Farmers' concern about drought, their perception and remedial measures to maintain crop productivity

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Abstract

Three basic aspects of drought environmental, ecological and socio-economic nature in rural areas of Bhiwani District of Haryana (India) have been presented here. Aridity is the main cause of drought consistence. Drought has been quantified based on the different perception of local people, migration of local people and increase of small land holdings with rise of population levels. Remedial measures have been suggested to combat this drought situation for the benefit of farmers.

Keywords

Drought, perception and remedial for drought, rainfed farming.

Introduction

Accumulation of aridity and frequent occurrence of drought in Bhiwani have resulted in numerous environmental, ecological

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and socio-economic problems, particularly in rural areas. These changes have resulted in decrease of land productivity, low soil water availability with depletion of arable and natural grazing resources. These aspects have influenced the land and water resources and migration to adjoining rural areas in recent time (Ahmad et al, 2004 and Khera, 2004).
It will be very useful to look at micro-level to bring out the farmers' concern about drought, their perception and remedial measures to maintain crop productivity in Bhiwani District to understand the causes of drought with socio-economic variables and their likely impact and the resulting response in terms of drought mitigation and relief policies and programmes. In order to suggest any development programmes to reduce the impact of drought, it will be useful to examine the optimum and proper use of local potential resources to maintain the ecological imbalance. To increase the effectiveness of modern drought management techniques, a better grasp and understanding of the importance of traditional coping strategies adopted by farmers is undoubtedly called for (Jodha N.S., 1991).

Therefore, the present study have been planned grass root level at Block level of farmer's community based on their perception of drought and on the actual farming practices being adopted.

Study area and data used

The study was conducted at block levels in District Bhiwani of Haryana (India) (fig. 1) located at 28° 19' to 29° 05'N latitude and 75° 28' to 76° 28'E longitude with an area of about 5099 km. Bajra, jowar, wheat and gram were the main crops grown here. The study area does not have adequate irrigation facilities. Climate of area is very hot in summer reaching upto 48°C and markedly cold in winter touching even -2 °C. The rainfall is low and erratic besides being unevenly distributed during the year except for two well marked seasons i.e. south-west monsoon period lasting from July to the middle of September, for kharif (summer season) crops and the other is with few winter rains which occur in December to February benefiting rabi (winter

season) crops. Normally one crop is feasible on rainfed conditions either kharif on monsoon rainwater or rabi low water requiring crop based on conserved soil water of monsoon season on fallow lands (HARSAC 1992).

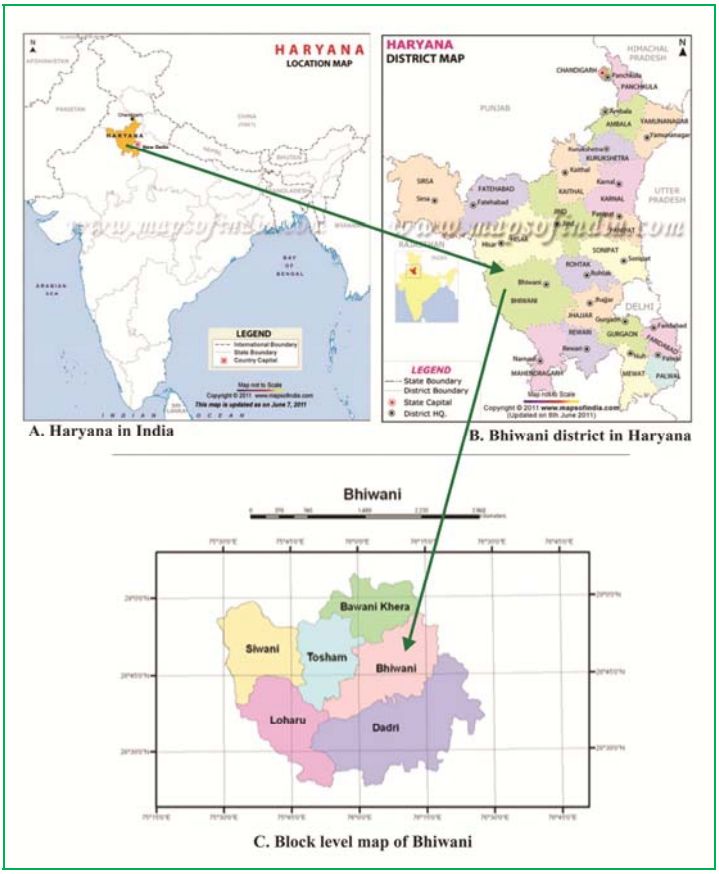

Figure 1: Location map of study areas.
Source: www.mapsofindia.com.

Methodology

Drought has been considered as a hazard which is the outcome of physical, economical and cultural environment. Abu-Sin

(1985) reported that drought also depends on personal characteristics of each individual, his age and educational level, religious belief and occupation.

Abu-Sin (1985) methodology was adopted in the present study with the following detailed aspects. The primary data was collected based on a standardized set of perceptions about different variables through socio-economic field survey during a series of visits to the area from 2007 to 2010. For the selection of the villages from each of the six tahsils (blocks) of Bhiwani district, a two-stage random sampling procedure was adopted. The first stage was a selection of clusters, which were taken to be revenue villages according to their population size as per the 1991 census. One village each from small-sized, medium-sized, and large-sized population was selected randomly.

A simple random sample of villages would give rise to bias in the estimates of population characteristics because it would give equal probability of selection to houses in small and large villages as it would to houses in medium-sized villages. To improve the precision of the sample, the medium-sized villages should have a greater probability of selection since the bulk of the population lies in villages with a population of 800-1500. This suggests that to get unbiased sample estimates for the population, households in medium sized villages should have a higher probability of selection than those in small or large villages. This was achieved by selecting the number of households in the ratio of 6:2:2 from medium sized, small sized and large sized population villages respectively. Thus, at the second stage, for the selection of the households a simple random sample of 18, 6 and 6 households were chosen from the voter list prepared by the district authorities of the medium sized, small sized and large sized village respectively. In the case of members of sample households being unavailable or unresponsive, five replacement households were interviewed.

18 randomly selected representative villages from six tehsils of the Bhiwani district are: -Villages *Lohari Jatu, Siper* and *Bawani Khera (rural part)* from *Bawani Khera tehsil, Badesra, Ninan and Tigri* from *Bhiwani tehsil, Chhapar, Ram Bass and Suraj garh* from *Dadri tehsil, Mandholi Kalan, Nangal* and *Bithan* from the *Loharu tehsil,*

Dhani Mahu, Khariawas and Ladianwali from the *Tosham tehsil* and *Jhumpa Kalan, Rupana and Devsar* from the *Siwani tehsil* respectively.

A detailed socio-economic field survey was undertaken in the study area for 2007 to 2010. A questionnaire survey was undertaken in 18 randomly selected representative villages from six Tahsils of the Bhiwani District. Thirty respondents (again selected based on random sampling technique) were interviewed from each tahsil.

Mitchell (1974) emphasized the following responses that people can make in the situations of drought hazard such as (i) dealing with the cause of hazard; (ii) modifying the hazard; (iii) adjusting methods to minimize hazard losses; (iv) advance planning to minimize losses; and (v) bearing the losses (Abu-Sin, M.H., 1985). In fact, with the exception of the first and second, remaining are measures of reducing damage from hazard.

Results

First of all, there is a need to understand all the relevant dynamic variables involving the people's perception of drought, indicators based on climatic and socio-economic variables, perception of a wet and drought years and their opinions regarding wettest and driest years. Secondly, the ranges of various possible adjustments that their social pattern affords have been discussed. Finally the possible ways to reduce losses with adoption of strategies under varying sets of circumstances i.e. crop strategies including choice of crops and cropping systems adopted to mitigate drought conditions and the various crop strategies during dry/wet year's continuity, etc. have been investigated.

Perception of drought

Perception has been considered as the image created in the human mind as a result of the stimuli from the surrounding environment, both physical and cultural (Abu-Sin, MH, 1985). Based on observations and analysis of the data and group

interviews, following results have been achieved about the perception of drought in the social structure of the study area.

Drought indicators based on climatic variables

Table 1. Presents drought indicators based on climatic variables and their severity values experienced in the region.

Indicators	No. of respondents	Percentage
1 Experience of old people, dreams, position of stars, *etc.*	38	21.1
2. Westerly dry wind after mid June with dust storms	29	16.1
3. Lack of cloud, poor onset of monsoon	45	25
4. Growth of plants and natural vegetation	68	38.8
Total	180	100.0

Table 1. Drought Indicators based on climatic variables.
Source: Field survey data.

Table 1 identifies predictive indicators of drought depicting that out of a total of 180 of total respondents 68 (38.8% of the respondents) feel the growth of plants as most suitable indicator of rainfall inadequacy. One-fourth of the respondents consider a weak southwest monsoon or less than normal rainfall or a late monsoon as an indicator of drought. Only 16.1 percent believe that westerly dry wind during hot summer with much dust as an indicator of drought in that particular year. An interesting observation showed that a very strong statistic of 21.1percent out of total respondents depend upon prevalent local believe which have been in circulation since ages and which strangely have turned to be quite reliable too in most cases in early assessment of rainfall situation.

Drought indicators based on socio-economic conditions

Table 2 presents the drought indicators in Bhiwani based on the socio-economic conditions in terms of agricultural wealth. It is reflected that out of a total of 180 persons selected for the survey, 48.3 percent of the people consider drought as the lack of plant cover, crop failure and loss of livestock. About 34.4 percent of the population feels that drought means "near-famine" conditions associated with extremely low production of crops due to poor food grain production, but at least vegetative fodder is available for their livestock. A lower percentage of 17.2 consider that a drop in crop yield due to any agricultural input factor as drought conditions like non-adoption of weeding, uneven distribution of rainfall or even excess rainfall leading to crop damage and infestation of pests and diseases. It may not be considered as a dry year by all as these conditions might vary from a field to field.

Drought means	No. of respondents	Percentage
1. Lack of plant cover, crop failure, and livestock losses	87	48.3
2. Near-famine conditions associated with very low production	62	34.4
3. Drop in crop yields, which may be due to many variables	31	17.2
Total	180	100.0

Table 2. Drought Indicators based on socio-economic conditions. Source: Field survey of study area.

Perception about a wet year

Table 3 illustrates the percentage figures for the perception of people about a wet year. Out of total of 180 respondents, 80 respondents (44.4 percentage) consider a wet year as a year when there is a good crop production not only to cater the needs of the current season, but the grain left out to store for the future also. A good percentage of 36.7 respondents consider that a low indebtedness without any other secondary occupation (other than agriculture) as an indicator of a year of adequate rainfall. Low indebitness is also referred to good economic returns so that there is either no need to borrow any loan from the village merchants or the loan taken in previous year could be returned. If there is impending marriage of a daughter, part of house to be built/ extended, then these too are undertaken when the rainfall is good throughout the season so that farmer's get good returns. Only 18.9 percent respondents consider increase in number of livestock as an indicator of a wet year.

Measure of assessment	No. of respondents	Percentage of total
1. Sufficient crop production to allow storage for the future	80	44.4
2. Increase in the number of livestock	34	18.9
3. No need for secondary occupation and low indebtedness to village merchants	66	36.7
Total	180	100.0

Table 3. Respondent's perception about a wet year.
Source: Field survey of study area.

Perception of a drought year

Table 4 provides the figures for assessment of a permanent/extreme drought year. Out of the total respondents, 36.1 percent consider that the shortage of food, drinking water, etc. in a particular year as an indicator of drought. Small farmers need to borrow a certain amount of money, which they may return later on after harvesting of field crops. However, with the failure of crops due to insufficient rain it leads to an economic crisis. In such circumstances, they are not left with any money to return to the moneylender and even face hardship to buy seeds for the next crop. While another 27.8 percent people, preferred migration to work elsewhere this serves as another indicator of a drought year. But during some field surveys it may be sometimes misleading because young mass and technically competent people may migrate to other places for better opportunities. These days it has been observed that people from Bhiwani region migrate mainly to nearby town areas from the village to work as a laborer at a construction site, *etc.* It was particularly noticed that the village farmer with a medium size holding does not want to work as a laborer in the village but

Quantification of Drought inception	No. of respondents	Percentage of total
1. Shortage of food, water, etc.	65	36.1
2. Migration for work elsewhere	50	27.8
3. Economic insecurity	45	25
4. Danger of famine and poor health	20	11.1
Total	180	100.0

Table 4. Respondent's perception of a drought year.
Source: Field survey of study area.

goes to nearby city to get higher cash remuneration. During these days there is enough work at road and construction sites in rural areas being funded by the government, he is not required to leave the village. Also the farmer with a big landholding can survive the drought year by management of his savings, etc.

Opinions regarding wettest and driest years

Table 5 shows a very high percentage of 23.5 and 20.0 respectively for the years 2002 and 1987 the driest year over the past years. Actually, these were the years of severe drought when both the crops food grains and fodder failed completely. Those years were not viewed as a dry year when a farmer and his livestock were not adversely affected due to stored grain of previous season. On the other hand, the years when there are rich crop yields and animal productivity were considered as wet

Years	Driest year		Years	Wettest year	
	No. of respondents	Percentage		No. of respondents	Percentage
1968-69	12	6.7	1953	7	3.9
1983	19	10.6	1957	11	6.1
1987	36	20.0	1960	9	5
1991	14	7.8	1976	12	6.7
1995	4	2.2	1977	15	8.3
1996	15	8.3	1984	20	11.1
1998	8	4.4	1993	37	20.5
2000	18	10	1999	23	12.8
2001	11	6.1	2003	25	13.9
2002	43	23.9	2004	21	11.7

Table 5. Opinions regarding the wettest and the driest years over the past years. Source: Field survey of study area.

years. However, during extreme flood year there was heavy damage of crop losses of standing crops and animal's causalities. Such causalities were largely in a few pockets where cloudbursts type events took place in monsoon months of year 1993.

Remedial measures for improving crop productivity

Characteristics in drought conditions

Practices	Bajra (Pearl Millet)	Guar	Moong bean
Sowing date	In the month of June/July with the onset of monsoon	In the month of July/ August with good rains	In the month of April(in irrigated areas) / In the month of July (in rainfed areas)
Suitable soil	Sandy, sandy loam and loamy soils	Sandy to sandy loam and loamy soils	Sandy to Sandy loam soils
Crop maturity	90-110 days	140-170 days	45-65 days
Agronomic practices adopted	Planting in parallel rows by *Kera* method, Seed rate about 1-2 kgs per acre, Seed buried in top soil to allow quick germination by early	Dispersed in the field by broadcasting method and also by ploughing in rows (*kera* method); Seed rate about 10-20 kgs per acre, Planted	Mostly by *Kera* method but sometimes by broadcasting method too; seed rate 4-5 kgs per acre, Planted after onset of monsoon, Little time

	showers, Planted immediately after monsoon rains, Weeding once after 25 to 30 days	when soil is fairly moist	for weeding
Drought resistance	High (average dry year yields about 60% of average wet year yield)	It is drought sensitive. Irrigation need with withdrawal of monsoon	Only 1-2 irrigation are enough
Conserved soil moisture on fallow land	Low, Short duration varieties are preferred	High, long duration crops, guar gum	Low, short duration pulse crop
Utility	Used both for human consumption as well as cattle feed; rich in minerals, proteins and iron; Multiple use and stable crop under rainfed conditions	Traditionally used as cattle feed but with increasing industrial use only by-products are available for cattle. Stable crop in good rainfall years.	High Yielding and disease resistant variety is feasible but with lesser yield potential. Also risk factor is high in case of seed borne disease, unstable crop
Quality of	High	Processed	Rich in

food products	particularly in arid areas: good taste, easy to prepare; nutritionally very rich	locally for gum production, By-products for cattle feed	proteins

Table 6. Kharif crops (Bajra, guar and moong) grown in the Bhiwani area

Table 6 presents the performance and characteristics of major food grain crops (Pearl millet, guar and moong bean) grown in the study area, providing the stable economic base for the farmers. These crops are sown with the onset of southwest monsoon rains normally in the last week of June to first fortnight of July. The study area being located in less rainy areas, it is very essential to conserve the rainwater in the furrows of the cropped area with no competition from the weeds so that fertilizer and soil water are completely utilized by the cropped plants. Plant population is maintained to survive within the availability of soil water in the root zone. Split doses of nitrogen fertilizer are preferred, whereas other fertilizers are used as basal doses on soil test basis. Pearl millet, being a nutritive food both for human and animal's consumption, is widely cultivated in the area under rainfed conditions.

Crop strategies adopted to mitigate drought conditions

The choice of crops as well as the cropping systems are influenced by various factors such as size of land holdings and quality of soil and water resources. Table 7 presents the cash returns per acre from the crop combinations like Bajra + Moong or *Bajra* + *Til* which are much more remunerative than the monoculture. It was observed during the field survey that farmers with smaller land holdings usually prefer the mixed

Crop	**Average yield in kg/ha**		**Cash returns per hectares (Rupees)**		**Crop**	**Cash returns per hectares (Rupees)**		**Percentage deviation from average of wet and dry years**
	Wet	**Dry**	**Wet**	**Dry**		**Dry**	**Wet**	
Bajra	1,500 to 3,000	500 to 800	12,500 to 20,000	3,500 to 5,000	Bajra + Moong	25,000	6,250	50
Gawar	1,000 to 2,000	300 to 400	nearly 25,000	4,500 to 5,000	Bajra +*Til*	32,500	12,000 to 12,500	47
Moong/ Moth	1,000 to 1,400	0 to 300	20,000 to 30,000	6,000 to 9,000	*Guar*+ Bajra	25,000	4,500 to 5,000	37

Table 7. Farmer strategies in a simple wet/dry year sequence (For a farmer with *less than 2 hectares* land).
Source: Field survey of study area.

cropping as the family members work as labor during the harvesting period and they tried to generate the complete requirements of the family. The usual trend is that in one hectare of land, the farmer would mix around 2.5 kgs seeds of Bajra, ten kgs seeds of Guar and around 2.5 kgs seeds of Moong and Moth and dispersed them in the field. In the case of good rainfall or assured irrigation, the farmers with smaller holdings have also adopted the practice of growing cash crops like vegetables for better returns.

Even in dry years, cultivation of short duration crops like moong / moth provide better returns. But during wet or good rainfall years, Bajra + moong mixed cropping give better returns. However, Bajra + *til* combination provide still higher returns because of higher prices of oilseed *til* crop.

Crop strategies during dry/wet years continuity

In contrast, farmers with a higher land holding prefer monoculture-cropping system with the aid of mechanization tools and less labour intensive crops. The major deterrents to the mixed cropping system in this case are different times of maturing of different crops, denser plant population which act as a big obstacle during the time of harvesting. Besides, a different spray and fertilizers requirement for different crops is another major factor. For example, in the crop of Bajra, urea is used as a fertilizer, while DAP is used for the crop of Guar. As opposite to the farmer with a smaller holding, more labour is required at the time of harvesting the crops and one cannot do with merely family members working as labourers. So scarcity of labour too discourages a bigger farmer for going for mixed farming technique. The economic returns gaps are reduced due to the use of tractor drawn implements. Competition of weeds with crops is also observed as a major problem to utilize water and nutrient resources reducing the crop yields.

Crop	**Average yield in kg/ha**		**Cash returns per hectares (Rupees)**		**Crop**	**Cash returns per hectares (Rupees)**		**Percentage deviation from average of wet and dry years**
	Wet	**Dry**	**Wet**	**Dry**		**Dry**	**Wet**	
Bajra	2,500	500 to 1,000	20,000	3,750 to 5,000	Bajra + Moong	25,000	6,250	34
Gawar	1,750	500	22,500	4,500 to 5,000	Bajra +*Til*	25,000	3,750 to 5,000	10
Moong / Moth	1,250 to 1,750	200 to 300	25,000	6,250 to 8,750	*Guar*+ Bajra	30,000	7,500	20

Table 8. Farmer strategies in a simple wet/dry year sequence
(For a farmer with *more than 2 hectares* land)
Source: Field survey of study area.

Preference of crops in dry/wet years

Wet Year			Dry Year		
Crop	**No. of respondents**	**Percentage of total**	**Crop**	**No. of respondents**	**Percentage of total**
For Kharif Crops					
1. Cotton	63	35	1. Bajra	67	37.2
2. Bajra	53	29.5	2. Guar	52	28.9
3. Guar	37	20.5	3. Moth/ Moong	34	18.9
4. Moong / Moth	27	15	4. Cotton & mixed cropping	27	15
Total	180	100.0	Total	180	100.0
For Rabi Crops					
1. Wheat	54	30.0	1. Barley	52	28.9
2. Mustard	46	25.5	2. Gram	48	26.7
3. Barley	32	17.8	3. Taramira	34	18.9
4. Gram	27	15	4. Mustard	26	14.4
5. Taramira	21	11.7	5. Wheat	20	11.1
Total	180	100.0	Total	180	100.0

Table 9. Ranking of crop preference given by the Bhiwani District people. Source: Field survey of study area.

Table 9 presents the cropping systems adopted in the study area under rainfed and irrigated conditions. Crops grown in the district are divided into two main categories, i.e. *kharif* and *rabi,* locally named *sawani* and *sadhi*. The former is the summer and

rainy season sowing and latter the winter sowing. Any crop which does not fall in timing within these two harvests is known as a *zaid* crop and its harvest is called *zaid kharif* or *zaid rabi*, according to the harvest with which it is assessed. Toria (an oilseed) is cultivated as a *zaid kharif*: while vegetables, melon, tobacco and green fodder as *zaid Rabi*.

The major kharif crop of the district is bajra, which occupies about 55 percent of the cropped area. Other important kharif crops are moth and guar almost entirely a fodder crop. Bajra crop is particularly good as this crop does well on sandy soil, low and erratic rainfall and high temperature conditions.

The major Rabi crop is gram, which occupies about 42 percent of the cropped area. The other Rabi crops are wheat, barley, oilseeds and vegetables. A part from these, tobacco is grown in some villages of Loharu and Badhara blocks and a few villages of Bhiwani block. The quality of tobacco is particularly good. The Rabi crops are mainly grown where underground water quality is good and tube wells are main source with benefit of sprinkler irrigation.

Bajra, guar and pulses (during kharif) are comparatively drought resistant and grow well in sandy loam soils. Gram, oilseeds and barley (during Rabi) are suitable for these soils for the water requirements of these crops are smaller compared to wheat. The dry and hot climate prevailing in the District is suitable for cotton but its area is limited by the scanty irrigation facilities available during summer. Groundnut has been introduced consequent upon the availability of canal water during the rainy season, i.e. July to September, in almost all the newly developed irrigation systems.

Socio-economic aspects

Socio-economic adjustment to drought

The people in Bhiwani have been taking precautions to adjust cropping plans with the arrival of southwest monsoon season with adoption of mid-season corrections with late arrival or early cessation or long breaks of monsoon conditions.

Adjustment	No.	Percentage
1. Careful cultivation of appropriate drought- resistant short duration crops	68	37.8
2. Change balance within crop-livestock economy	28	15.5
3. Adjust cultivation practice of crops i.e. use of seeds, fertilizers and costly inputs	50	27.8
4. Bringing fodder, etc. from relatives in nearby areas	31	17.2
Total	180	100.0

Table 10. Adjustments to minimize drought damage in cultivated crops. Source: Field survey of study area.

Out of the total of 180 respondents, 37.8 percent opt for the careful cultivation of the appropriate drought resistant crops as the major adjustment to minimize drought damage in agriculture. In a dry year, Bajra is the major Kharif crop as it is more drought resistant. Emergency irrigation by tube wells or wells are also adopted in a few cases. In the case of availability of ground water, at least food crops are sown so that the situation of drought can be dealt with at least that particular year. 27.8 percent of the population felt that adjustment of cultivation practices of crops was a way to minimize drought damage. For example, deep ploughing, suitable plant population, row-to-row and plant-to-plant distance, soil moisture conservation (soil mulching), use of split dose of fertilizers are commonly practiced. Another 17.2 percent of the respondents suggested that getting fodder from the relatives is also a way to compensate the drought damage.

Socio-economic adjustments in drought spells

Adjustment	No.	Percentage
1. Participating in Government relief programmes	62	34.4
2. Changing mode of living (i.e. out of agriculture)	47	26.1
3. Shifting more towards livestock economy	42	23.3
4. Migrate to the other areas as a temporary sustenance	29	16.1
Total	180	100.0

Table 11. Preferred adjustments when drought strikes for two or more successive years. Source: Field survey of study area.

When droughts fall in continuously in two or more years, there is cumulative impact of this grave situation leading to famines and large-scale causalities. Out of the total respondents 36.1 percent considered participating in the government run relief operations as the preferred adjustment whereas 26.1 percent people considered changing their mode of living i.e. shifting from agriculture occupations to construction sites of roads, canals, buildings, etc. to balance the damage of livelihood.

Discussion

Drought perception and drought indicators based on physical, climatic and biological variables were studied and analysis of coping strategies in mitigationg droughts that emerged in the sample areas, how people deal with drastic crop and livestock losses in a mainly agro based economy was provided

It is clearly apparent for people in Bhiwani district the agricultural vegetative conditions and general atmospheric conditions were the basis on which the perceptions regarding

concepts of drought were based (Table 1). Besides, the rural people also depended upon the indigenous weather forecasting indicators such as flowering of local trees, behavior of birds, animals, etc. and these have turned out to be reliable too in most cases of rainfall pattern prediction. Some examples are:

- It is believed that the number of days the easterly winds blow in the month of "*Jyestha*"ll be a drought accompanied with dry winds for the same number of days in the month of "*Sawana*".
- Bigger size of fruit of "*Khejari*" and "*Kikar*" tree indicates the probability of favorable amount of rainfall, whereas a smaller size of the fruit indicates the probability of drought conditions.
- Sparrow showering sand all over itself is also considered a good indicator of rainfall.
- The depth of nest of a local bird in dry pond (*Johar*) is indicator of the rainfall conditions that greater depth indicates drought and lower depth indicates occurrence of good rainfall.
- The presence of moonlight on the night of "*Makar Sakranti*" is an indicator of drought.

Therefore, the perception differs from one society to another and from one environment resource to another, there is still no working definition of drought hazard with a wider applicability.
Therefore, there is a wide range of causes of drought, based purely on meteorological parameters to those based on the inability of an area to provide for the basic human needs of water and food in a particular year or years (Abu-Sin, 1985).
The meaning of drought to people of Bhiwani is centered on crop production required for human consumption and animal's maintenance to support economic balance (Table 2). A year in which there is drop in production severely threatens the welfare of the family and its livestock is perceived as a drought year. In drought conditions, people tend to lean more towards livestock economy to make use of dry vegetations, shrubs and roots. Therefore, the meaning of drought to people depends upon

individual outlook for his own requirement and difficulties faced in order to maintain his family and livestock population.

The survey results indicated that the economic security was the main factor than the general atmospheric conditions in defining a dry or wet year. People tended to identify drought by its immediate impact, which also has future implications for grain supply and animal productivity. Thus, in defining a wet year, economic security is the most important factor among the meteorological conditions of an area. Since their economy revolves mainly around agricultural activities, thus a good crop yield is a significant factor (Table 3).

A drought year was considered to be one in which the crops failed threatening the food security of a family and its livestock irrespective of its rainfall pattern (Table 4).

When people were asked about the present drought situation about 70 percent of respondents in rain fed areas indicated that there has been continuously a drought like situation since the last 7-8 years. Thus, it is important to look at drought severity not in terms of shortage of rainfall but in the terms of the demand made by man and its livestock on the water's supply (Table 5).

The choice of crops as well as the cropping systems is influenced by various factors such as size of land holdings and quality of soil and water resources. Pearl millet, being a nutritive food both for human and animal's consumption, is widely cultivated in the area with rain fed conditions. In low and erratic rainfall years, when the monsoon showers are not intense or there is late onset or early withdrawal of monsoon takes place, the inadequate availability of soil water favors short duration crops like moong bean, moth and ephemeral grasses. Pearl millet crop during such years will provide very poor uneconomic yield and may be useful to harvest as green fodder for animals. In years , when monsoon rains are very good pearl millet, guar and even sorghum as green fodder are preferred in the area. With the advancement of agricultural technology for cultivation of these crops, farmers have been tempted to adopt new hybrid fertilizer responsive varieties where yield potentials are three to four times over the local / desi cultivars (Table 6).

It was observed that cash returns per acre from the crop combinations are much more than the returns in case of monoculture but mainly farmers with smaller land holdings preferred the mixed cropping in contrast to the farmer with a bigger land holding who preferred monoculture cropping system with the aid of mechanization tools and less labor intensive crops (Table 7 and 8).

A change is observed in the ranking of the crop preference in wet and dry years (Table 9). In the case of Kharif crops, Bajra occupies the first place in a dry year followed by Guar, Moth, Moong and cotton respectively. Whereas,in a wet year, Bajra is replaced by Cotton in the ranking of preference. The second place goes to Bajra followed by Guar, Moong and Moth respectively. Even in the case of pulses, Moong is preferred over Moth in a wet year or when enough water is available where as in a dry year Moth is preferred as it is a more drought resistant crop out of the two.

Main coping strategies adopted by the people included use of food rain and fodder stocks, sale of livestock and livestock products, diversifying activities/ livelihood systems, credit indebtness, using kinship ties, reducing consumption expenditure, mortgaging or sale of assets, working in relief programmes and migration (Table 10). The survey results also indicated that migration as a coping strategy by much smaller number than expected due to the option of getting work in relief programmes in or near their villages. It is usually the farmer with middle size land holdings that tend to go elsewhere to work as he does not want to be seen working as a lobourer in his own village. In the case of scarcity of water after the crops have been sown, the technique of ploughing and thinning of plant population is adopted for conserving moisture. Besides sowing more seeds per acre during wet year and low seed rate during dry year is adopted according to the availability of soil water in the root zone during the season. Besides, rain water is conserved in root zone after every effective rainfall by soil mulching in order to remove the soil crust for improving the infiltration rate of the top soil and to provide a soil mulch for reducing the evaporation losses and maintaining the soil water reserve for uptake of soil

water by roots as well as deeper penetration of roots in the soil. In that case, at least the livestock could survive and the people tend to sustain on the livestock economy in such years to reduce the damage. However, in circumstances when the fodder is not available, people opt to adjust with the resources available by selling their livestock as a last option for survival of family members.

Preferred adjustments when drought strikes for two or more successive years are changing occupation/ livelihood (i.e. out of agriculture, working in transport sector, selling fodder in Rajasthan), participating in govt. run relief programmes, reducing or modifying consumption, sale of assets and mortgaging, etc (Table 11).

Conclusion

1. Perception of drought is a lack of growth of plants, lack of plant cover, crop failure and livestock losses which results into the scarcity of water, food and fodder.
2. Lack of employment results into the economic insecurity among them and are forced to migrate elsewhere even though they have medium to large-scale land holdings.
3. People's perception about drought, their diverse local livelihoods and socio-economic adjustments results into inducing programmes to combat through proper use of their resources without creating any ecological imbalance.
4. The survey also indicates that migration as a coping strategy is adopted by much smaller number than expected due to the option of getting work in relief programmes in or near their villages.
5. The evolution of new drought resistant crop varieties, raising of short duration grass and fodder crops for animal population, awareness of in-situ soil moisture conservation measures after each effective rainfall benefits the farmers to make use of technology developed for rainfed agriculture.

Government policies on grain and fodder banks, crop insurance schemes, use of drip and sprinkler irrigation, cooperative societies to provide farmer's requirement on seeds, fertilizers, machinery; use of crop weather outlook reports through remote sensing and agro meteorological forecasts will certainly enhance the socio-economic status of poor farmers. [1]A consortium approach should be adopted for the management of water and drought (Narain et al., 2005).

Annexure

1 hectare = 2.47 acres

Local name with botanical name

Moong bean/ Moth:	*Vigna mungo*
Bajra:	*Pennisetum typhoides*
Jowar:	*Sorghum bicolor*
Til:	*Sesanum indicum*
Guar:	*Cyamopsis tetragonoloba*
Cotton:	*Gossypium hirsutum*
Taramira:	*Brassica Napus*
Gram:	*Cicer arietinum*
Mustard:	*Brassica campestris*
Wheat:	*Triticum aestivum*
Barley:	*Hordeum Vulgare*

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