in the water shortage period there is a serious need of water at the tail command area for the crop and domestic purpose, but the head and middle area use water ironically and tail end area being deprived of canal water. Many times the discharge of a canal and rotation has frequency influenced by the local politicians and industrialists.

5.2.7 Wastes of Water (Canal Burst) and Water Theft

The water wastes from the canal burst due to the poor maintenance which is a common practice in an unlined canal. Many times it happen's naturally, but some times canal is broken intentionally by people in the water scarcity period. After the burst of canal in the middle or tail command area, enormous amount of water is wasted due to the head regulator control system in the unlined canal. It is commonly seen on the canal bank site that people install an illegal pump set for lifting water, which is water theft. The illegal lifting of canal water raises a new problem among the stakeholders.
5.2.8 Malpractice in Management

The misconduct approach of some administrative staff grabs vast amount of illegal charges for distribution of water (Wade, 1982). There is no measurement or volume metric scale to the water discharge on the farm. Some economically and politically powerful farmers, by bribing the staff or using influences to take more water than the limit. The small farmers are deprived of water (Rinaudo, 2002). Due to the corruption and injustice, farmers have lost trust in the canal system. The poor quality and irregular work in canal construction and maintenance lead to low efficiency and water loss.

5.2.9 Social Conflicts (Social evils)

Water and conflict are the two sides of the same coin (Deulgaonkar, 2012). When availability of water is low and the demand is high, the struggle is created. This situation comes every year during the summer or drought period. Folke (2001), and Svubure (2010) have described the social conflict between the head command area and tail command area
farmers due to an illegal water trapping. The water conflicts are observed at international to local levels. Many times, some farmers are not allowed the field canal for below stages because of an excess seepage on the particular farm. When farmers use fertilizers in their fields, they oppose the field canal due to fear of dehydration of fertilizers with an excessive water flow. The lower stage farmers face more problems because of the upper stage, government laws, ethical norms, and social burden regulate the canal flow but at lower stages individual farmers are affected.

5.2.10 Issues Related to Demand and Supply

The canal water rotation schedule depends on the cropping pattern of the command area. Many times the suggested cropping pattern and implemented cropping pattern are different. In case of the small command the cropping pattern and physical parameters are similar in the region, but in case of vast command the spatial variations are observed in the cropping pattern and the physical parameters in the region. According to soil types, temperature and cropping pattern, there is an unusually demand for water in relation to the time and place. The concept of water on demand is not workout in the open canal system.

5.2.11 Low overall efficiency

The unlined canal overall efficiency is very low in India. As stated above the problems related to the open canal, the overall efficiency has been decreased (figure 5.1). The overall efficiency includes main canal, branch canal, minor distributor, field canal and field application efficiencies (Table 5.1). According to the United States Agency for International Development (USAID) the present LBC project is considered 42 percent overall efficient under the unlined canal.
Table 5.1
Water conveys and Field operation efficiency

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Water Convey System</th>
<th>Efficiency in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Main Canal</td>
<td>85</td>
</tr>
<tr>
<td>2</td>
<td>Branch Canal</td>
<td>85</td>
</tr>
<tr>
<td>3</td>
<td>Minor Canal</td>
<td>85</td>
</tr>
<tr>
<td>4</td>
<td>Field Channel</td>
<td>90</td>
</tr>
<tr>
<td>5</td>
<td>Field Application</td>
<td>75</td>
</tr>
</tbody>
</table>

Source: Irrigation Planning report, Upper Pravara Project Nilwande

Figure 5.1
LBC Overall Efficiency

5.2.12 Other Issues

Other issues include the health problems due to water logging inside settlements, marshes, unwanted water bushes become the colonies of various insects like mosquito and cause the water born diseases like malaria. Water pollution in farm also increases with an alarming rate due to
an excess use of chemical fertilizer and water in agriculture. The biodiversity of flora and fauna has been also affected by the construction of canals.

5.3 Merits of the Pipeline Canal Irrigation System

In the drought prone command area, water resource has been utilized optimally on the sustainable basis. The traditional water conveys systems have low efficiency, so that, there is a need to improve an overall efficiency at all feasible stages in the irrigation projects. It is the prime requirement of the time to adopt the conservative and sustainable strategy for better utilization, regulation, and scheduling the water resource for irrigation and other purposes. Hence, water distribution with minimum loss and high efficiency are the key factors in the modernization of the irrigation projects. Pipeline canals are widely accepted water convey system in the world. It is a network of open/ underground piped system to convey water with minimum loss from source to command area. It has been arrived into vogue in many parts of the country. A comparative merits and demerits of PCIS are discussed in this section.

5.3.1 Zero Seepage and water logging in conveyance network

The pipeline canal irrigation system conveys water very efficiently, so there is no chance to seepage loss. If pipeline is adapted to all water convey stages the seepage loss will be virtually reduced. Hence, the seepage loss controls the water logging problem in the command area. Water is saved through PCIS which can be utilized for irrigating the additional area.

5.3.2 No evaporation loss and soil degradation

The evaporation loss depends on the free surface, proportion of water. In PCIS the water is conveyed by the closed pipes. So, there is not an evaporation loss in the transportation. Only farm level evaporation loss is considered in pipeline canal irrigation. The pipeline canal has flexibility to
convey water resource according to the demand and regulate the schedule and volume. Hence, soil degradation is also under control.

5.3.3 Equitable distribution of Water and no Water Waste

The canal discharge in the pipeline canal is regulated by valve system; there is no option for illegal water trapping, hence tail command area farmers also get their allocated water share in the scarcity period. In case of a burst of pipeline the control valve regulates the waste flow, hence, waste water can be controled compared to an open canal burst. With this system domestic water requirement will be fulfilled over the year.

5.3.4 Control on Malpractice and social conflicts

The PCIS distribute the water resource through the volume metric meters, which can be installed on each outlet. The unauthorized and unaccounted water withdrawal is prohibited in PCIS. The volume metric distribution system will help to minimize the malpractices of administrative staffs. However, the water pricing concept will be applied for revenue generation. Farmers from head, middle and tail command area will obtain their allocated water share from the reservoir. There will not be any discrimination in water distribution in the sectors like Agriculture, industry, drinking water and individual level. Therefore, this will help to stop conflicts among the stakeholders in the command area. At the farm level the field provides water by underground pipeline outlet and which can be easily carried from the outlet to the farm with a flexible pipes. Thus, this will reduce the social conflict.

5.3.5 Possible Water on Demand and flexibility in the cropping pattern

The concept of ‘water on demand’ is unattainable in the traditional open canal system due to the fix rotation schedule. The vast command area have diverse physical characteristic in case of the temperature, soil types, precipitation etc. As per the physical parameters of the region. There are numerous differentiations in water requirement in relation to time and
place. It is observed from the existing irrigation projects that in the command area the actual cropping pattern is varies than suggested. In these situation farmers from different parts of the command area demand water as per the crop requirement, but they are unable to get it from the reservoir due to the fix rotation schedule. In the PCIS system individual farmer or group of farmers will obtain volumetric water as per their requirement and place. Hence, water on demand can possible with PCIS.

The PCIS allows flexibility in the cropping pattern. The rotation can be planned as per the water availability in the reservoir and the proposed cropping pattern which shall be planned before the project work start. In case of Nilwande irrigation project the cropping pattern have been approved in 1983 by the government. Presently, farmers from the LBC command area are interested to take cash crops Onion, Sugarcane and fruit gardens like, Promogrenet, Grapes, Gaua etc. which require water continuously throughout the year. In PCIS the water demand for cash crops will be fulfilled with the drip irrigation method.

5.3.6 High Overall efficiency

The pipeline canal irrigation system minimizes the conveyance loss (Main canal, branch canal, minor) and field operation loss which are of 75 to 95 percent of overall efficiency (Satpute, 2016, Roy, 2017). There are no weed and water bushes in the PCIS, which obstruct the water flow. The siltation is also minimized and water conveys capacity will be maintained in this system. Hence, the overall efficiency of PCIS is attained at high efficiency levels.

5.3.7 No land acquisition

The pipeline canal irrigation system saves the productive land. In case of an open canal irrigation system, government enforces farmers to acquire agricultural land. The project cost is also increased to disburse the large amount of land acquisition by the government. The social conflict is
arised between the project affected farmers and the government. In case of the LBC project authority has acquired about 1212 hectares land, within that 637 ha. is Bagayat and remaining 575 ha. is Jirayat land in the command area. With this right, for 129 wells and 43 houses compensation also have paid by the government. According to the interviews of the farmers in the head command area, they are not satisfied with the government compensation and oppose the open canal system by forming the local farmer organization named ‘Nilwande Kalwa Kruti Samiti’. Therefore, the PCIS will save the productive agricultural land in the command area.

5.3.8 Other merits

With the above merits, several other merits have also been considered in the PCIS. The developed countries have adopted a canal automation system with pipeline canal, therefore, in future the PCIS will be flexible for automation. This system is easy to install compare to an open canal system. Beside agricultural water supply, this system will provide a permanent and sure source of drinking water in the water starved rural part of the command area (4.4.1)

5.4 Demerits of the Pipeline Canal Irrigation System

The pipeline canal irrigation system has a high efficiency, even though it has some demerits or limitations. They are as follows.

5.4.1 Large Initial Investment

The pipeline canal irrigation system requires a huge initial investment for construction and maintenance. In the ancient period pipeline was developed from bamboo, which was easily available in the forest. The modern pipelines are made from various types of materials like iron, steel, cement, asbestos, reinforced pipe, polyethylene, plastics, fiber etc. The selection of materials depend on the gravity, water carrying capacity, adjusted pressure and other technical factors. As per the considered
economic issues the construction cost, life of the pipeline, durability, and maintenance expenses require a huge capital investment in the pipeline.

5.4.2 Corrosion Problems

The iron pipelines have the problem of corrosion. When the iron pipe comes in contact to soil and leaf, the process of pipe rust start. Pipe corrosion reduces the life of pipelines and requires maintenance continuously also. But in recent times the technique of coating pipes and use of the other materials can be an alternative.

5.4.3 Design and Installation Require High Skill

The design of pipeline depends on the water requirement and the topography of the region. It is a difficult task to design as sufficient diameter line with proper pressure. All the necessary control valves, outlets and water quantity measurement devices should be planned and designed as per the data collected from the command area. The important technical issues should be considered in the pipeline i.e. water velocity in the pipeline, pressure relief valve, vacuum relief valve, air release valve etc. The timely maintenance, inspection, security, and pipeline protection require high skill and skillful workers.

5.5 Resume

It is necessary to evaluate both the irrigation systems for the firm decisions about its efficiency. Therefore, the present chapter deals with the merits and demerits of the surface canal irrigation system and the pipeline canal irrigation systems. In the next chapter the geographical site suitability analysis for pipeline canal has been conducted. As well as a sustainable model for pipeline application has introduced. Moreover, the comparative study between the SCIS and PCIS has been carried out in the next chapter.

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