GUIDELINES FOR LESS WATER CONSUMING (LEANER) CROPPING PATTERN FOR IRRIGATION SYSTEM IN DROUGHT-PRONE AREAS

GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION
IRRIGATION PLANNING DIRECTORATE

NEW DELHI
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FOREWORD

Variations in climate, rainfall and soil warrant careful planning of irrigation projects in the country. Special attention is required to be paid to drought prone regions where land is abundant, but water is scarce. In such areas, it is important that there should be atleast one assured crop in a year to sustain the farmer. Irrigation supplies in these areas have to be put to the most economical use in order to extend the benefit of irrigation to as large a number of holdings as possible, apart from optimising production per unit of water.

This brochure aims at fulfilling the above objective. For drought prone areas, among other practices, using less water consuming (leaner) cropping pattern in irrigation systems is imperative. These Guidelines are region specific and are based on agro-climatic conditions. It is hoped they would be of use not only to the planners but also to Irrigation Engineers, Agricultural officers and farmers, as well.

I would like to place on record the interest and initiative taken by S/Shri B.B.Karajagi, Chief Engineer (IMO), C.D.Khoche, & A.K.Shangle, Directors, R.K.Bhar, and K.Krishnasamy, Dy.Directors and other staff in the Irrigation Planning Directorate, in the preparation of this document.

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GUIDELINES FOR LESS WATER CONSUMING (LEANER) CROPPING PATTERN FOR IRRIGATION SYSTEMS IN DROUGHT PRONE AREAS

1.0 INTRODUCTION

1.1 Drought Area

Drought is a complex environmental phenomenon. Its severity depends mostly on the amount of precipitation and its distribution in space and time over a region. The Irrigation Commission, (1972) identified 77 drought-prone districts in the country based on the criteria of annual rainfall being 750 mm or less. The Commission had also observed that another 22 districts receiving rainfall between 750 mm to 850 mm and having very little irrigation facilities were equally vulnerable. The matter was further examined by the National Commission on Agriculture (NCA), (1976), the Central Water Commission, (CWC) and others. CWC has reported a list of 99 districts spreading over 13 states as 'drought prone' as given in Annexure-I.

It is estimated that about 20% of the cropped area in these drought prone districts is irrigated which may be enhanced to about 25% after completion of all the identified irrigation projects. The remaining 75% of the cropped area will still continue to depend on rainfed cultivation as transportation of water from other basins may not always be possible, due to techno-economic considerations.

1.2 Policies for Drought Area

THE NCA, (1976)

The National Commission, in their report, in order to make the optimum use of the available Water Resources have laid down certain policies which, iter-alia, include the following:

(i) Making maximum use of rainfall for raising crops, utilising irrigation for making up the deficiencies.

(ii) Adoption of the most suitable cropping pattern from consideration of soil, climate and availabilities of irrigation supplies.

THE NATIONAL WATER POLICY (NWP), 1987

The NWP document (para 18.1) states:

> "Drought Prone areas should be made less vulnerable to drought associated problems through soil-moisture-conservation measures, water harvesting practices, the minimisation of evaporation losses, the development of the ground water potential and the transfer of surface water from surplus areas where feasible and appropriate. Pastures, forestry or other modes of development which are relatively less water-demanding should be encouraged. In Planning water resources development projects, the needs of drought prone areas should be given priority".

2.0 DROUGHT MANAGEMENT

2.1 Rational Approach

In drought prone areas in the country, inadequacy of water is the major constraint in improvement of productivity from land in general, and from small and marginal holdings in particular. However, past experience reveals that the harmful effects of drought could be managed by following a planned and rational approach towards, among others, cropping pattern and proper irrigation scheduling practices during the critical stages of crop growth in these areas.

2.2 Critical Stages of Growth of Crops

Due to inadequacy of water in the drought prone areas, Irrigation system may cater for fewer waterings than required for maximum yields. This will extend the benefit of irrigation to a larger number of farmers. Under such conditions, it becomes very important that irrigation is done during the critical stages of crop growth to avoid serious reduction in yield.

In experiments conducted by the Indian Agricultural Research Institute (IARI), New Delhi, with wheat (Sonar-64) a single irrigation 25 days after sowing raised the yield to 3 times that of an unirrigated crop. With three waterings at the most appropriate stages, the yield was 3.8 times, with four waterings 4.5 times, and with five waterings 5.1 times. These results show that, in drought prone areas, with a fewer than the optimum number of waterings on a larger area and appropriate timing of irrigation, a greater overall production can be secured.

Although the number and period of critical stages vary from crop to crop, seeding, pre-flowering and grain development stages, are generally considered as the critical ones for most of the crops. The critical stages of some of the important crops are as given in Annexure-II.

3.0 OBJECTIVES

3.1 In order to meet the food and fibre requirements of the ever increasing population and fodder requirements of animals, every metre of land and every drop of water have to be used with utmost care. Much more care is required in crop planning where abundant land is available, but water is scarce. Production of crops have to be optimised per unit of water in places of water scarcity. Drought resistant-deep-rooted, less water consuming, short duration crops and high yielding varieties are the needs of the area taking into account the local conditions.

3.2 For each drought prone area, the crops in an irrigated command are best chosen from amongst those which are natural to the area under rainfed conditions and their yields increased and assured with irrigation supplies. In this context, consideration of agroclimatic zones assumes importance in planning an irrigation project. The NCA (1976) have on the basis of distribution of monthly rainfall in a year delineated the country into various rainfall pattern zones. It is found that the pattern of cropping in rainfed zones are dictated largely by climate and physical parameters and needs of the area. By keeping these points in view, broad guidelines for adoption of suitable cropping pattern for the project commands in drought-prone areas have been suggested herein.

4.0 CROPPING PATTERN

4.1 Climate and Physical Parameters

The crops that can be grown in a drought-prone area are generally determined by the factors like temperature rainfall and type of soil in that area. For example, wheat is best sown in the cool climate above latitude 20°. While wheat does well in loam and sandy loam, rice requires clayey soils which have low permeability. Generally ground-nut does well in loose and sandy soils, but rice is discouraged in sandy soils and that too in drought prone areas.

As the time span of most crops is usually of the order of 90 days or longer, considering the extent and distribution of rainfall, the cropping pattern as recommended by NCA (1976) is given below in Table 1.

TABLE - 1

Sl. No.	Rainfall for 3 consecutive months (mm/month)	Suitable crops	Remarks
1.	More than 300	Paddy	Discouraged in drought prone areas.
2.	300 - 200	Maize and Black gram	If rainfall is for a month, then supplemental irrigation is required for good yield.
3.	200 - 100	Bajra, Jowar and small millets.	-do-
4.	100 - 50	Moth (Faconitifolius) & ephemeral grasses.	Irrigation is required when rainfall is less.
5.	Less than 50	Not of much significance for crop production.	(-)

In some years there may be early or timely on set of monsoon, while in some other years the monsoon rains may be delayed. In such conditions, sowing of crops would have to be adjusted depending on the occurance of actual rainfall. However, kharif crops if planted in time will not only result in higher production than that from late planting, but will also indirectly result in increasing water use-efficiency. Delay in planting of Rabi crops will not only reduce yield, by exposing them to high temperature during March, (when crop is in developmental stage), but will also reduce water use efficiency.

4.2 Choice of Crops

Suitable cropping pattern with their duration for different ranges of water availability as recommended by NCA (1976) is given in Table-2. A number of crops can be chosen for low rainfall/water availability areas.

TABLE - 2

Water availability range (in mm)	Kharif Crops	Kharif Duration (in days)	Rabi Crops	Rabi Duration (in days)
250 - 400	Sorghum, Maize fodder & green gram.	60 - 90	Peas	90 - 130
			Barley	120 - 140
			Gram	120 - 140
	Black gram	80 - 105	Mustard	120 - 150
	Pearl millet	85 - 100	Linseed	140 - 160
	Seasamum	100 - 120	Safflower	140 - 180
	Castor	180 - 240		
400 - 600	Vegetables	60 - 90	Sorghum	90 - 120
	Sorghum	90 - 120	Barley	120 - 140
	Groundnut	100 - 150	Wheat	120 - 150
	Soyabean	110 - 130	Coriander	120 - 150
	Tobacco	120 - 150		
	Cotton	180 - 210		
600 - 1000	Vegetables	90 - 120	Potato	90 - 120
	Maize	110 - 130	Onion	140 - 160
	Cotton	180 - 210	Berseem	210 - 240

Where the interval between successive waterings is prolonged, deep rooted crops do better if there is good depth of soil as they can tolerate longer dry spells than shallow rooted ones. Amongst the different groups, the species in increasing order of moisture stress tolerance as recommended by NCA (1976) are given in Table - 3.

TABLE - 3

Sl. No.	Season	Moisture stress tolerant crops: Cereals	Pulses	Oilseeds
1.	Kharif	Maize, Pearl-millet, Sorghum, crowfoot millet.	Cowpeas, black gram, greengram soyabean, Pigeon pea, cluster bean.	Groundnut, seasamum, castor.
2.	Rabi	Wheat, oats, barley.	Lentil, peas, gram.	Linseed, sunflower, safflower, mustard.

4.3 **Agro-Climatic Zones & Cropping Pattern**

On the basis of the rainfall and cropping pattern studies made in detail by the NCA (1976), Planning Commission, Government of India in their report had finally come out during 1989, with cropping pattern for 15 Agro-climatic zones taking into account the climate, soils and agronomical aspects of each zone in the country. Cropping pattern for each zone have separately been indicated. It is found that in some subzones of 9 zones, annual rainfall is below 850 mm and so these can be taken as drought affected.

It would, therefore, be advisable to adopt in those subzones, cropping pattern as recommended by Planning Commission. The same is given in Annexure III.

5.0 NEED BASED CROPPING PATTERN

5.1 In drought prone area, it is important that there should be at least one assured crop to sustain the farmer. As water resources in such areas are scanty, irrigation supplies have to be put to the most economical use in order to extend the benefit of irrigation to as large number of holdings as possible.

5.2 The existing cropping pattern represents the integrated effect of the climate and physical parameters of the area as well as the local habits and economic factors of the farmers as evolved over many years. The existing pattern should, therefore, be retained as far as possible with supplemental irrigation to improve the yield of crops.

5.3 Some of the existing cropping pattern may, however, require to be replaced judging from their duration and water consumption angles. The following general criteria may be followed for this purpose.

i) Less water consuming crops may be introduced in place of high water consuming crops

ii) Long duration varieties of crops should be replaced by short duration varieties, and

iii) Improved and hybrid varieties with drought resistant properties should be preferred.

5.4 It is reported that under limited water supply, deep rooted and high value crops like sunflower, safflower, mustard, linseed and gram grow better than shallow rooted and low value crops like wheat and lentil. It has also been reported that, with less than four irrigations, cultivation of wheat may not be remunerative and therefore, larger area should be put under pulses and oilseeds.

5.5 Berseem, lucerne and senji are excellent legume fodders of winter whereas cowpea and guar are high yielding leguminous fodder crops of kharif season. These crops may be included in the cropping pattern of the project in the drought prone area, depending on the fodder requirement and water availability.

5.6 There is a tendency for using lesser quantity of fertilizer for the crops in water scarcity areas. Crop rotation is suggested so as to avoid the depletion of the soil fertility. In this regard, Arhar, Urad, Moong and Cowpea are important pulses of kharif season and may be included in rotation with wheat. Gram, peas and lentil are important rabi pulses and may be included in rotation with maize, bajra and jowar.

5.7 Grain legumes will not only provide protein rich food but will also enrich the soil with Nitrogen content by fixing atmospheric Nitrogen. Besides grain legumes, fodder legumes also enrich the soil with Nitrogen. Inclusion of such legumes in cereal based cropping pattern will thus help in diverting proportionately more fertilizer to unit areas of cereal crops and will also contribute to increasing production of subsequent cereal crops.

6.0 CONCLUSION

6.1 The guidelines are general in character and region specific based on agro-climatic conditions. They highlight the need to adopt a suitable cropping pattern to mitigate the effect of drought. However, they are in no way exhaustive and may have to be reviewed in light of data as would be available for the local conditions from various research centres in the country.

6.2 It is hoped that these guidelines would be equally useful to planners, irrigation engineers, agricultural officers and farmers.

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Annexure - I

STATEWISE DROUGHT AFFECTED DISTRICTS IN INDIA

Sl.No.	State/drought districts	Sl.No.	State/drought districts
I.	ANDHRA PRADESH	V.	JAMMU & KASHMIR
1.	Anantapur	32.	Doda
2.	Chittoor	33.	Udhampur
3.	Cuddapah		
4.	Hyderabad	VI.	KARNATAKA
5.	Kurnool		
6.	Mahbubnagar	34.	Bangalore
7.	Nalgonda	35.	Belgaum
8.	Prakasam	36.	Bellary
		37.	Bijapur
II.	BIHAR	38.	Chikmagalur
		39.	Chitradurga
9.	Monghyr	40.	Dharwad
10.	Nawadah	41.	Gulbarga
11.	Palamau	42.	Hassan
12.	Rohtas	43.	Kolar
13.	Bhojpur	44.	Mandya
14.	Aurangabad	45.	Mysore
15.	Gaya	46.	Raichur
		47.	Tumkur
III.	GUJARAT		
		VII.	MADHYA PRADESH
16.	Ahmedabad		
17.	Amreli	48.	Betul
18.	Banaskantha	49.	Datia
19.	Bhav-Nagar	50.	Dewas
20.	Bharuch	51.	Dhar
21.	Jamnagar	52.	Jhabua
22.	Kheda	53.	Khandwa
23.	Kachchh	54.	Khargone
24.	Mahesan	55.	Shahdol
25.	Panch Mahals	56.	Shajapur
26.	Rajkot	57.	Sidhi
27.	Surendra Nagar	58.	Ujjain
IV.	HARYANA	VIII.	MAHARASHTRA
28.	Bhiwani	59.	Ahmadnagar
29.	Gurgaon	60.	Aurangabad
30.	Mohendragarh	61.	Bir
31.	Rohtak	62.	Nasik
		63.	Osmanabad

Sl.No.	State/drought districts	S.No.	State/drought districts
64.	Pune	98.	Midnapur
65.	Sangli	99.	Puruliya
66.	Satara		
67.	Solapur		
IX.	ORISSA		
68.	Phulbani		
69.	Kalahandi		
X.	RAJASTHAN		
70.	Ajmer		
71.	Banswara		
72.	Barmer		
73.	Bikaner		
74.	Churu		
75.	Dungarpur		
76.	Jaisalmer		
77.	Jalore		
78.	Jhunjunun		
79.	Jodhpur		
80.	Nagaur		
81.	Pali		
82.	Udaipur		
XI.	TAMIL NADU		
83.	Coimbatore		
84.	Dharmapuri		
85.	Madurai		
86.	Ramanathapuram		
87.	Salem		
88.	Tiruchirapalli		
89.	Tirunelveli		
90.	Kanya Kumari		
XII.	UTTAR PRADESH		
91.	Allahabad		
92.	Banda		
93.	Hamirpur		
94.	Jalaun		
95.	Mirzapur		
96.	Varanasi		
XIII.	WEST BENGAL		
97.	Bankura		

Annexure-II

CRITICAL STAGES OF GROWTH OF SOME IMPORTANT CROPS FOR IRRIGATION

Sl.No.	Crop	Critical stages of growth
I.	**Cereals**	
1.	Paddy	Seedling establishment, Tiller formations, Prionordia formation, flowering, milking.
2.	Wheat	Crown root initiation, tillering, late jointing, flowering, milking
3.	Jowar	Grand growth, Milking, grain formation
4.	Maize	Vegetative state, tasselling, silking
5.	Barley	Active tillering, flag leaf stage
6.	Bajra	Heading, flowering
II.	**Pulses**	
1.	Arhar	Flowering or post flowering
2.	Gram	Branching, pod filling
3.	Peas	Flowering, grain filling
III.	**Oilseeds**	
1.	Mustard	Seedling, flowering
2.	Lentil	Pre-flowering, Pod development
3.	Linseed	Flowering, Pod development
4.	Raya	Flowering - Pod development
IV.	**Fibre-crop**	
1.	Cotton	Seedling, Preflowering, flowering, milking

Annexure-III

CROPPING PATTERN IN THE DROUGHT-PRONE AREA HAVING ANNUAL RAINFALL LESS THAN 850 MM IN 9 AGRO-CLIMATIC ZONES

Sl.No.	Agro-climatic zone and climate	Soil	Cropping Pattern
I.	Western Himalayas		
1.	Sub-humid	Sub-mountain, mountain, meadow, skeletal	Wheat, Maize, Rice, Sugarcane
II.	Upper Gangetic Plains		
1.	Semi-arid	Alluvial	Wheat, Bajra, Rice, Maize, Tur, Potato.
III.	Trans-Gangetic Plains		
1.	Semi arid to Dry sub-humid	Alluvial (recent) calcareous	Wheat, Rice, Bajra, Maize, Sugarcane
2.	Arid & Extreme arid	Calcareous, Siero-zemic, alluvial (recent), desert.	Wheat, Cotton, Gram, Bajra, Rice.
IV.	Central Plateau & Hills		
1.	Dry sub humid to dry arid	Mixed red & black	Wheat, Gram, Jowar, Rice.
2.	Dry sub humid to semi-arid	Mixed red & black	Wheat, Gram, Jowar, Rice.
3.	Semi arid (half drier & wetter)	Medium black & alluvial	Wheat, Gram, Jowar, Rapeseed, Bajra.
4.	Semi arid (wetter half)	Medium Red & black grey, brown	Maize, Rice, Wheat, Gram.
5.	Semi arid to arid	Desert soil, grey brown.	Bajra, Wheat, Sesamum, Rapeseed, Jowar.
6.	Semi arid (wetter half)	Red and Yellow, grey, brown	Maize, Wheat, Gram, Jowar
7.	Semi-arid (drier half)	Alluvial	Wheat, Bajra, Jowar, Gram.
8.	Semi arid (drier half)	Alluvial (recent)	Bajra, Wheat, Rapeseed, Gram, Jowar.