

**Chapter – 9**  
**Command Area Development and Drainage**

**9.1 Command Area Development**

**9.1.1 Location and Classification of Land in the Command Area**

The command area of Polavaram project is spread in the following mandals of West Godavari and Krishna districts. List of mandals is given in Table 9.1

**Table 9.1**  
**List of Mandals in the Command Area**

|   |   |
|---|---|
| <p><b>I. West Godavari District</b></p> <ol style="list-style-type: none"> <li>1. Polavaram</li> <li>2. Gopalapuram</li> <li>3. Tallapudi</li> <li>4. Devarapalli</li> <li>5. Chagallu</li> <li>6. Kovvur</li> <li>7. Nidadavolu</li> <li>8. Nallajerla</li> <li>9. Tadepalligudem</li> <li>10. Ungutur</li> <li>11. Dwaraka Tirumala</li> <li>12. Denduluru</li> </ol> | <ol style="list-style-type: none"> <li>13. Eluru</li> <li>14. Pedavegi</li> <li>15. Pedapadu</li> <li>16. Pentapadu</li> <li>17. Bhimadole</li> </ol> <p><b>II. Krishna District</b></p> <ol style="list-style-type: none"> <li>1. Bapulapadu</li> <li>2. Gangavaram</li> <li>3. Vijayawada</li> <li>4. Ungaturu</li> </ol> |
|---|---|

Major portion of the command area is presently under cultivation as indicated in Table 9.2.

**Table 9.2**  
**Details of irrigation in the command area**

| Description                                    | Area (ha) |
|--|-----------|
| Gross geographical area                        | 166710    |
| Gross command area                             | 162691    |
| Cultivable command area                        | 139740    |
| Total unirrigated area                         | 39985     |
| Area under tanks and channels, tube wells etc. | 99755     |

**9.1.2 Climate of Command Area**

Normals of the climatological data of Kakinada IMD station are furnished below in Table 9.3.

**Table 9.3**  
**Monthly normals of climatological data of Kakinada IMD Station**

| Month         | Normal temperature (°C) |              | Normal wind speed (kmph) | Normal relative humidity At (percent) |           | Normal cloud cover (Octa) |            |
|---------------|-------------------------|--------------|--------------------------|---------------------------------------|-----------|---------------------------|------------|
|               | Mean Maximum            | Mean Minimum |                          | 0830 hr                               | 1730 hr   | 0830 hr.                  | 1730 hr.   |
| Jan           | 27.3                    | 19.1         | 10.3                     | 72                                    | 70        | 2.0                       | 1.5        |
| Feb           | 29.6                    | 20.7         | 10.3                     | 72                                    | 70        | 2.0                       | 1.5        |
| Mar           | 33.0                    | 23.1         | 8.3                      | 73                                    | 62        | 2.2                       | 1.3        |
| Apr           | 35.3                    | 25.8         | 9.1                      | 73                                    | 65        | 3.7                       | 2.3        |
| May           | 36.9                    | 27.7         | 11.1                     | 71                                    | 64        | 4.3                       | 3.0        |
| Jun           | 35.9                    | 27.1         | 12.1                     | 72                                    | 61        | 5.1                       | 5.1        |
| Jul           | 31.8                    | 25.4         | 12.3                     | 81                                    | 73        | 6.1                       | 6.0        |
| Aug           | 31.8                    | 25.6         | 11.0                     | 81                                    | 74        | 5.6                       | 5.7        |
| Sep           | 32.0                    | 25.5         | 8.6                      | 80                                    | 76        | 5.4                       | 5.5        |
| Oct           | 30.8                    | 24.5         | 9.5                      | 78                                    | 74        | 4.5                       | 4.8        |
| Nov           | 28.7                    | 21.6         | 12.0                     | 71                                    | 69        | 3.4                       | 3.6        |
| Dec           | 27.1                    | 19.2         | 11.3                     | 71                                    | 69        | 2.2                       | 2.2        |
| <b>Annual</b> | <b>31.7</b>             | <b>23.8</b>  | <b>10.4</b>              | <b>75</b>                             | <b>69</b> | <b>3.9</b>                | <b>3.5</b> |

Source: India Meteorological Department

### 9.1.3 Present Sources of Irrigation

The present sources of irrigation in the command area are open head channels, tanks and wells.

### 9.1.4 Socio-economic Aspects

NWDA has got a study conducted by the National Council for Applied Economic Research (NCAER), New Delhi to generate micro-level information on agro-economic and socio-economic aspects of the command areas under the proposed six link canal projects for inter-basin transfer of water in the Peninsular Rivers Development Component. Polavaram - Vijayawada link is one of those six projects studied by the NCAER.

The study has generated information at household level on various aspects of crop cultivation, pattern of employment, income, consumption, assets, demographic characteristics, access to various amenities etc., based on the data pertaining to the agricultural year 1991-92, which was the reference period for the study. The study has highlighted the differences between the households with and without irrigation facilities. The NCAER, based on the benchmark survey carried out by them, has submitted their report in October, 1993.

The selection of the sample households and methodology for data collection are discussed here. A total of 150 households spread over 10 villages in the command were selected by NCAER for the benchmark study.

**Selection of Villages:** The village level information on cultivated area and irrigation area was compiled from Census Handbooks. The proportion of irrigated area in the cultivated area was worked out. The villages were also grouped by geographical locations to ensure wide dispersion of the sample villages in the command area. The village strata for the link canal project are as under:

**Stratum 1:** Villages having good irrigation facilities.  
Total villages - 184; Selected villages - 8.

**Stratum 2:** Villages having average irrigation facilities.  
Total villages - 30; Selected villages - 2.

**Selection of Households:** All the households in the selected villages were listed. The listed households were stratified according to the major source of income (occupation) of their Heads. The cultivating households were further classified (strata) by size of land area cultivated. Keeping in view of the overall limit of sample households (1524), the number of households selected from each village was 15. Random selection procedure was used for the purpose. The findings of the study done by NCAER are presented here:

#### a) Population and Major occupations

The command area spreads over 17 mandals in West Godavari district and 3 mandals in Krishna district. The population in the command area as per 1991 census works out to 8.08 lakh out of which rural population consists of 7.04 lakh. The occupational distribution of rural population is given in Table 9.4.

**Table 9.4**  
**Occupational distribution of population in the command area**

| <b>Activity</b> | <b>Man days / percentage</b> |
|-----------------|------------------------------|
| Crop farming    | 65 / 12.68                   |
| Farm wages      | 358 / 69.40                  |
| Self employment | 34 / 6.53                    |
| Non-farm wages  | 59 / 11.39                   |
| All activities  | 516 /100.00                  |

#### b) Classification of Farmers

The command area of Polavaram - Vijayawada link canal lies in Lower Godavari sub-basin, Kolleru catchment and Lower Krishna sub-basin. These areas are in West Godavari and Krishna districts of Andhra Pradesh.

The farmers in this command area can be classified into three groups depending upon their size of land holdings as detailed in Table 9.5.

**Table 9.5**  
**Classification of farmers based on size of land holdings**

| <b>Group</b>                            | <b>Percentage</b> |
|---|-------------------|
| Marginal farmers (less than 1 ha)       | 31.2              |
| Small farmers (between 1 to 2 ha)       | 28.1              |
| Medium and big farmers (more than 2 ha) | 40.7              |

#### c) Land Tenure

Farming is the main economic activity in the command area. Land is the principal factor of production for farming activities and the ownership of the cultivated land is likely to affect them. The land ownership status of household in the command area of Polavaram - Vijayawada is given at Table 9.6.

**Table 9.6**  
**Land ownership status of households**

| <b>Ownership status</b> | <b>Percentage of households</b> |
|-------------------------|---------------------------------|
| No land                 | 48.4                            |
| Land owners             | 47.9                            |
| Tenants                 | 1.0                             |
| Both                    | 2.7                             |
| <b>Total</b>            | <b>100.0</b>                    |

#### **d) Income**

Since the objective of this study is broadly to assess and quantify the likely impact of irrigation on production, productivity and income levels in the command area, it was essential to examine the sources and composition of income of households with irrigation and without irrigation. Estimated average annual household income from all activities with and without irrigation is given in Section 9.1.7.

#### **e) Availability of Agricultural Labour**

About 40% of work force has been classified as agricultural labourers. As such availability of agricultural labour would be adequate even after introduction of irrigation.

### **9.1.5 Infrastructure facilities**

#### **a) Railways and Roads**

The Polavaram - Vijayawada link canal is running parallel and very close to NH-5 and Howrah - Chennai Railway line. The area is also served by very good network of district and other roads.

In the command area about 60% of the villages have Pucca roads and 50% of the villages have Bus stands and 10% of the villages have Railway stations.

#### **b) Marketing Facilities**

Marketing infrastructure will be the major thrust area with the acceleration of economic activities in the agricultural sector in the command area. Only 10% of the villages have marketing facilities. 30% of the villages have outlets within the village for agricultural inputs like seed and fertilizer.

#### **c) Financial Institutions**

Farmers need financial assistance for various purposes such as to meet cultivation expenses, purchase of livestock, agricultural inputs, to acquire new land, land improvement and drainage and other personal necessities. More than 60% of the villages have Co-operative Societies and 30% of the villages have Bank branches within the villages in the command.

### 9.1.6 Awareness and Popular Participation

More than 70% of the households in the command area are not satisfied with the existing irrigation facilities. Among cultivators 73% of the marginal farmers, 83% of small farmers, and 80% of medium and large farmers have reported inadequate irrigation facilities. The widespread view among the farmers of inadequate irrigation facility suggests urgent need for creation of additional irrigation potential in the area. 10.8% of the households in the command area are aware of the proposed link project. During the field enquiry the households were asked to indicate the likely advantages and disadvantages on account of the introduction of canal irrigation in their areas. 6.4% of households are expecting higher cropping intensity and 0.4% of the households think that the introduction of the canal irrigation will result in higher income. Regarding disadvantages, the waterlogging problem has been anticipated by only 1% of the households.

The Union Ministry of Water Resources has been advocating the concept of farmers' participation in the irrigation water management since a very long time. Under the command area development programme, one of the objectives is to encourage farmers in construction activities such as land levelling and shaping, construction of field channels and equitable distribution of water among the farmers' land holdings. Formation of Water Users' Associations offers considerable scope to improve the farmers' participation in the irrigation water management, in the command area.

### 9.1.7 Assessment of Likely Economic Impact

An attempt was made here to assess the likely economic impact of irrigation water made available through the proposed inter-basin water project. The increase in income from crop farming with the availability of irrigation facilities is considered as the direct benefit of the project. The changes in income of the other activities of the households in the command and consequent changes in total employment are taken as the indirect effects due to higher benefits in agriculture.

Table 9.7 given below provides the information on average income per household in various economic activities and total amount of employment generated for households with and without irrigation facilities.

**Table 9.7**  
**Average annual household income from various sources and total employment**

| <b>Description</b>              | <b>With irrigation</b> | <b>Without irrigation</b> |
|---------------------------------|------------------------|---------------------------|
| Income from crop farming        | 34422                  | 6185                      |
| Livestock and allied activities | 4903                   | 3201                      |
| Farm wages                      | 2279                   | 7352                      |
| Non-farm wage and salaries      | 800                    | 1574                      |
| Other activities                | 2011                   | 2712                      |
| Total income (Rs.)              | 44415                  | 21024                     |
| Total employment<br>(Man days)  | 642                    | 516                       |

The information presented in the above table is collected through household survey and reflects the comparison in income from different sources for households with and

without irrigation facilities. The income from crop farming and livestock is higher for house holds with irrigation facilities and this has resulted in higher income. Even if the existing irrigation facilities, which are reported inadequate by the households, have beneficial effect on total household income, then the better irrigation system to be provided after the construction of the proposed link project will perform result in even better impact on household incomes.

Although the primary impact of link project is the generation of higher income in agricultural sector but the level of income rises with time. This will generate demand for various goods and services and give an impetus for various non -farm activities.

It is observed that for households having no access to the irrigation facility, employment for farm wages is predominant in the command area. Crop farming becomes the major activity with the advent of irrigation facility in the households. The quantum of employment per households increased appreciably in the command area of the proposed link. Crop cultivation accounted for about 71% of the total employment in the command.

Farm wage activity comes next to crop farming and its share in the total employment is about 18%. There is considerable decrease in the amount of employment per household in this activity with irrigation.

Non-farm wage activity has slightly decreased with the introduction of irrigation. Self-employment activity is the least important and there is considerable decline in the per household employment for households with irrigation.

It is clear from the above discussions that the availability of irrigation directly affects crop farming and related activities (like livestock, fisheries, etc). The considerable increase of returns from these activities would take place. However, decline in non-farm activities has been observed for households having access to irrigation. But the situation is likely to change with further increase in the income.

### **9.1.8 Topography and Soils**

#### **Topography**

In the first 30 km, the ayacut under Polavaram - Vijayawada link canal lies between the canal alignment and the Godavari river and extends up to Godavari anicut near Dowlaiswaram. Beyond 30 km, the ayacut extends up to the Eluru canal under Krishna -Godavari Delta system. In the first 50 km, the width of the ayacut land extends up to 10 to 20 km from the alignment while it narrows down to 6 to 8 km beyond. As per the toposheets, the country is almost flat in the first 50 km except for a few isolated patches. Beyond 50 km, the fall of the country is of the order of 1 in 300 to 1 in 500

#### **Soils**

The soils in the command area may be broadly classified as follows:

- (i) Red soils with clay base
- (ii) Black cotton soils (deep to very deep)
- (iii) Deltaic alluvium

A brief description of these soils is given in the following paragraphs.

### **(i) Red Soils with Clay Base**

The red soils with clay base are located in low lying areas on flat lands without much facility for surface run off and in valley bottoms overlying natural streams. In view of the low lying topographic situation, in most of these soils paddy is grown either rain fed or irrigated under bore wells.

These soils resemble the orchard soils but differ significantly in regard to colour, texture and structure of the sub-soils. The sub-soil colour is greyish-grey brown strongly indicating the seasonal wet conditions. The sub-soil merges into clay. The structure is blacky-prismatic with secondary granular structure. Fluctuating water table and seasonal high moisture conditions prevailing due to topographic location, besides the heavy clay texture and the consequential partial oxidation and reduction processes appear to be responsible for the mottlings. The soil reaction is not seriously alkaline. The salt content does not exceed critical limit of 0.2 percent throughout the profile. Different layers composing the profile have different textures, and permeability percolation rates. As such the removal of excess water is not accomplished at a uniform rate throughout the profile. As a result, percolation water tends to over saturate the clay sub-soils and create temporary water logged conditions impairing aeration. But under rainfed conditions this appears to be top transient to adversely affect the crops, under irrigation farming. The same favourable conditions may not be expected to continue unless good management practices including provision of drainage are adopted. Difference in percolation rates between the surface and sub-surface layers has to be minimised by deep ploughing to incorporate a portion of the sub-soil in the surface layers and application of bulk quantities of farm manure, green manure, etc to increase the water holding capacity of the surface layer. These soils are found in the West Godavari district portion of the command area.

### **(ii) Black Cotton Soils**

These soils may be sub-grouped into two categories, viz., (a) deep black soils developed from lime stones and (b) normal regurs developed from Archaean rocks.

#### **(a) Limestone Soils**

These soils are seen in the Krishna and West Godavari districts. They are derived from sedimentary limestones of purana group and from Kurnool-Cuddapah formation.

These clay and loamy-clay soils are grey to dark grey brown in colour and are developed under the influence of arid type of climate. These soils are sufficiently deep with depth commonly in the ranges of 75 to 120 cm. In the valley bottoms and on the ridges, however, these soils are deeper and the depth is seen to exceed even 180 cm. These soils overlay either limestone slabs or cemented lime modular zone or loose lime modular zone or lime gravel. Limestone slabs of varying sizes occur in parts either as outcrops or embedded in the soil body. These stones have to be cleared to develop the areas for irrigation as otherwise they are expected to seriously interfere with tillage implements. In general, these soils have a mildly alkaline reaction at surface (pH 8.0) and it increases with depth reaching a value of 8.5 and more. The major soluble salts of the top layers are bicarbonates with small amounts of chlorides and occasionally traces of carbonate of soda. In general, the

chloride content increases with depth. The salt concentration to a depth of 75 cm from surface is well within the critical limit (less than 0.2 percent).

The sub-soil clay is wet throughout the year, very sticky and highly plastic. The sub-soils excepting the zone of maximum salt accumulation is usually alkaline. An efficient surface and sub-surface drainage system is necessary in view of the heavy nature of these clayey soils and their poor drainage conditions.

These soils respond more to phosphates than nitrogen, and combined application of nitrogen and phosphorous gives maximum yield. These soils are found to be deficient in zinc.

### **(b) Regur or Black Cotton Soils**

The regurs are grey, dark, and brown in colour. These are both shallow and very deep types, the soil depth varying from 15 to 240 cm. There are gypseous and non-gypseous soils in the deeper type. They are heavy in texture and high in salt content (0.05% to 1.0%). These are found in the West Godavari and Krishna districts. Invariably these soils are calcareous. These soils contain high amounts of free lime which occur as modules of varying sizes. The structure is usually sub-angular blocky to platy in the sub-surface layer and tends to be biconvex lentle with depth in the case of moderately well drained profiles. The pH value ranges from 7.0 to 8.5. In the deeper soils yellowish salt accumulated horizon occurs at a depth of 90 to 180 cm, depending on the relief and drainage conditions. These soils are poor in humus and nitrogen. These soils are well provided with potash. The clay content varies from 30 to 60 percent. The clay minerals are of montmorillonite and baidelite groups with exchange capacity of 1.0 milli equivalent per gram of clay. The shallow and medium deep soils are suited for light irrigated rabi crops. Irrigated crops like paddy and sugarcane can be successfully grown in these soils by providing adequate drainage and application of bulky organic manures and water soluble phosphates.

### **(iii) Deltaic Alluviums**

These occur in the deltas of West Godavari and Krishna districts. These are rich soils with high content of fine fraction of 60-70%. A section of the profile shows alternative layers of sand and silt deposited as they are brought down by rivers. The Godavari alluviums are considered to be fertile, rich in lime, potash and phosphate. The soils in Kovvur taluk of West Godavari are loamy fine sands and silts with either loamy or clayey sub-soils. The Godavari alluvium is composed of brown clay and sandy silts with modules of Kankars. The Krishna delta alluviums are composed of loamy clay and sandy clay with flat basin type topography. These soils differ greatly in texture and consistency, ranging from sands through loams and silts to heavy clay that are ill-drained and some times charged with injurious accumulations of sodium salts.

The old alluviums of Krishna and West Godavari districts are heavy clays with flat and basin type topography without facility for either surfacial or vertical drainage. These are very deep soils and the texture becomes heavy with depth. They are invariably affected by salinity and/or high water table. Application of gypsum in doses of 2.4 hundred weights per acre per season may help to promote internal drainage and prevent accumulation of toxic products arising due to reduction process. Agriculturally these are very important soils due to their high fertility status



and also assured canal irrigation. A wide variety of crops are grown, such as rice, turmeric, chillies, cotton, maize, vegetables, banana, sugarcane, groundnut etc.

### 9.1.9 Groundwater

In the command area of Polavaram - Vijayawada link, the thickness of weathered zone varies from 10 to 15 m and depth of water table varies from near surface to 25 m below ground level.

The groundwater potential estimated by the Central Ground Water Board in respect of West Godavari and Krishna districts is presented in Table 9.8. The potential in respect of the command areas under the Polavaram - Vijayawada link canal as worked out by NWDA is also presented in the same table.

**Table 9.8**  
**Groundwater potential in the command area (Mm<sup>3</sup>)**

(i) District as a whole

| District      | GCA (km <sup>2</sup> ) | Estimated potential | Provision for drinking and other uses | Utilisable groundwater resources for irrigation | Net draft | Balance groundwater available for exploitation |
|---------------|------------------------|---------------------|---------------------------------------|---|-----------|--|
| West Godavari | 7795                   | 2345.6              | 351.8                                 | 1993.8  | 472.8     | 1521.0   |
| Krishna       | 8797                   | 1234.8              | 185.2                                 | 1049.6  | 166.4     | 883.2  |

Source: CGWB Statistics – 1995

(ii) Under Polavaram - Vijayawada Link Command (worked out by NWDA)

| District      | GCA (km <sup>2</sup> ) | Estimated potential | Provision for drinking and other uses | Utilisable groundwater resources for irrigation | Net draft    | Balance groundwater available for exploitation |
|---------------|------------------------|---------------------|---------------------------------------|---|--------------|--|
| West Godavari | 1306                   | 392.99              | 58.94                                 | 334.05  | 79.21        | 254.84   |
| Krishna       | 321                    | 45.06               | 6.76                                  | 38.30   | 6.07         | 32.23  |
| <b>Total</b>  |                        | <b>438.05</b>       | <b>65.70</b>                          | <b>372.35</b>                                   | <b>85.28</b> | <b>287.07</b>                                  |

Once the irrigation is introduced after the construction of the canal system, percolation from the irrigated and the canal distributary system will contribute considerable amount of recharge to the groundwater. As such the scope for groundwater development under the command of the link canal appears to be reasonably good.

Groundwater quality in the command area is generally within the permissible limits for irrigation. Florides vary from 0.25 to 1.75 ppm. However, it appears that the crops in these areas have not been affected by the presence of rare elements.

### 9.1.10 Identification of Problems in the Command Area

## Physical Problems

There are no significant physical problems in the command area. The slopes of the area are gentle ranging from 1 in 500 to 1 in 5000. The soils are suitable for growing the crops proposed. There is also not much of a waterlogging problem.

## Financial Problems

No financial problems could be foreseen. The farmers are already in the field of agriculture. With the introduction of assured irrigation water under the link project more inputs have to be put in to achieve greater yield. This may call for more finances. Banks in general provide every assistance to the farmers, the present policy of the Government both at Central and State level being to grow more food and achieve self sufficiency by providing every conceivable assistance to the farmers.

### 9.1.11 Land Development Works

Detailed command area surveys have been got done by Survey of India by the Andhra Pradesh Government. The maps have not yet been supplied by them. The different items considered for estimating the costs under land development are as under.

#### (a) Land Levelling / Shaping

| Slope of the ayacut                                  | Extent                                    |
|--|---|
| 0 to 1%  | 1.60 lakh acres (50% of the total ayacut) |
| 1 to 2%  | 0.80 lakh acres (25% of the total ayacut) |
| 2 to 3%  | 0.80 lakh acres (25% of the total ayacut) |
| Clearance of forest, boulders and filling up of pits | 0.80 lakh acres (25% of the total ayacut) |

#### (b) Field Channels

Field channels are proposed for the entire ayacut under the canal.

#### (c) Field Drainage

Field drainage is also proposed over the entire ayacut lands.

#### (d) Farm Road

There are a good number of village roads, which in turn are linked to district roads because of the existence of developed towns and villages in the command area. No further roads are contemplated under this link project. Further, development in the road system will automatically take place as a sequence of the economic development of the area.

## **9.2 Drainage**

### **9.2.1 Basin Characteristics**

#### **Geology of the Command Area**

The geographical area of the command is 166710 ha. The cultivable command area is 139740 ha. The description on the soils encountered in the command area of link canal is furnished in Section 9.1.8.

#### **Physiography**

The country through which the link canal passes is undulating and the horizon is broken up at some places, by scattered hills and hillocks. The general soils of the track are river alluvium, red earth and black cotton and are best suited for both wet and dry crops under irrigated conditions. The main crops grown are paddy, sugarcane, pulses, groundnut and chillies.

#### **Existing Drainage Lines**

There are a number of natural streams, Chief among them are Kovvada Kalva, Yerra Kalva, Gunderu, Tammileru, Ramileru and Budameru. Practically, there would not be much of a drainage problem in the command area as the country has adequate slope along the cross section of the main canal, which will facilitate free flow of drainage water.

#### **Farm Drainages**

There are no definite courses for collecting the farm drainage. The drainage, flows from field to field and enters into minor streams which drains off ultimately into major ones.