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Impact of Drought on Food Security in Arid and Semi Arid Regions

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ABSTRACT : Agriculture supports up to 75% of the population and generates almost all the food requirements. However drought are the major constraints to rain-fed agricultural production, especially in arid and semi arid lands (ASALs) of which form about 88% of the population. The frequency and severity of droughts seems to be increasing in the population over time. The result has been total crop failures and livestock deaths triggering severe food shortages in the population and more . Between 1993 to date, the government has declared 7 national disasters out of which 5 were drought related. These declarations followed the droughts of 1992-93, 1996-97, 1999-2000, 2005-06 and 2008-09 when the government requested international communities for food aid. About many regions have been under Emergency Operation Programme (EMOP) due to the heightening food insecurity caused by droughts. This paper highlights the effects of drought on food security in with special reference to arid and semi arid areas of different areas.

KEYWORDS: arid and semi arid regions, food security, crop failures, livestock deaths, food aid, government, emergency operation programme

I.INTRODUCTION

Drought, a devastating natural hazard, affects a significant proportion of the global population, particularly those living in semi-arid and arid regions. The percentage of the planet affected by drought has more than doubled in the last 40 years and in the same timespan droughts have affected more people worldwide than any other natural hazard. Climate change is indeed exacerbating[1] drought in many parts of the world, increasing its frequency, severity and duration.Severe drought episodes have a dire impact on the socio-economic sector and the environment and can lead to massive famines and migration, natural resource degradation, and weak economic performance. Drought can also exacerbate social tensions and fuel civil unrest. Agriculture bears much of the impact, and in developing countries it is the most affected sector, absorbing up to 80 percent of all direct impacts, with multiple effects on water availability, agricultural production, food security and rural livelihoods.[2,3] With nearly 1.3 billion people – 40 percent of the world – relying on agriculture as the main source of income, drought is putting the livelihood of many at risk, often halting and reversing gains in food security and poverty reduction and hampering efforts to reach SDG1 and SDG2.

Drought cannot be stopped, but due to the growing availability of technological innovations it can be forecasted – in some cases up to a month in advance. Likewise, when appropriate policy instruments are in place, the impacts of drought can be substancially mitigated and reduced. [4]

Experience shows that proactive, risk-based management approaches are effective in enhancing the resilience of communities and their capacity to cope with drought, but despite the progress made, drought management and planning is often overlooked until a crisis unfolds. This reactive, crisis-led response gives rise to a fragmented policy space where interventions are sectorally isolated, and drought mitigation strategies under-perform.

FAO is firmly committed to build on the momentum provided by the SDGs, the Paris Climate Agreement, and recent efforts by other international actors to support the creation of national drought management policies and the shift to a proactive drought management approach, which is at the heart of FAO’s Strategic Objective of increasing the resilience of livelihoods to threats and crises.[5,6]

FAO’s support materializes through the following actions:

- Awareness creation to improve understanding among policy-makers and decision-makers of the importance of drought risk management (e.g. through the organization of high-level events, such as the International Seminar on Drought and Agriculture, MHNDP, the African Drought Conference);
- The development of guidelines tailored for specific drought-prone regions and of other technical tools to facilitate the adoption of proactive drought management policies at the country level;

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- Capacity development in drought policy through training at the regional and country levels;[7,8]
- The provision of direct support to countries to implement proactive drought management policies through field projects;
- Building partnerships with specialized organizations and research centres as well as with country-level and regional networks of institutions concerned with drought to promote proactive drought policies and enhance country support;
- Carrying out studies to characterize drought and its management in different regions;
- Hosting the Drought & Agriculture Forum, a common learning, sharing and planning platform on best practices in drought management to enable the design of multi-sectoral initiatives that benefit all stakeholders.

FAO's programme on proactive drought risk management cuts across the Organization's technical and cooperation departments and involves strong partnerships with specialized organizations and research centres beyond FAO. Collaborating partners include the World Meteorological Organization (WMO), the Secretariat of the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biodiversity (CBD) and UN-Water, as well as the Robert B. Daugherty Water for Food Institute and the National Drought Mitigation Center at the University of Lincoln-Nebraska, United States of America. The programme also coordinates with several national research centres and regional networks concerned with drought issues.[9,10]

The arid and semi-arid regions comprise more than forty present of the Earth's land surface on which a large number of people situated and largely engaged in agriculture to meet their basic needs. However, agriculture in these regions are highly influenced by several factors including water limitation, extreme heat, frequent drought, bared and marginal soil, vulnerable topography for natural hazards, erosive rain and wind. In order to cope with these challenges a number of essential scientific investigation and cultural practices have continuously released, modified and recommended to sustain agriculture production in these regions. Some of these indispensable investigation and practice included that soil and water conservation, rain water harvesting and supplementary irrigation, use of stress tolerant crops and integrating of diverse farming system.

Arid and semi-arid regions are characterized by hostile environmental conditions that include low and erratic rainfall, high wind velocity, intense solar radiation and high potential evapotranspiration during most parts of the year [1,2]. Arid lands cover about 41 percent of the earth's terrestrial surface and are home to more than a third of all human being in the world [3].

The situations in arid and semi-arid tropical areas are likely to have increased risks and vulnerabilities due to climate change [4]. The main causes of the existence of these climates are the low frequency of adiabatic rise of large bodies of air and the remoteness from an oceanic source of moisture [5]. The agriculture in these regions is facing multiple and complex challenges in terms of decline in factor productivity and the degradation of natural resources [2]. Due to various natural and anthropogenic factors affecting agricultural production, many arid and semi-arid regions are food insecure [6]. In such regions the production of adequate and renewable supplies of food, fodder and firewood is critically limited by the scarcity of water [7].Limited and erratic precipitation often results in low crop yields and sometimes in total crop failure [8].

Soil degradation issue is one of the most important factors that threaten the crop production thereby reflecting on food security particularly in arid and semi-arid regions [9]. Many countries in arid and semi-arid lands of Sub-Saharan Africa are challenged by land degradation, low water productivity and high rainfall variability which are often associated with climate change [10,11].Land degradation is a major cause for poverty in rural areas of developing countries [12]. Mitigation of land degradation impacts depends on understanding the natural cause of degradation [9]. For example extensively cultivated on steeply slope farmlands has led to highly susceptible to water erosion in the rainy seasons [13,14] that resulted decline in soil productivity [15]. Land degradation and rainfall variability are severe problems affecting such farmlands so that various landscape restoration and soil and water conservations are essential practices for such area [16]. On other handWind erosion is a major land degradation problem in arid and semi-arid regions where irregular and insufficient precipitations, high wind speeds, smooth surface topography, light soil texture, poor aggregation and poor vegetation cover is common [17,18]. Wind erosion and resultant dust emissions create significant risks for land degradation and ecosystem health in arid and semi-arid regions [18]. Minimum tillage and crop rotation has significant impacts on protecting soil surface against wind erosion [18]. So appropriate soil conservation that integrating biophysical aspects and socio-economic parameters are needed in dryland ecosystems [9].

Not only soil and water conservation is enough to cope with harsh condition in arid and semi-arid land agricultural production but also other agronomic practices and adopting of various agricultural production techniques contribute

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significant roles. Changing cropping patterns, irrigation, rearing livestock as mixed farming, and agro forestry based adaptation strategies are another means of income sources for the livelihoods of households in arid and semi-arid regions [19].

Thus in order to meet diverse need of agricultural products of a growing population, it is necessary to find or develop appropriate techniques for agriculture in every region of the world. Particularly, in arid and semi-arid regions, where natural risks have frequently occurred, more viable food-producing agricultural systems that can be mastered by the local population are required. For this reason, arid zone agriculture is the subject of much research because of the increasing interest in the agricultural problems of developing countries, many of which are located in the arid and semi-arid regions of the world [20].

II.DISCUSSION

- Within the drylands, arid area is 50.8 mha (15.8% of TGA), semiarid is 123.4 mha (37.6 % of TGA) and dry sub-humid is 54.1 mha (16.5 % of TGA).

- The drylands comprise a large belt running from the border in the northwest through Peninsular India to the southern tip of the country. The hot arid regions in India occupy major parts of Rajasthan (Western), Gujarat, southern Punjab and Haryana and a small portion of Deccan Peninsula in the States of Andhra Pradesh, Karnataka, and Maharashtra. Roughly, three-fourth of the State of Rajasthan, comprising 12 western districts, falls within the hot arid zone.

- About 123.4 mha (37.6% of TGA) consist of semi-arid region. Crops and cropping systems are quite diverse here depending on soil type and length of agricultural season. Sorghum, cotton, soyabean, groundnut and pulses are the major crops.[11,12]

- About 54.1 mha (16.5% of TGA) fall within the dry subhumid region. About 54.1 mha (16.5% of TGA) fall within the dry subhumid region.

- The hot arid region suffers low and erratic rainfall, frequent droughts, high evaporation, intense heat and high winds. The agricultural season here is very short, so livestock farming forms an integral part of livelihoods.

Causes of Land Degradation

- Desertification in this context refers to 'land degradation in drylands'. In fact, UNCCD (Art.1) defines desertification as “land degradation in arid, semi-arid and dry sub-humid areas resulting from multiple factors, including climatic variations and human activities.”

- It is estimated that about 32% of India's total land area is affected by land degradation and 25% of the geographical area is affected by desertification. About 69% of the country's land is drylands and degradation of this land has severe implications for the livelihood and food security of millions.

- The major process of land degradation is soil erosion (due to water and wind erosion), contributing to over 71% of the land degradation in the country.[13,14]

- Water erosion, the most widespread form of degradation, occurs widely in all agroclimatic zones. It has caused up to 26.21 mha (10.21% of TGA) of land degradation. Wind erosion dominant in the western region, leading to loss of topsoil and shifting of sand dunes, has caused upto 17.77 mha (5.34% of TGA) in degradation.

- Also vegetal degradation of 17.63 mha (9.63% of TGA), and frost shattering of 9.47 mha has occurred.

- The other processes include problems of water logging, salinity-alkalinity. Rajasthan (12.79% of TGA), Gujarat (12.72% of TGA) and Maharashtra (12.66% of TGA) have high proportions of land undergoing degradation.

- Scare water resources in dryland regions limit green coverage coupled with stress on land due to increasing demand for agriculture and fodder production for livestock.

• Drought is another causative factor for land degradation in arid and semi-arid regions, instigating crop failures and then famines. Recurrent droughts cause lower biomass production, poor grain yields and scarcity of fodder.[15,16,17]

• The process of land degradation is further aggravated by high biotic pressure - human population and livestock population. India has livestock population of about 485 million, consequently burdening the limited land resources for fodder.

• Anthropogenic causes include expansion of agriculture and unsustainable agricultural practices such as intensive cultivation, chemical nutrient use, poor irrigation practices, and overgrazing. Such unsustainable resource management practices are often induced by population pressures, social conflicts, unsuitable planning etc.

• Diversion of land from forestry and agriculture to other land uses has been one of the principal causes of land degradation.

• Some direct causes of deforestation are land clearance for agriculture (including shifting cultivation). Other land use changes include unplanned development, land transfers, different forms of encroachment, over-grazing, uncontrolled and wasteful logging, illegal felling and excessive fuel wood collection.[18,19]

• Industrial effluents are emerging as significant agents of land degradation. Industrial effluents discharged into barren lands and inland water bodies degrade the land and the water table. Industrial effluents discharged into non-perennial streams and rivers cause long term contamination impacting local agriculture and the quality of ground water. Mining is another factor causing land degradation in India. This is especially the case with unplanned open cast mining and where dumping of mine refuse occurs in the vicinity of agricultural lands.

III.RESULTS

Biodiversity and a healthy soil are central to ecological approaches to making farming more drought-resistant.

• Over 60% of the world's food is produced on rain-fed farms that cover 80% of the world's croplands. In sub-Saharan Africa, for example, where climate variability already limits agricultural production, 95% of food comes from rain-fed farms. In South Asia, where millions of smallholders depend on irrigated agriculture, climate change will drastically affect river-flow and groundwater, the backbone of irrigation and rural economy.

• There will be a drop in precipitation of up to 10% in South Asia by 2030, accompanied by decreases in rice and wheat yields of about 5%.

• According to a review by the Food and Agricultural Organisation (FAO) in the 1990s, about half of the cultivable soils in India were degraded, and the situation has not improved. Since World War II, soil degradation in Asia had led to a cumulative loss of productivity in cropland of 12.8%

• Soil degradation, mainly the decline both in quality and quantity of soil organic matter, is one of the major reasons linked to stagnation and decline in yields in the most intensive agriculture areas in India, such as Punjab.[20,21]

• Over-application of nitrogen fertilisers (usually only urea), common in Punjabi farms and influenced by the government's subsidy system on nitrogen, is not only causing nutrient imbalances, but also negatively affecting the physical and biological properties of the soils.

• Burning rice straw after harvest, now a widespread practice in many places of the Indo Gangetic Plains of India, is also causing large losses of major nutrients and micronutrients, as well as organic matter

• Another common detrimental effect of the excessive use of nitrogen fertiliser on soil health is acidification, and the impact it has on soil living organisms, crucial also for natural nutrient cycling and water-holding capacity.

• Some varieties of wheat developed during the Green Revolution have only short roots – decreasing their capacity for drought tolerance

• Increasing temperatures and less and more erratic rainfall will exacerbate conflicts over water allocation and the already critical state of water availability.

• In 2007, MAS 946-1 became the first drought-tolerant aerobic rice variety released in India. To develop the new variety, scientists at the University of Agricultural Sciences (UAS), Bangalore, crossed a deeprooted upland japonica rice variety from the Philippines with a high yielding indica variety. Bred with MAS, the new variety consumes up to 60% less water than traditional varieties. In addition, MAS 946-1 gives yields comparable with conventional varieties

• In 2009, IRRI recommended two new drought-tolerant rice lines for release, which are as high yielding as normal varieties: IR4371-70-1-1 (Sahbhagi dhan) in India and a sister line, IR4371-54-1-1 for the Philippines. Field trials in India are being reported as very successful, with the rice tolerating a dry spell of 12 days.[22]

• Agriculture will not only be negatively affected by climate change, it is a substantial contributor to greenhouse gas emissions. However, by reducing agriculture's greenhouse gas emissions and by using farming techniques that increase soil carbon, farming itself can contribute to mitigating climate change
• In the race to produce larger industrial monocultures fuelled by agrochemicals and massive irrigation, the diversity of plant traits available to cope with little water in industrial cultivated crops has been reduced.
• In sub-Saharan Africa, something as simple as intercropping maize with a legume tree helps soil hold water longer than in maize monocultures.
• Scientists have computed that "agricultural losses in the US due to heavy precipitation and excess soil moisture could double by 2030".
• Scientists now believe that practices that add carbon to the soil, such as the use of legumes as green manure, cover cropping, and the application of manure, are key to the benefits of increasing soil carbon in the practice of soil conservation and reduced tillage.
• It has been shown that a combination of harvesting 25% of the run-off water combined with reducing evaporation from soil by 25% could increase global crop production by 20%.
• Healthy soils rich in organic matter, as the ones nurtured by agroecological fertilisers (green manures, compost, animal dung, etc), are less prone to erosion and more able to hold water.
• Organic matter improves the activity of micro-organisms, earthworms and fungi, which makes the soil less dense, less compacted and with gives it better physical properties for storing water.
• Mulching with crop residues, introducing legumes as cover crops, and intercropping with trees all build soil organic matter, thus reducing water run-off and improving soil fertility.
• Many fungi associated with plants (both mycorrhizal and endophytic species) increase plant resistance to drought and plant water uptake.[23]

Due to climate change, the hydrological cycle is likely to be altered and the severity of droughts and intensity of floods in various parts of India is likely to increase. Further, a general reduction in the quantity of available run-off is predicted.
Simulations using dynamic crop models indicate a decrease in yield of crops as temperature increases in different parts of India. However, this is offset by an increase in CO_2 at moderate rise in temperature and at higher warming, negative impact on crop productivity is projected due to reduced crop durations.
Climate impact assessments using BIOME-3 model and climate projections for the year 2085 show 77% and 68% of the forested grids in India are likely to experience shift in forest types under A2 and B2 scenario, respectively. Indications show a shift towards wetter forest types in the northeastern region and drier forest types in the north-western region in the absence of human influence. Increasing atmospheric CO_2 concentration and climate warming could also result in a doubling of net primary productivity under the A2 scenario and nearly 70% increase under the B2 scenario.
Malaria is likely to persist in many states and new regions may become malaria-prone and the duration of the malaria transmission windows is likely to widen in northern and western states and shorten in southern states.
Globally, about 1900 Mha of land are affected by land degradation, of which 500 Mha each are in Africa and the Asia-Pacific and 300 Mha in Latin America. Climate change leading to warming and water stress could further exacerbate land degradation, leading to desertification.[24]

IV.CONCLUSIONS

The United Nations Convention to Combat Desertification (UNCCD) aims to address the problem of land degradation, which is linked to climate change.
It is important to note that the climate-sensitive sectors (forests, agriculture, coastal zones) and the natural resources (groundwater, soil, biodiversity, etc.) are already under stress due to socio-economic pressures. Climate change is likely to exacerbate the degradation of resources and socio-economic pressures. Thus, countries such as India with a large population dependent on climate-sensitive sectors and low adaptive capacity have to develop and implement adaptation strategies. [25]

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