CHAPTER VI
SUMMARY AND CONCLUSIONS

Field investigations were carried out in eight places in the black soil region of North-East Karnataka from 1966-1973.

The objectives were to evolve methods of land development to conserve maximum rain water in the soil and to collect run-off water in the farm pond for supplemental irrigation. Studies were also included to tackle problems under irrigated conditions like land development, designing stable earthen channel, estimating seepage in earthen channel and its control, subsurface drainage and allied problems involved in the layout of such drainage systems.

6.1. Land Development Under Unirrigated Farming

Land Development Systems

The three systems of land development namely, (1) contour bunding (2) contour bunding with border strip layout within the bunded area and (3) border strip layout with farm pond construction to store run-off water, were found superior to local practice
of block bunding to reduce soil erosion and to conserve more rain water in the soil. The average sorghum grain yields were 6.8, 8.5 and 11.2 quintal per hectare on an average in the three systems of layout as compared to 5.6 quintal per hectare in compartment bunded area. Further, the increase in land value due to development was estimated to be Rs. 250, 625 and 1,250 per hectare respectively.

Border strips along with construction of farm pond was more effective and economical considering more assured and better crop production in kharif and rabi with provision for supplemental irrigation. This system needs a minimum land holding of 4 hectares.

Contour bunding with border strip layout between the two contour bunds and land levelling within the strip had all the advantages of the third system except run-off water harvesting for supplemental irrigation. This could be adopted in already contour bunded areas with less than 4 hectare in extent and in the soils of medium depth.
6.2. **Land Levelling in Stages**

Border strip layout was found to be profitable when completed in two years instead of levelling at a stretch. Levelling spread over two years period, did not decrease the crop yields and it also reduced the cost of levelling by Rs. 44 per hectare.

**Border Strip Widths and Gradients**

Among the five border strip widths of 3.3, 6.6, 10.0, 15.5 and 20.0 metres and five gradients, viz., 0.0, 0.2, 0.4, 0.6 and 1.0 per cent tried, the widths and slopes upto 10.0 metre and 0.2 per cent respectively were more effective in reducing soil erosion, and in conserving of rain water, resulting in increased crop yields.

The data on the intensity and frequency of rainfall and the quantity of earth work involved in land levelling indicate that border strip widths of 3.3, 6.6 and 10.0 metre were suitable for land slopes upto 2.0, 1.5 and 1.0 per cent respectively.
6.3. Farm Ponds for Run-off Water Harvesting

Investigations on the optimum size and cost of farm ponds in relation to catchment area, rainfall run-off and its harvest for supplemental irrigation in the lands laid into border strip indicated the following:

1. The minimum catchment needed for a pond was 4 hectare to store enough water for supplemental irrigation.

2. The investment on pond construction reduced from Rs. 750 to Rs. 450 per hectare, as the catchment area increased from 4 to 20 hectares.

3. The evaporation and other losses of water in farm pond was reduced by 40 per cent when pond depth was increased from 3.0 to 4.5 metres, and also by floating of sheep manure pellets on the surface of pond water.

6.4. Land Development under Irrigated Farming

In the investigations carried out on land grading for irrigation, it was found that land grading
with bullock power was 50 times more time consuming than machine power. Further, machine power saved Rs. 40, Rs. 54 and Rs. 70 per hectare respectively in land slopes of 1.0, 1.5 and 2.0 per cent over bullock power.

6.5. Lining of Irrigation Channel

The earthen irrigation channels of 12.5 cm free-board and 15 cm berm width were stable for stream sizes of 0.5 to 1.0 cusec flow to convey irrigation water in the field channels.

The lateral seepage loss and its adverse effects on germination and growth of crops, due to weeds and excess soil water, up to four metres distance, below the embankment, could be reduced considerably by lowering the bed of the channel to 30 cm below the ground level and fixing one RCC gate for every 15 cm vertical fall in the channel. This cost works out to Rs. 25 for 100 metre length.

Among the twenty different channel lining materials tested, it was found that precast cement channels followed by burnt brick and size stone in channels.
cement mortar linings were suitable, considering the efficiency in seepage reduction, low cost and durability.

The use of washing soda, common salt and clay in 1:5:20 proportion was the most efficient but the crop growth below the channel was adversely affected due to leaching of sodium salt.

6.6. Drainage

Bell and spigot type of clay tiles with holes were found suitable and efficient when tested for A.S.T.M. standards and field performance along with butt-end, butt-end with slits, butt-end with tongue and groove, bell and spigot types with slits and holes and precast cement tiles with seating and sliding slab with holes.

Tile drains were more effective in lowering water table and leaching soluble salts resulting in higher crop yields compared to open or boulder drains.

Tile drains with holes had greater open area for water entry (3 to 6 per cent of surface area of tile)
compared to same diameter tiles with slits (less than 3 per cent of opening to total surface area of tiles). Greater the area of opening on the tiles for water entry higher was the drainage coefficient. Increase in the diameter of clay tiles from 5 to 10 and 15 cm did not relatively increase the drainage coefficient. Five cm diameter clay tiles with holes were also found effective for subsurface tile drainage in black soils of low hydraulic conductivity along with those of 10 and 15 cm diameter.

Depth and Spacing of Tile Drainage

Studies on different depths and spacings of tile drains indicated that tile depths of 105 to 120 cm with spacings of 15-18 metres were effective in lowering water table, to more than 60 cm below the ground level and in leaching the soluble salts.

The testing of Hooghoudt's drain spacing formula showed that it could be conveniently made use of without recourse to field investigations to fix up optimum tile drain spacing in black soil, provided the information on hydraulic conductivity and depth to barrier, if any, are known.
The use of filter materials for the drains was not found essential in black soils when bell and spigot type clay tiles with slits or holes were laid with openings facing downward.

Economics of Tile Drainage

Cost of tile drainage for 12 and 18 metre spacing worked out to Rs. 2,298 and Rs. 1,780 per hectare respectively when 10 cm diameter clay tiles were used for lateral or relief and 15 cm for main drains. But 5 cm clay tiles with holes for relief drains along with 10 cm tile for main drains were also found to be effective in black soils. This reduced the cost per hectare by Rs. 500 for 18 metre spacing and by Rs. 1,000 for 12 metre spacing.

Results of Practical Significance

1. In the rainfed areas of black soil of North-East Karnataka State, the method of land development, consisting of layout of land into border strip with provision of a farm pond to collect run-off water could be followed to increase the crop yield in holdings of about 4 hectare and above. With this method it was found
that soil erosion was effectively checked and moisture was uniformly conserved. It is also possible to take two crops in part of the catchment area in place of one crop by supplemental irrigation with run-off water collected from its own catchment in the pond. This is a new approach developed as a result of the investigation carried out in the area. With this approach it may be possible to increase the crop yields to a marked extent on the vast dry tract of North-East Karnataka.

2. Land layout into border strip can be conveniently taken up in two instalments at an interval of one year in order to reduce the burden of investment on the part of the cultivator and also to minimise the reduction in yield due to land levelling at a stretch.

The border strip widths of 3, 3, 6.6 and 10 metres up to 0.2 per cent gradient can be conveniently adopted where land slopes are 2.0, 1.5 and 1.0 per cent respectively.

The farm ponds can be constructed to collect about 8 per cent of the annual rainfall for supplemental irrigation, wherever the minimum catchment area of 4 hectare is available. With increase in the area of
the catchment the farm ponds are more economical. In the deep black soils increase in the depth of farm pond decreases the evaporation loss considerably. Wherever soils are deep the depth of farm pond can be increased.

3. Stable earthen irrigation channels can be constructed with 12.5 cm free board and 15 cm berm width at top, keeping the bottom of the channel 30 cm below the ground level and fixing one ROC gate at every 15 cm vertical fall in the channel to reduce lateral seepage that adversely affects the crop growth as an immediate temporary step until the channels can be lined.

The precast cement channels and single burnt brick lining and size stone with cement mortar, can be recommended for lining in the black soils, often in assessment under dynamic conditions of flow.
It has been found that five cm tile drains with holes can be used for tile drains to reclaim waterlogged areas in black soils.

Filter materials may not be used in black soils for laying tile drains when bell and spigot type of clay tiles with holes are laid with openings facing the ground.

Hooghoudt's drain spacing formula can be used to decide the spacing of tile drains in the black soils.