Arid and Semi – Arid Technology

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Abstract

Desertification is a major global concern and must be controlled for ecosystem preservation in many arid and semiarid regions. Vegetation restoration has been mainly regarded as an effective ecological measure for desertification control and has been widely implemented in many desert regions around the world. Arid land is a terrain where there are so little rainfall plants and animals either don't exist or are very sparse and impeded in growth. Desserts are arid, but other areas with very little moisture are also. Semiarid region are dry regions with very little vegetation. The major technologies implemented to promote vegetations in these areas are highlighted in this work.

Keywords:-*Arid, Semi arid, Moisture, Technologies*

INTRODUCTION

Afforestation in desert areas with shifting sand dunes presents a formable challenge due to deprival of high- quality water, soil salinization, and sand blasting and burial of vegetation. These challenges are at the forefront of developing sustainable afforestation practices in the Taklimakan Desert, China. The major problem encountered when trying to establish and support vegetation in arid ecosystems is the availability of good quality water for plant growth (Wuyunna et al., 1999). Because of the water shortage, saline water is widely availed for irrigating vegetation to overcome the water scarcity Survival and growth of three afforestation species under high saline drip irrigation in the Taklimakan Desert, China. Afforestation of shelterbelts is a sustainable practice to protect highways from shifting sand dunes in desert areas.

The Taklimakan Desert Highway Shelterbelt (TDHS) in China is known as “the Great Green Wall of Taklimakan Desert” and borders a 435km distance along the highway. This study assessed the early survival, above- ground growth, and root growth of three salt- and drought-tolerant plant species (Calligonum aborescensLitv., Tamarix ramosissima Ledeb., and Haloxylon ammodendronin TDHS; those were drip- irrigated with local high saline groundwater.

The results demonstrated that more than 811% of Haloxylon ammodendron seedlings could survive regardless of irrigation water salinities ranging from 2.81 to 29.70 g/L. In contrast, survival rates of Calligonum aborescens seedlings were greater than 65% when using irrigation water salinities ≤13.99 g/L and less than 52% when irrigated with water having salinities of 20.99–29.70 g/L, respectively.

However, plant survival rates of Tamarix ramosissima were much lower than 50% when irrigated with water having salinities >4.82 g/L. Under the same salinity, the height, crown width, and maximum width of basal stems were the greatest for Calligonum aborescens plants and the lowest for Tamarix ramosissima plants. Root length is varied among the species depending on tree age and the applied water characteristics. It can be concluded that afforestation is feasible with saline water in this extreme arid shifting desert, particularly Calligonum aborescens plants should be grown at the outer margin of the shelterbelt due to its faster growth to more quickly stabilize the shifting sand.

Recent research may provide a good resolution for afforestation and marginal saline water utility in most arid and semiarid regions. However, the solutes in groundwater may increase soil salt contents and affect plant growth and survival in irrigated areas. When exposed to salt stress, plant growth may be typically influenced by the osmotic effects on water uptake and disrupted ion homeostasis in the plant cells that may cause an inhibited metabolism and damaged membranes.

Plants under salt stress extremely require more energy to adapt to the harsh environment and decrease the risk of salt-injury .The Taklimakan Desert, which is the second largest shifting sand desert in the world, is located in north western China. The Taklimakan Desert is called “The Sea of Death” because of the large expanse of shifting sand dunes and extreme drought conditions. This region receives very limited precipitation that averages 26mm/yr and has a high evaporative potential that averages 3638 mm/yr an Desert Highway was constructed in 1997 and is oriented in the north to south direction across the desert. A mechanical sand prevention system was previously constructed to stabilize shifting sand dunes which would otherwise result in the burial of the highway.

The straw checkerboard prevention system, however, was buried by the shifting sand about 3–5yr after installation. As a result, the Taklimakan Desert Highway Shelterbelt (TDHS), also called “the Great Green Wall of Taklimakan Desert” was constructed to protect the highway from shifting sand burial (Weaver et al., 1949).

Drought is a permanent constraint to agricultural development in some of the developing countries where inhabitants are dependent on agriculture for their subsistence. It is probably the single most common and severe stress that subsistence farmers face. Chronic or sporadic periods of water deficit paves to substantial crop losses, and because access to irrigation is scarce, farmers are almost completely dependent on rainfall.

Arid lands (Fig: 1, 2) are rapidly increasing and already 35%of the world’s area is classed as arid or semi-arid (Fig: 3). The rate of increase in the population of the Third World lends typically added urgency to the selection and breeding of crops that display tolerance to drought while maintaining their productivity.

Fig:1 Arid regions

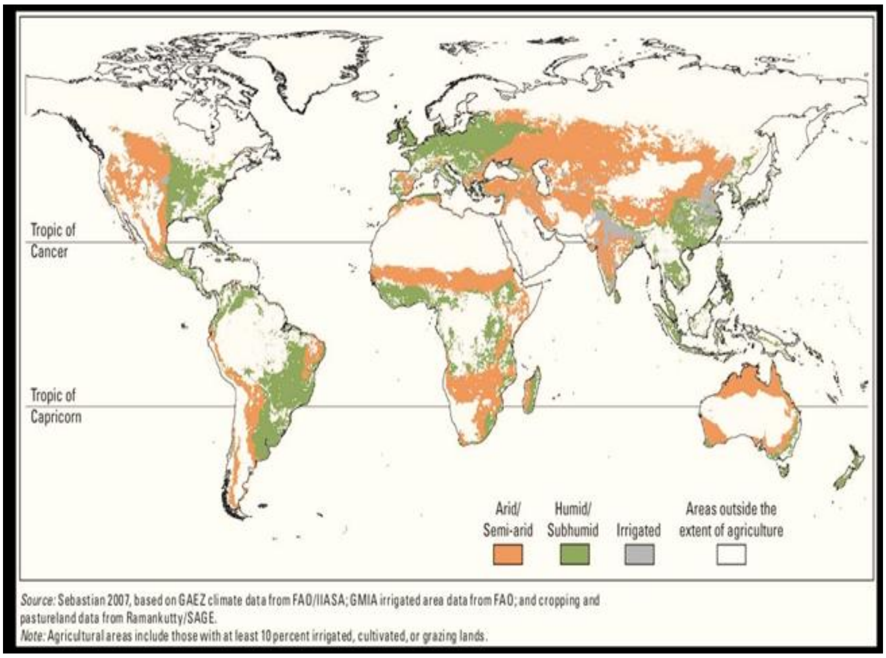

Fig: 2 Arid regions

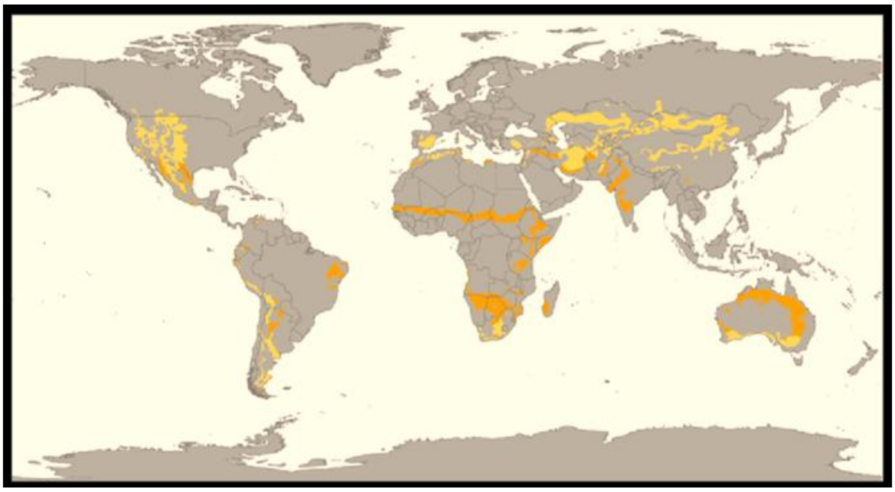

Fig: 3 Countries with Semi Arid Regions

While relatively few commercial crops predominate the world's food supply, many traditional crops are important in the daily nutrition of millions of people in resource-poor countries. These crops are an indispensable part of daily nutrition, particularly in the rural areas where it is impossible to grow the exotic crops. Many of these crops have been naturally and traditionally selected and are able to survive and grow under conditions of low or frequently changing water supply (Ve et al., 2001). Diverse drought tolerance mechanisms exist at the molecular, metabolic and physiological levels, and under harsh African conditions crop yields are often higherthan those of exotic commercial crops. These indigenous crops are maintained and produced through traditional use and socio-cultural preferences, but until recently have been almost completely ignored in agricultural research programmes. Significant potential exists to develop and improve these crops, as well as to increase genetic diversity, which in turn would promote synthesis and agricultural use (Kigel, 2000).

Screening Methods for Drought Tolerance in Traditional vegetable Crops

As even traditional vegetable plants can typically survive a limited period of water deficit, it is essential to understand the effect of drought on their growth, metabolism, development and yield. Because of the inherent diversity in the different traditional crops, grown for a variety of purposes, water requirements have to be determined for each individual crop. A project to develop genotypes that might contribute to food synthesis in developing countries was initiated at the Agricultural Research Council (ARC) at Roodeplaat, Pretoria. Physiological and biochemical mechanisms were investigated in conjunction with drought survival traits. This allowed development of effective screening methods for drought tolerance and which in turn could be mainly applied to arrange of regionally-adapted vegetable crops for practical breeding purposes (Pielou, 1969).

Stream flow Forecasting

Water-supply forecasting is one of the prime and mostimportant technologies related to precipitation and runoff in the Western United States for long-term sustainable agriculture. Improvements in the accuracy of these technologies will entail much advances in understanding the impacts of weather modification and watershed management on the hydrologic environment. Improved water-supply forecasting could provide the connection between the resource and the water user or planner because it directly relates to the timing and volume of water available to downstream or low land agriculture. A vast range of forecast models exists, from very sophisticated computer simulation technology to simpler statistical correlation models. Studies has given ample information that no single forecast model may be sufficient for all the hydrometeoro logical environments in the West. Research also suggests that progress in accurately forecasting stream flow for certain regions in the Western United States would reap considerable economic benefits for agriculture (Howard, 1940).

Technologies Affecting Surface water Storage and Delivery

Natural stream flow and precipitation seldom meet agricultural demands for water in the western States. Three approaches make more surface water available when the demand exceeds supply:

1. aggrandizing the total amount of storage,
2. augmenting supplies with additter, and water inionalwa
3. Stretching existing water supplies by conservation.

Opportunities to develop large sources of previously unavailable surface water or to augment existing supplies are feasible technologically but are limited by economic, environmental, legal, and social considerations. They are unlikely to add important amounts of water to irrigation supplies in the future, Technologies that reduce water losses [i.e., conserve water) in storage and delivery systems can be applied relatively easily but tend to be expensive. Furthermore, their effects on the entire hydrologic cycle are often difficult to measure and their application, attimes, can have unexpected, negative effects on riparian (areas of shrubs, trees, and grasses generally along stream banks) and wetland wildlife habitats (Numata,1975).

Technologies That Store and Augment Water Supplies

Technologies that elate the amount of water in storage include storage facilities, Desalination processes, and inters basin transfers of water. The extensive and complex system of large and small reservoirs in the Western States represents about 78 percent of storage capacity in the Nation. These storage areas include a few reservoirs that contribute much to the total storage capacity, a sizable number of medium-sized reservoirs, and an even larger number of farm and ranch ponds (Nakamura et al., 2000).Storage facilities permit more convenient and efficient use of available water supplies by downstream agricultural users. Construction technologies for reservoirs are well developed, and technologies to manage reservoirs are advancing rapidly. The Federal Government has a sizable investment (at least $26.5billion) in completed water resource projects and owns some 2,000 dams, ranging in size from small reservoirs to large, multipurpose projects. While the benefits to irrigators and other users have been typically sizable, the costs have also been substantial. Barriers to new, large-scale developments are not technological; they are physical, economic, and environmental. Because of these major constraints, many experts expect that the Federal role in building and operating new, large scale water-storage facilities will diminish markedly in the future (Li et al., 2000).

The Semi-Arid Tropics

The semi-arid tropics include parts of 47 countries in the developing world: most of India, locations in south east Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and a few locations in Latin America, which are characterized by unpredictable weather, long dry seasons, inconsistent rainfall, and soils that are poor in nutrients(Kawada et al,2005). These environments provide home to one-sixth of the world's population, who are the poorest among the poor. Half of them live on less than US $ 2, and“work hard to sustain a living through typically daily and seasonal struggle to protect poorly endowed natural resources, conserve scarce water, improve soil fertility, and diversify crops choices” .Sorghum, millet, cowpea, chickpea, pigeon pea and groundnut are among the major vital crops that feed the poor people living in the semi-arid tropics, or the "home of the hungry" due to the expanding population and associated demand for food. These crops are mainly affected by many biotic and abiotic stress factors contributing to crop losses. Salinity and drought still remain as major abiotic stresses that pose a threat to agricultural production in many parts of the world (Manish et al., 2006). Arable lands are lost annually due to typical desertification and salination, toxication, and mismanagement of the natural resource base for agriculture .Water is becoming a scarce resource that requires extreme careful economic and environmental management. Expansion of irrigation does not seem feasible in many countries in Asia, the Middle, East, and North Africa, where most of the available and easily accessible water resources have been already developed. Moreover, public irrigation systems need substantial investments for rehabilitation, modernization, operation and maintenance. Likewise, irrigated soils are affected by salting, although the yield loss estimates differ widely. Desertification may be aggravated typically by both over exploitation by native populations and regional climatic changes. Breeding programs must rank high the development of crops with tolerance to both drought and salinity stress. The genetically ramified control of these stresses in the plant genome may be facilitated through the manipulation of specific genes governing the component characteristics needed to achieve tolerance to salt or drought in plant crops (Shekhawat et al., 2005).

THE INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARIDTROPICS

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was created in 1973 to address the challenges associated with "growing marginal crops on marginal lands with marginal resources". The challenges for agriculture in the semi-arid tropics are to: (1) improve the productivity of the subsistence crops that typically include coarse grains such as sorghum and millet, and food legumes such as cow pea, groundnut, and pigeon pea; (2) improve, protect and promote the assets and resources of the poor farmers living in this agro-ecological zone; and (3) build partnerships with local organizations to enhance and protect natural resources. The mission of ICRISAT is to help the developing world in the semi-arid tropics to increase farm productivity and food security, reduce poverty, and protect the environment through optimum use of natural resource endowment, through partnership-based international agricultural research, specifically with national agricultural research systems (NARS) and advanced research institutes. ICRISAT and its partners expect that their "research for development" will lead to copious production of these crops and to improved management of the limited natural resources of the semi-arid tropics. To achieve its mission, ICRISAT has mainly focused its work following a four-point mandate to (1) improve the most important crops of the semi-arid tropics and safeguard their seeds, (2) develop improved farming systems, (3) find major ways to overcome agricultural constraints, and (4) collaborate with local organizations in participatory research and technology exchange with farmers(Shekhawat et al.,2006).

Genetic enhancement for crops of the semi-arid tropics

The genetic resources available in the crops grown in the semi-arid tropics have garnered the source of genes for their betterment. A few genes from wild species have been transferred to the cultivated gene pool by inter specific hybridization followed by embryo culture, which overcomes the cross incompatibility that often occurs after pollination in the so-termed "wide-crosses" between species. In some inter specific incompatible crosses, fertilization occurs but the embryo aborts a few days later (Neumann, 2006). Hybrid plants may be typically obtained by preventing pod abscission and saving aborting hybride mbryos with "rescue" techniques Yet, millions manner by developing low cost varieties based on use of people live in such regions and if current trends in bio fertilizers and integrated pest management and hence population elate continue, there will soon be millions are more appropriate for small and marginal farmers in arid more. These people must eat and produce their own food (Krüger et al.,1997).Biotechnological tools -Arid implies prolonged dryness and is availed with respect can also be used to improve the nutritional content of to the climate itself and the land below it. In such regions food crops so as to address the problem of malnutrition in the ability to produce agricultural crops is restricted in arid regions of countries. Generally on arid lands the potential evaporation of water. The Convention on Biological Diversity (CBD) from the land exceeds the rainfall. The word, "arid" can be defined in biotechnology as “any technology application not adequately characterize the soils, however, for that uses biological systems, living organisms, or may vary in many ways(Gwathmey et al.,1992). Often they are alkaline or saline. Derivatives thereof, to make or modify typical products or several degrees of dryness must be recognized. The first processes for specific use.” In a broad sense, where the dry climate is modified by seasonal rainy definition covers many of the tools and techniques, seasons. The arid regions present globally are often very which have been commonly used in agriculture and extensive, but in the tropics it is common, even on a small food production, processing and utilization (Howell, 1994). In a narrow island, to mainly find arid regions not far from regions of sense, however, it encompasses DNA techniques, abundant rainfall. The extreme arid region extends over molecular biology and reproductive technological about 0.32 million km forming approx. 9% of the total applications dealing primarily with gene splicing and geographic area of India. More than 61% of this area leisure combination and genomics (Guazzelli et al., 1988). Biotechnology is already in the State of Rajasthan. Arid region of Rajasthan underpinning the sustainable development of agriculture forms the eastern extremity of the great arid and forestry and fisheries, as well as the food and other semi-arid belt of the world. Owing to strong variations primary product- related industries. It has tremendous impacts in climatic, physiographic, topographic and geological potential for impacting global food security, human and characteristics, the arid regions show a wide diversity of animal health, environmental health and overall livelihood habitats. Thar Desert is home of varying tribes and of mankind communities who have got a rich culture heritage and colorful traditions.

Arid Stressed Ecosystems and Biotechnology: Abiotic stresses represent the most limiting environmental broad range of annual crops during the short rainy season, factors affecting agricultural productivity in arid enough to sustain animals and feed mankind, although regions of Rajasthan (Grubben et al.,1981).

To overcome these typical limitations few food or feed trees might be feasible without special and to improve production, to feed the ever-increasing techniques. The second situation is a year round aridity, population, it is imperative to develop crop cultivars that sometimes modified by light or irregular rains, which might are stress tolerant. When crop plants are subjected to make production of crops impossible, the third phase is the environmental stress conditions, they fail to express is where water is brought in by wells, canals, or other their full genetic potential for production (Grove, 1985). The effect means so that normal agriculture can exist, in spite of the stress depends on the developmental phases, aridity of the climate. For some time now there has been genotype of plant species as well as duration and a discussion on the potential of biotechnology for intensity of the stress. Usually, plants respond to this development in arid regions. It is now well established stresses under low or very moderate levels, but when these technologies provide valuable tools for meeting stress levels exceed a certain critical level (which varies a number of developmental challenges in different areas, from crop to crop), the physiological mechanisms. In agriculture for instance, the high yielding varieties typically imparting tolerance to plants start breaking down which have been extensively used since the mid-sixties causing ultimately plant death. Consequently, the abiotic and ushered in green revolution are not only reaching a stress factors cause a massive decrease to the productivity plateau in terms of yields but are not sustainable given of crop plants. Their heavy dependence on chemical fertilizers, pesticides, Classical plant breeding methods much involving and irrigation (Goli, 1997). Moreover, they are not suited to inter-specific or inter-generic hybridization and in vitro stressed arid ecosystems. The conventional breeding those genes that are extremely added need not come from a species strategies are limited by the complexity of stress tolerance that is sexually compatible with the crop in question. Traits, low genetic variance of yield components under Conventional breeding is, of course, limited to the stress condition and lack of potential selection criteria. Introduction of genes from plants of the same species Orit is significant, therefore, to look for alternative strategies very near relatives. By employing the science of genetics to develop stress tolerant crops, currently, marker assisted engineering, it is possible to bring into crop plant different selection of specific traits that are related to yield, e.g. genes from other plants or even bacteria, fungi or animals (Fowler, 2000).Genes are, simplistically, made up of two parts: the coding tolerance indices, has been recommended. QTL region which determines what the gene product is and that are linked to tolerance at one stage in plant promoter, a set of instructions specifying where, when development can differ from those linked to tolerance at and to what degree a gene is expressed. Moreover, desirable QTLs can require and promoters from different genes can be spliced extensive breeding to restore suitable traits along with the together in the laboratory to provide genes with new and introgressed tolerance trait. The best alternative, useful properties (recombinant DNA) (Duke, 1981). These foreign or therefore, is the direct introduction of genes by geneticre combinant genes can then be introduced back into crop engineering to incorporate tolerance traits in target crops. Crop biotechnology, which broadly includes are as transformation. The introduced genes concoction into the development of transgenic crops, structural and plant genome and will be passed on to the offspring in the functional genomics and marker-assisted breeding could normal way. Many genes and gene barrier to gene exchange has been removed. Sequences products have been identified which get induced from varied sources like bacteria, viruses and eukaryotic upon exposure of plants to various abiotic stresses-systems can be typically transferred to plants to develop drought, salinity, low and high temperature stress, etc. transgenic crop varieties. Achievements, to date, in plant biotechnological tools have been applied biotechnology have surpassed all previous expectations to transfer some of these useful genes implicated in stress and with the development of high through put tolerance to plants. In addition to these stress-induced instruments, the future is even more profoundly promising. There proteins, genes encoding enzymes of the biosynthetic care two main applications of biotechnology to arid land pathways of different osmolytes such as proline, glycine crop synthesis: as an aid to conventional breeding betaine, trehalose, sorbitol, pinitol, etc. have been cloned programmes and; its ability to transfer genes between and exploited in improving abiotic stress-tolerance indifferent organisms. The ability to monitor and assess the number of genes show elevated transcript levels in plants (Davis et al.,2000).

CONCLUSION

An Arid Landscape is a terrain that lacks water or moisture, generally due to low or completes deprival of annual rainfalls. Arid landscapes are parched, dry lands that cannot much ideally support plant growth. Deserts are apt arid landscapes. Semi-arid is a land categorized based on annual average rainfall, usually between 250-410mm per year. There are certain biotechnological approaches implemented to promote cropping in arid and semi arid regions.

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