CONSERVATION OF WATER AND ITS UTILISATION

By
D. Singh and P.N. Bhargava
Institute of Agricultural Research Statistics, New Delhi-110012
(Received : February, 1977)

Introduction

1.1. It needs no emphasis that efficient utilisation of water resources is crucial to agricultural production for meeting the challenge of feeding the ever increasing population of our country. The total foodgrain production in 1950-51 was about 51* million tonnes to feed the population of 361* million people and the irrigated area was about 22.55* million hectares. Realising the role of adequate and timely supply of water, as one of the basic inputs for increasing the productivity per unit land, intensive efforts were made to bring more area under irrigation through the construction of major irrigation projects as well as the extensive spread of minor irrigation works over the entire country. With this comprehensive effort, the total area under irrigation increased to 38.55* million hectares (1970-71) and the total foodgrain production increased to the level of 108.42* million tonnes to feed about 548* million people. Even though, there has been a substantial increase in the production as well as irrigation facilities still about 80% of the country's cultivated area depends on the rainfall. Moreover the distribution of irrigated area over the different states has not been even. There are certain states like Madhya Pradesh, Maharashtra, Karnataka., Gujarat and Rajasthan where only 6 to 12 per cent of the cultivated area enjoys the facility of irrigation. The highest and the second highest percentages of irrigated area are in Punjab and Tamil Nadu which are of the order of 58 and 43 percent respectively.

1.2. It has been experienced that wherever irrigation facilities have been extended, there has been a substantial increase in productivity as well as complete transformation in socio-economic structure of the countryside. The well known example is that of Punjab, Haryana and the area covered by Ganga canal in Ganga Nagar District (Rajasthan). In order to increase the potential of foodgrain pro-

Source : *Basic Statistics relating to Indian Economy 1950-51 to 1970-71, C S.O. Deptt. of Statistics, New Delhi.

duction, it is very necessary to have a comprehensive strategy for the conservation and development of our water resources keeping in view its limited availability.

2. Water Resources

2.1. The entire water available in the country is through precipitation received by different parts of the country. The precipitations are in various forms like rainfall, hail, sleet, snow and dew. It is estimated that India receives on an average an annual rainfall of about 370 million hectare-metres. Out of this amount it is estimated that about 80 million hectare-metres seep into the soil and another 170 million hectare-metres flow into the rivers as can be seen from Figure 1. The remaining 120 million hectare-metres evaporates. Out of 170 million hectare-metres of river flow (Fig. 1E), only about 35 per cent can be utilised for irrigation purposes due to limitations imposed by topography, river flow characteristics, climate and soil conditions. The utilisation of this surface water by the end of 1968-69 was only about 26.6 million hectare-metres. There was thus a utilisable surplus of 33.1 million hectare-metres of water at the beginning of the Fourth Five Year Plan. Assuming that the Fourth Plan period target of 5.3 million hectare-metres of water has been fully utilised, the remaining 27.8 million hectare-metres is still available for future utilisation (Fig. 1E). It was estimated that the total ground water utilised in India through wells was of the order of 8.15 million hectare-metres by the end of 1968-69 (Fig. 1D). The development programme for the ground water under Fourth Five Year Plan aimed at utilising an additional 3.1 million hectare-metres of water. Assuming the entire target as having been met, there is still a surplus of 15.50 million hectare-metres of ground water for future development from the annual recharge alone. However, the unutilised surplus water due to river flow as well as under ground water, which is 43.30 million hectare-metres (Fig.1F) can be beneficially utilised for increasing the production in the areas where the availability of water is inadequate. It could thus be seen that even though our present position with regard to water supply is generally satisfactory from an overall point of view, the supply is by no means unlimited. Our water resources are insufficient to meet the long term requirements of agriculture and as such call for its judicious and economic use. The available resources are ill distributed, resulting in seasonal abundance and devastating floods in some areas while large tracts in other regions are chronically drought affected. There will be increasing competitions for available supplies as more and more water getsharnessed and committed.

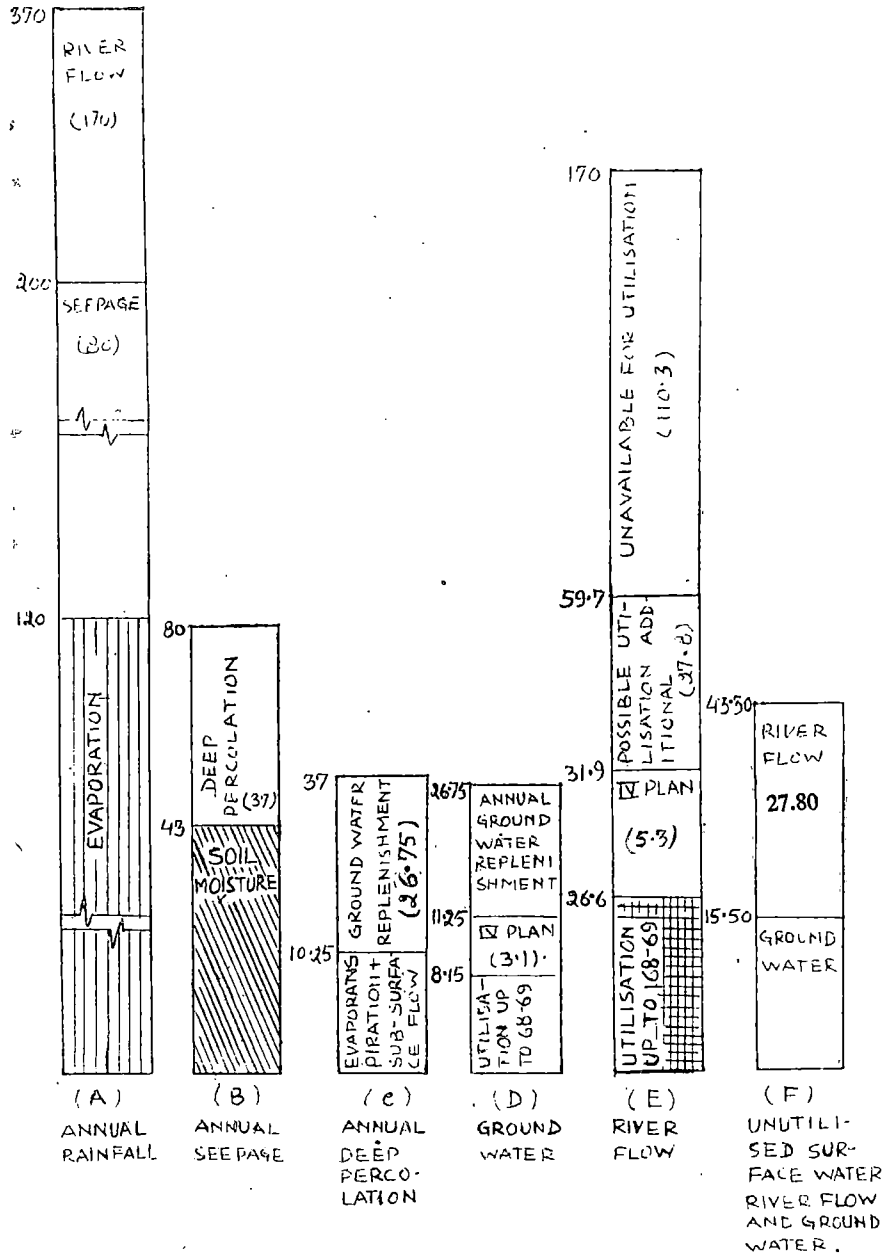

Fig. 1. Water Budget.

3. Background, Potential and Development of Water Resources

3.1. The areas where the potential of conservation of water has to be created and developed can broadly be classified into the

following three categories keeping in view the amount of rainfall received in a particular area during the whole year :

(*i*) The regions where the rainfall is very low and of unpredictable nature (less than 75 cms.);

(*ii*) Areas which have assured rainfall but do not have adequate irrigation facilities (rainfall between 75 cms and 115 cms) and

(*iii*) The areas which have excessive rainfall and are affected by floods (more than 115 cms).

The following table gives the distribution of net irrigated and cultivated area according to low, medium and high rainfall regions.

TABLE 1

Distribution of irrigated and cultivated area according to low, medium and high rainfall regions in 1967-68

(*Area in thousand hectares*)

Rainfall (in cms)	*Net irrigated area*	*Net area sown/cultivated*	*% of irrigated area to net area sown*	*Range of % of net irrigated area to net area sown*
0—75 (low rainfall)	8724 *(32.2)	47457	18.4	8—76
75--115 (medium rainfall)	11219 *(41.4)	50167	22.4	4—52
115 and above (high rainfall)	7148 *(26.4)	42127	17.0	6—52
Total	27091 *(100.0)	139751	19.4	

Source : Fertilizer Statistics 1972-73 ; the Fertilizer Association of India, New Delhi.

*Figures in brackets indicate the percentage of irrigated area in each category to the total irrigated area in the country.

It will be seen from the table that the net cultivated area is lowest in high rainfall regions and highest in medium rainfall areas. Further, the corresponding net irrigated area also follows a similar trend. The percentage area irrigated for the entire country was only 19·4 per cent.

3.2. In the areas having rainfall less than 75 cms, the irrigation facilities are highly inadequate for about 80 per cent of net cultivated area. The remaining 20 per cent of such areas enjoy the irrigation facilities to the extent of about 50%, these areas being largely located in Haryana, Punjab and Uttar Pradesh.

3.3. For the areas having assured rainfall in volume and spread (75-115 cms) about 45 per cent of the net area sown has very little irrigation facilities while in remaining areas the irrigation facilities are available to some extent but these do not cover more than 34 per cent of net area sown. In the regions where the amount of rainfall received during the year is more than 115 cms about 72% of net area sown have inadequate irrigation facilities. The net area irrigated in these regions ranges from 6% in Goa to 24% in Meghalaya. The remaining 28% of net area sown enjoys irrigation facilities to the extent of about 30% only.

3.4. The areas having soil moisture deficiency ($\leqslant$75 cms rainfall) are not only unproductive but also suffer from drought frequently because of unpredictable nature of rainfall. Due to this, the areas, like Telengana region of Andhra Pradesh, Gujarat, East Rajasthan, Kashmir and West Uttar Pradesh suffer from drought once in three years while there are areas like West Rajasthan where its incidence on an average is once in two and a half years. In addition to this, in these regions a large proportion of water is lost through non-beneficial evaporation, stream flow and seepage. As such, large areas remain uncultivated throughout the year. In these areas generally only one non-remunerative crop is grown which is either Bajra or *Jowar*. In the other season most of the land is kept fallow because of non-availability of moisture in the soil. The receptive soil of these regions goes waste by being utilised for crops which can grow under dry conditions but which are economically not so remunerative and useful to meet the economic needs of the country. These areas are really the seat of poverty and in this part socio-economic structure of the countryside is also very disappointing and depressing. In such areas, the need for water harvesting and development of water resources through scientific method is of immense importance.

3.5. In regions having an assured rainfall but inadequate irrigation facilities, the conditions are no better. In these regions if the rainfall is delayed or before time the crops grown are adversely affected, which results in the loss of production. Normally rice or long duration crops are grown in *Kharif* season and the land is kept fallow in the next season. The main difficulty in growing a second successful crop after a *Kharif* crop in such areas is the insufficiency

of moisture for cultivation of the next crop. The problem under these conditions can be solved to a large extent, by conserving sub-soil moisture and by artificial harvesting of water during the monsoon period. Conservation of rain water in such unirrigated areas is possible by taking steps which are conducive for the maximum absorption into ground, of the rainfall, reaching a given area.

3.6. In the areas where the rainfall is heavy and causes floods the problems are awful and challenging because these areas are affected by floods in one season and by drought in other part of the year. In these regions, on an average about 30 lakh hectares are affected by floods annually and thus suffers from crop damage. The average value of crop damaged annually is about Rs. 12,560 lakh. The total crop losses in different years in the country are presented in a graph (Fig. 2). It will be seen that the loss due to floods is quite heavy each year and there has been an increasing trend since 1965. Such loss during 1965 was minimum as drought conditions prevailed over the entire country. Again, on account of widespread drought in large parts of the country the loss due to floods was comparatively less in 1972. The production of foodgrains which has risen to an all time record of 108 million tonnes in 1970-71 also declined by approximately 10 per cent during the year. The average loss due to floods in different states was examined and it was, however, observed that the loss is more pronounced in areas of Andhra Pradesh, Orissa, Bihar, U.P. and certain regions of Assam. The problem of these areas is not only to provide irrigation facilities but also to minimise the loss due to frequent floods and run off water. Not only that during this season run off water is lost but also the rich soils of the land which has been fertilised by the farmers with chemical fertilisers and organic manures is also carried away along with this run off. It has been estimated that every year during this season the total annual loss of nutrient from the soils is 2.5 million tons of Nitrogen, 3.8 million tons of phosphorus and 2.6 million tons of Potash*. In fact, this fertility loss is much more than what is being done at present to fertilise the crop annually. Thus the soils in these regions are always deficient in respect of nutrients and as such the productivity does not improve. Long range planning is necessary to mitigate the effect of floods, loss of run off water and soil nutrient. These include afforestation and provision of intercepts in the catchment areas to conserve water and soil in these regions.

*Swaminathan, M. S., "Agriculture on Space Ship Earth", Coromondal Lecture, New Delhi, February, 1973.

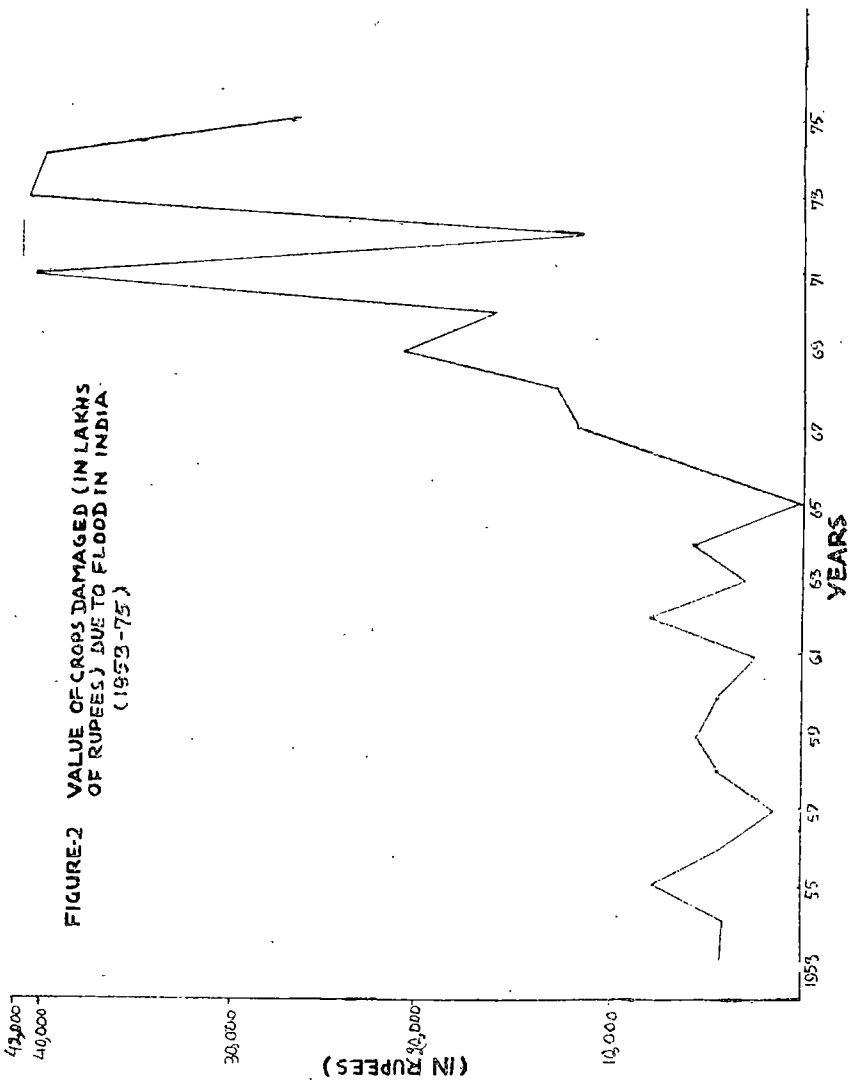

Fig. 2. Value of crops.

3.7. It is thus seen that owing to deficiency of soil moisture, loss of water due to evaporation, lack of irrigation facilities, lack of means to conserve water for future use and excessive run off, there is a large area which remain-uncultivated in one season or the other. The productivity remains marginal and the land cannot be utilised properly for the purpose of intensive cultivation. Keeping this in view, a method for the conservation of this water has been suggested in the subsequent section. Its utility and advantages are also discussed in a separate section.

4. Proposed System of Conservation of Water

India receives more than 70% of the annual rainfall during monsoon season *i. e.* from June to September. This gives rise to a large amont of un-utilised river flow water which is mainly constituted of run off. Thus, this is the period suitable for the conservation of water.

4.1. Table 2 gives the annual average rainfall and total run off expressed as percentage of total rainfall received for some of the places. From the table it is seen that in some regions about 70% of the rainfall goes waste as run off. It can also be seen that for the same amount of rainfall there is a considerable variation in run off. Thus the run off not only depends on the average quantity of rainfall but also on other factors like intensity, distribution of rainfall, soil type, topography, infiltration rate and maximum water holding capacity of the soil. Only a small fraction of rainfall percolates into the underground water reservoir. Thus, there is a possibility of utilising this run off for the benefit of entire nation by a little effort at national level. This can, however, be done by storing it in large basins, reservoirs, tanks or other storage devices. The water so conserved can, however, be utilised subsequently for domestic purposes as well as for minor irrigation. It is this resource of water to which we should turn our attention in order to restore the balance between irrigated and dry areas. There is no doubt if conentrated scientific effort is made by engineers, statisticians, meteorologists and agricultural scientists, some efficient and economical method of collecting this nature's bounty can be devised which otherwise goes as waste through neglect. In this way we will be able to conserve and augment useable supply/stock of water resources for types of areas categorised above; further this will help in bringing more areas under cultivation which could not be done otherwise because of deficiency of moisture in the soil.

4.2. For conserving the water in basins or reservoirs at village level, methods will have to be tailored according to the needs of the areas. In regions of excessive rainfall large basins will have to be constructed to intercept floods, this would not only moderate the floods but also decrease their incidence to some extent. These reservoirs can, however, be constructed in land of uneconomic use or waste land. In order to induce the maximum run off, the catchment areas can be properly levelled. In the areas with an assured rainfall, by properly treating the land and spreading chemicals in catchment areas, rate of evaporation can be reduced. Through this system new water supplies can be developed in these regions. Owing to dry climatic conditions, high wind velocity and fluctuations in temperature, there is always a chance of unrestricted evaporation which results in

loss of 25% or more water stored in tanks. It is, therefore, necessary to cover the surface of the reservoir with fully compressed mono-molucular layer of fatty alcohol series of compoun ds or solid floats to retard evaporation.

5. Utility of Proposed System

5.1. This system has a large number of advantages over the other systems—The main advantage of the system is that it takes into account the socio-economic structure of the farming community since the bulk of the farming community is constituted of small and medium size holders. It gives the control over water supply to individual farmers. Its operation, maintenance etc., involves less capital and may be acceptable to a large number of cultivators without affecting the existing system. It does not depend on thte expensive and unreliable modern source of energy. Since the sys em utilises surface water, there is no danger of decline in water table; on the other hand, it helps in improving the water table th rough artificial re-charge. This system induces multiple cropping n these regions, thereby increasing the income of the farming community. Another major advantage of this system will be that the rich soil which flows with the run off water during monsoon season is retained in the water reservoir and with proper planning, the soil can be taken back by the farmers to their land.

5.2. The water so conserved can also be utilised for the development of other allied activities like fisheries and grooves. The rearing of the fishes in the tank will not only provide the employment to the agricultural labourers but also will enrich the soil of the tank, which can be utilised subsequently by the farmers. Because of the rise in the water table around the tank, the proper planting of grooves will provide the extra income to the cultivators as well as employment to the agricultural labourers of the region.

5.3. In order to utilise this conserved water, a proper cropping pattern will have to be developed to obtain maximum output per unit of water. This will need scheduling of irrigation in context of climatological factors and investigation into the water requirements of the individual crops.

5.4. Thus, if this run off is collected in large basins as a community programme, it will have a far reaching effect on the rural economy. The programme of water conservation can also be very well fitted into plan of development of individual village and even individual farmers. It is not out of place to mention that if its cost and benefits ratios are worked out the benefits accruing from such

projects will be manifold. It will not only provide the best way of conserving natural resources of water and soil but will generate tremendous employment in rural areas. The success of the system of conservation and utilisation of water will need the joint efforts of the specialists in different scientific disciplines on the one hand and local rural leaders on the other. Initially, it can be taken up as a pilot project to serve as a demonstration and thereafter for its implementation the public institutions may be asked to come forward for necessary consultative service and financial help.

5.5. There is a large number of problems associated with the conservation and utilisation of water, like selection of site, estimation of run off, size of reservoirs, determination of catchment and command areas, the development of suitable cropping pattern etc. Obviously, multi-disciplinary approach is the solution to this problem.

SUMMARY

The extension of irrigation facilities have been considered essential for increasing crop production as well as the income per unit area. In this regard, a large number of major and minor schemes were initiated in the past by the Government but they have failed to make the impact on the agriculture front. Keeping in view the economic background of the bulk of the cultivators it is suggested in the present paper that the run-off which goes as waste during the heavy rainfall period may be conserved. The method of conservation of a fraction of this run-off for different areas to be tailored according to the availability of the amount of run off is discussed. The utility of this system over the existing system is given in detail.

ACKNOWLEDGEMENT

Authors are highly thankful to Smt. Asha Saxena and Shri R. K. Ghai, Scientists of the Institute for their valuable help while preparing this paper.

TABLE 2

Annual rainfall and annual run off

Sl. No.	*Name of the Station*	*Average annual rainfall (mm)*	*Average annual run off (mm)*	*Percentage of rain*
1.	Agra	805.2	259.1	32
2.	Dehradun	2222 5	1422.4	64
3.	Kota	749.3	195.6	26
4.	Ludhiana	754.4	157.5	21
5.	Patna	1023.6	350.5	34
6.	Cuttack	1529.1	647.7	42
7.	Ranchi	1483.4	723.9	49
8.	Lucknow	1052 8	408.9	39
9.	Sagar	1375.9	723.9	53
10.	Bombay	2090.9	1478.3	70
11.	Ahmedabad	722.2	309.9	43
12.	Shillong	2242.6	1557.0	69
13.	Dibrugarh	2547.6	1770.4	69
14.	Udaipur	645.2	139.7	22
15.	Jagdalpur	370.1	42.7	11
16.	Khammam	1005.9	186.9	19
17.	Trivandrum	1822.7	675.6	37
18.	New Delhi	718.8	150.9	21
19.	Bellary	525.3	7.9	1
20.	Poona	707.4	89.7	13
21.	Raipur	1357.9	614.7	45
22.	Surat	1201.2	595.4	50
23.	Srinagar	675.9	155.9	23

Source: Soil Conservation Statistics Bulletin, Ministry of Agriculture (June, 1964), Table 7.5