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IMPACT OF CLIMATE CHANGE ON SUGARCANE PRODUCTION AND ITS MITIGATION A REVIEW

Dr. Namdev V. Kachare[1], Dr. A. I. Khan[2], Dr. Madanlal V. Suryawanshi[3]

[1]Research Student Department of Geography Dr. Babasaheb Abedkar Marathwada University, Chh. Sambhajinagar (Aurangabad), India.

[2]Head & Dept. of Geography Government Arts and Science College, Chh. Sambhajinagar (Aurangabad) India.

[3]Heand, Department of Geography, Dr. BAMU, Chh. Sambhajinagar (Aurangabad), India

ABSTRACT

India is the world's second largest producer of sugar after Brazil with an average annual production of 25.1 million tones, with about 5.1 million ha area under cane cultivation and its processing for value added products such as sugar, jaggery, bio-ethanol, paper, bio-fertilizer, power cogeneration etc. has drawn awareness because of its socio-economic impact and environmental concerns. Because sugarcane is a climate-sensitive crop, its global spread is limited based on a number of climate-related factors. Despite being a very slow phenomenon, climate change is currently accelerating due to significant human activity and natural disturbances to the atmosphere's composition. Numerous climate models' predictions for likely increases in temperature, precipitation, and sea level indicate a concerning situation for the ensuing decades. Since sugarcane is highly susceptible to changes in temperature, precipitation, solar radiation, and other factors, future production and sugar yield are anticipated to be significantly impacted. It is also commonly recognized that sugarcane is one of the most valuable commodities in the world and that demand for its byproducts, ethanol and sugar, is constantly rising on a global scale. As a result, research on how to produce sugarcane well in the face of climate change has advanced to the forefront and is a top priority for scientists everywhere. Advance agronomic practices, such as the creation of cane varieties that are suited to shifting climate conditions, land preparation, plantation timing and pattern, weed, disease, and pest management, nutrient management, appropriate timing, and sufficient water management, appear to be the most effective ways to achieve high crop yields and high-quality juice in the future.

Keywords: sugarcane, climate change, agronomy, soil.

1. INTRODUCTION

A tall perennial grass of the genus Saccharum in the family Poaceae, sugarcane is characterized by a robust, jointed, fibrous stalk that ranges in length from 2 to 6 meters and contains sugar (Clark et al. 1995). It is indigenous to humid, warm-tempered to tropical regions of Southeast and South Asia. This C4 plant converts solar energy efficiently and stores it with high efficiency. In general, the plant goes through four distinct growth phases: the germination period, the tillering phase, the major growth phase, and the maturity and ripening phase. The first phase, which lasts for four to five weeks and is dependent on the conditions of the field, begins with planting and ends when the buds fully germinate. Sprouting does best at a temperature of 20 to 30°C. The second phase, known as tillering, lasts for roughly 120 days and is crucial to optimal production. It is delicate and extremely susceptible to the local climate, the soil's temperature, and the availability of water and nutrients. In this phase, temperature and sun radiation are important factors. The ideal temperature is around 30°C, and healthy growth necessitates enough light. Other factors that affect tillering include weed control, spacing manuring, and water availability. The real cane production and elongation phase, known as the phase of primary growth, can take anywhere from 270 to 300 days. Warm, humid weather is ideal for cane growth since it promotes leaf creation and growth. The ideal conditions are similar to those of the second phase in terms of temperature and humidity, with about 80%. Over the course of roughly ninety days, the last stage of maturation and ripening occurs. Both the quick accumulation of sugar and the transformation of simple sugar into cane sugar occur during this period. Dry conditions, bright sunshine, and warm days quicken the process.

Brazil (677.6 MMT), India (35 MMT), China (103.38 MMT), Thailand (85.5 MMT), Pakistan (83.5 MMT), Mexico (5.95 MMT), Colombia (23. 3 MMT), Australia (3 4.4 MMT), Philippines (323.46 MMT), and the United States (8.37 MMT) are among the more than 120 countries that grow the crop. With 33% of the world's sugar produced, Brazil continues to top the production race, followed by the Philippines (323.46 MMT) (FNP 2023). According to FAOSTAT 2020, there are 26 million hectares of sugarcane grown worldwide, with 1.87 billion tonnes produced.

About 5 million hectares of sugarcane are planted in India, with Uttar Pradesh producing the most sugarcane with 133.3 million tons. Maharashtra is ranked second among the states in India that grow the most sugarcane. Following it are the following states: Uttarakhand (6.4 million tons), Gujarat (9.5 metric tons), Haryana (9.3 metric tons), Punjab (6.6 million tones), Andhra Pradesh (14.9 metric tons), Bihar (12. 2 metric tons), Tamil Nadu (37.5 metric tons), and Karnataka (34.6 million tons). India is an agricultural nation, with the majority of its population working in agriculture. A common term for sugarcane is cash crop. India's labor force is composed of 65% farmers. India grows almost every kind of crop, but sugarcane is one of the most widely planted crops there. Sugarcane is mainly used for sugar production. Although sugarcane agriculture is geographically limited due to climate, the demand for its byproducts such as sugar and ethanol is growing worldwide. For this reason, it is crucial to consider sugarcane cultivation, production, and yield in light of the changing environment. Although extremely adaptable, sugarcane is also quite susceptible to climate change. In essence, it is a crop that is fed by rain and is highly dependent on temperature, soil quality, humidity, moisture content, and the quantity and duration of precipitation (Gawander 2007). Due to their degree of interdependence, changes in one usually have an impact on the others. The global climate setup has been impacted recently by both natural phenomena such as variations in the earth's orbital characteristics, variations in atmospheric carbon dioxide, volcanic eruptions, and variations in solar output and human activities, especially the rapid industrialization that led to increased CO2 emissions, global warming, the greenhouse effect, etc. (Segalstad 1996). Studying how climate change is affecting many facets of sugarcane is therefore a top issue.

2. CLIMATE AND SOIL FOR SUGARCANE

Sugarcane is a tropical and subtropical crop that thrives in warm and humid climates. The climate and soil conditions play a crucial role in the successful cultivation of sugarcane. Here are the key requirements for sugarcane:

Climate:

1. Temperature: Sugarcane is a warm-season crop and requires a temperature range of 20-30°C (68-86°F) for optimum growth. It is sensitive to frost and cannot tolerate extremely low temperatures.
2. Rainfall: Sugarcane requires a well-distributed and consistent water supply throughout its growing season. Adequate rainfall or irrigation is essential for optimum growth. However, sugarcane is known for its ability to withstand drought conditions to some extent.
3. Humidity: Sugarcane prefers high humidity levels for optimal growth. Humidity levels above 60% are beneficial, especially during the growing season.
4. Sunlight: Sugarcane is a sunlight-loving plant. It requires full sunlight for most of the day to carry out photosynthesis efficiently. Wind and relative humidity have relatively little influence over plants, although in cases of extremes, they do have a significant impact. Cane grows quickly in warm climates with humidity levels between 80 and 85 percent. Moderate humidity and a restricted water supply are ideal throughout the ripening phase (SC 2012). Similar to this, plants are safe from wind damage until it reaches a speed that might break cane or injure leaves. In the early stages of plant growth, the high velocity could be detrimental. Moisture loss is a result of the high velocity wind for an extended period of time. In general, two distinct sets of climatic conditions are needed for the plant's life cycleextended warm season featuring brilliant sunshine and ideal rainfall High humidity throughout the growing season encourages quick plant growth and long, productive canes. The ripening season, which is a stage of sugar storage, requires warm, dry weather, clear skies, and no precipitation.

Soil:

1. Soil Type: Sugarcane can grow in a variety of soil types, but it prefers well-drained soils. Sandy loam and loamy soils are considered ideal for sugarcane cultivation.
2. pH Level: The soil pH should be in the range of 5.5 to 8.5 for sugarcane cultivation. However, a slightly acidic to neutral pH is generally preferred.
3. Organic Matter: Sugarcane responds well to soils rich in organic matter. The addition of organic material helps improve soil structure, water retention, and nutrient availability.
4. Drainage: Proper drainage is crucial for sugarcane cultivation. Waterlogged conditions can lead to root rot and other diseases, so well-drained soils are essential.
5. Fertility: Sugarcane is a nutrient-demanding crop. Soils should be fertile, and the application of balanced fertilizers containing nitrogen, phosphorus, and potassium is important for good yields.

Since sugarcane is a crop that responds to management, it is important to keep an eye on the relationship between the soil and the plant at every stage of growth. When the crop is left in the field for more than a year, it is subjected to various weather conditions such as high temperatures, high humidity, and intense sunshine. As a result, both the soil and plant conditions fluctuate greatly throughout this time. As a result, it is advised to preserve the favorable soil environment for healthy plant growth by appropriate management of the soil under a variety of harsh circumstances, such as watering during dry seasons, maintaining excess water drainage, insect and weed control, etc.

EFFECT OF CLIMATE CHANGE ON SUGARCANE

The cultivation of sugarcane may be impacted by climate change in both direct and indirect ways. A crop native to tropical and subtropical regions, sugarcane is susceptible to variations in temperature, precipitation, and other climatic factors. The following are some possible repercussions of climate change on sugarcane:

Variations in Temperature:

Elevated Temperature: Since sugarcane is a warm-season crop, rising temperatures have the potential to quicken its development. Severe heatwaves, however, can also cause heat stress, which alters plant metabolism and lowers yields.

Water Availability:

Modifications to Precipitation Patterns: Variations in rainfall patterns might result from climate change. For best growth, sugarcane needs a steady and sufficient supply of water. The cultivation of sugarcane can be adversely affected by drought, resulting in reduced production and quality.

Dynamics of Pests and Diseases:

Modifications to Pest and Disease Patterns The distribution and incidence of diseases and pests can shift in response to climate change. There's a chance that new pests will appear and that old ones will relocate. Variations in climate can have an impact on the dynamics of many pest and disease problems that sugarcane faces.

Carbon Dioxide Levels:

Elevated CO2 Concentrations: Sugarcane is one crop that may benefit from fertilization by higher CO2 levels, which can boost photosynthesis and perhaps enhance production. However, additional environmental factors influence the overall impact.

Extreme Weather Events:

Cyclones, Storms, and Flooding: These weather phenomena have the potential to physically harm sugarcane fields, resulting in production losses. Climate change may cause these occurrences to occur more frequently or intensely.

Sea Level Rise:

Coastal Sugarcane Cultivation: Sea level rise may cause saltwater intrusion in areas where sugarcane is produced along the coast, which may have an effect on soil salinity levels and sugarcane yield.

Strategies for Adaptation:

Creating sugarcane cultivars that are more tolerant of temperature fluctuations, water stress, and pests and illnesses linked to climate change is known as "climate resilience breeding." Better Water Management: To adapt to shifting precipitation patterns and guarantee water availability, effective irrigation systems and water management techniques should be put in place. Crop Rotation and Diversification: Examining crop rotation and diversification to reduce risks related to climate-related issues.

Precision Agriculture: Adopting precision agriculture techniques to optimize resource use and enhance overall productivity.

Overall, among all the sectors, the agricultural production activities are the most susceptible to the effects of climate change (IPCC 1990, 2005). The IPCC (2007) states unequivocally that there is and is being climate change. Its effects will be concentrated in poor nations, endangering the accomplishment of the MDGs, the fight against poverty, and the availability of clean food. Climate change affects crop productivity, but it also has a significant impact on a region's socioeconomic structure, which in turn has an impact on the national economy.

There are also major obstacles for the fair trade movement because of this transformation. Evidence suggests that the majority of small farmers in Southeast Asia and the Indian subcontinent are facing greater climate variability and change.

More extreme occurrences and effects with a delayed beginning, including variations in temperature and precipitation, are anticipated as a result of climate change (Nelson et al. 2010). According to Hannah et al. (2005), climate change is most likely to have detrimental effects on food security, agricultural productivity, and economic development, particularly in poor nations.

AGRONOMIC MEASURES

Agronomic measures are methods and procedures used in agriculture to maximize crop yield and manage resources in an environmentally responsible manner.

These actions are intended to reduce environmental impact, increase crop yields, and improve soil fertility. The following are important agricultural actions:

FIELD PREPARATION AND PLANTING

The first step in field preparation is clearing the area, usually by tossing out the previous crop. Sugar seed needs to be clear of undesirable leftovers from the previous harvest. In most of the Indian subcontinent, rice is a staple crop with an abundance of stems and roots. To get rid of them, it's usual practice to gather them, burn them, and then disperse the ashes around the field, which modifies the soil's composition and texture. An additional consequence of the crop's need for water is an increase in soil moisture due to local storage, which makes plow work more challenging. Therefore, it will take 1-2 weeks for the soil moisture to drop. A good seed yield is achieved by deep plowing two to three times with enough organic manure in between. Remove the tough stalks from the sorghum, maize, and wheat. Low moisture does not do much damage to previous crop wheat, so preparation is straightforward—just gather the residue and burn or remove it.

PLANTING MATERIAL

The next stage involves choosing the appropriate cane variety and designing the planting layout. Scientists from all around the world have been working for a long time to create new types of crops that are more productive and high yielding in response to changes in the local soil and environment. The selection of a variety varies depending on the region, needs, climate, types of soil, etc.; locally, information about these factors is available in nearly all of the major countries that produce sugarcane.

Two common viruses that seriously harm crops are Sugarcane Streak Mosaic Virus (SCSMV) and Sugarcane Mosaic Virus (SCMV) (Chatenet et al. 2005: Damayanti et al. 2010). According to Damayanti et al. (2011), the SCSMV's thermal inactivation point is greater than the plant's thermal death point, with a range of 55–60°C. On the other hand, ten minutes of therapy at 53°C can significantly lessen the severity of the disease while preserving 100% plant viability. In addition to soaking the cane water for a duration of 12 to 18 hours, treatments with mud or cow dung are also implemented to enhance germination rates. Better germination and bud sprouting can be achieved by treating with certain chemicals, such as KMnO4, MgSO4 or potassium ferrocyanide, ammonium sulphate, chlorohydrins, acetylene, etc. On the other hand, aretan and benzoene can be used to prevent fungal and insect assault.

The productivity and yield are directly impacted by the planting pattern. There were notable variations in the length, diameter, and weight of each individual cane, according to an experiment by Mahmood et al. (2007) to ascertain the impact of various planting patterns, i.e., number of rows, spacing between, width of the ditches, pit size, etc., on the yield potential and juice quality of autumn planted sugarcane. Due to the use of different planting patterns, the data also demonstrates a significant degree of variance in cane yield and millable cane production. In their 2009 experiment, Garside and Bell showed that no matter the location, crop duration, water availability, or soil health, high density planting did not result in a higher cane or sugar production at harvest compared to low density planting. Wide row planting generally yields higher cane weight, yield, and tiller survival, which contributes to a relatively high yield of millable canes with a longer shelf life and high yielding quality (Sundra 2002: IISR 2008: Kapur et al. 2011).

WEED MANAGEMENT

Probably the only thing that can lower agricultural production and output to the absolute maximum is weeds. With other nutrients, it can lower the potential sugar yield by 25–90%. Common weeds in India include Fumania sp. (broad leaves), Digera arvensis, Anagallis arvensis, Cyperus rotundus, Echinochloa spp., Saccharum sp. (narrow leaves), Chenopodium album, Solanum nigrum, Convolvulus arvensis, Trianthema sp., and Cynodon dactylon (grasses). Given that sugarcane is a long-standing crop, it is impacted by many weeds and shifting weather patterns. The main causes of sugarcane's easy susceptibility are its planting pattern, which calls for a wide row gap; the plant grows slowly since the germination period lasts for 4-6 weeks and the whole canopy development takes 8–10 weeks; and the plantation has relatively superior water and nutritional conditions. These conditions increase the likelihood of weed growth, yet controlling them is necessary for producing sugarcane at a reasonable cost. By competing with other plants for light, nutrients, and moisture during the growth season, it lowers yields. Utilizing cultural, manual, and chemical treatments at the right stage of plant growth will maximize output and production. The most effective and affordable strategy of managing weeds can also be achieved by carefully combining several techniques.

NSECT /PEST CONTROL

If not managed in a timely manner, both pests and insects can be equally deadly. In addition to being very sensitive to the same, sugarcane can suffer significant losses as a result of the pests' large and quick growth in a short amount of time, depending on the temperature, rainfall, and climate as well as the availability of enough food in the form of the crop itself. There are known to be over 200 bug species in India, however several are thought to be the most dangerous. The following are some common sugarcane insects, along with information on when they arrive and preventative steps to take:

Pyrilla perpusilla

It is an extremely harmful bug that feeds on foliage, severely reducing cane yield and sugar recovery. Planting in paired rows gives you more room to monitor and implement control measures. Paul (2007).

Termites

These underground insects prey on the stems and shoots of cultivated canes. Odontotermes asmuthi, O. Obesus, O. wallonensis, Microtermes obesi, Trinervitermes biformis, and Coptotermes hemi are a few of them. That being said, they are active from April through June and October. According to Chevegatti-Gianotto et al. (2011), farmers use insecticide spraying on the stems to suppress termites. Applying well-rotted manure and removing trunks and manure are examples of corrective actions.

Borers

These are the pests that prey on roots, canes, and tender shoots. Larvae of cane borer tunnel inside the stem, causing serious harm. Shoot borers (Chilo infuscatellus) attack plants in April through June by entering through stem holes on the plant's growth side.

Black bug

The primary concern for sugarcane farmers in northern India is this particular type of insects. The cane shoot becomes pale and yellow with brown patches and a sickly appearance as a result of the nymphs and adults congregating in the center of the shoot and sucking the sap. These subsequently have an impact on the length, girth, and weight of the stalk in addition to the chlorophyll content of the leaves. Growth is hampered by an increase in nitrogen content and a decrease in chlorophyll content in infected leaves (Yadav 2003).

Scale insect (Melanaspis sp.)

Probably indigenous to North India, it is also widely distributed in other regions (Rao, 1970). This post-monsoon pest typically shows up in crops that are 5–6 months old, following the establishment of internodes. Its optimal growth conditions are between 24 and 34 degrees Celsius and high relative humidity. The conventional irrigation technique of flooding fields greatly enhances the pest's ability to survive (CPC 2012).

Mealy bug (Saccharicoccus sacchari)

Clusters of them are found below the nodes, on the stalks behind overlapping leaf sheaths, and extend upwards and downwards to the other internodes and buds. Sucking the cell sap causes the most of the damage, depriving the plants of vital nutrients that can cause stunning, yellowing, and thinning of the canes. Because of the high amount of honeydew the insect secretes, it also plays a significant role in the spread of viruses and the growth of sooty mold fungus (Eid et al. 2011).

White fly (Aleurolobus barodensis)

It is the most feared pest that causes both independence and direct damage to leaves by draining cell sap. Population density is increasing, peaking in low-lying, wet, and nitrogen-deficient areas (Mann et al. 2006).

White grub (Holotrichia sp.)

Although it is primarily a concern in tropical India, the phrase "white grub" refers to a group of genera and species that have been documented from regions of the world that produce sugarcane. The phases of the pest life cycle are egg, larval instars, pupa, and adult; the late larval stage causes the greatest damage to sugarcane. In addition to eating the sugarcane root, it bores into the subterranean portion of the stem, causing harm.

DISEASE MANAGEMENT

According to Viswanathan and Padnabhan (2008), fungal, bacterial, viral, and phytoplasmic pathogens cause roughly fifty different sugarcane illnesses. Red rot, Smut, Wilt, Eye spot, Yellow spot, Brown spot, Pine apple, Banded scletioal, and Pokkah boeng are examples of fungal diseases; on the other hand, bacteria are mostly responsible for rat stunting, leaf scald, and red stripe. The illnesses mosaic, grassy shoot, and sugarcane leaf yellow are caused by viruses and mycoplasma. The following is a brief overview of several significant disease symptoms:

Red rot: Collectivism factotum is the fungus responsible for this illness. Environmental factors, pH, diet, and temperature all have an impact on this fungus's ability to flourish. It is among the most common diseases in the globe and on the Indian subcontinent. It can target the entire plant, including the stalk, leaves, buds, and roots, but the most astonishing stage is when it attacks the stalk. The symptom may not be noticeable in the early stages but may become lethal in later stages depending on the sugarcane variety's susceptibility, the period of infection, and the surrounding conditions.

Sett rot or pine apple disease: It is caused by Ceratocystis paradoxa, both sett borne and soil borne. It infects in the primary phase of cultivation due to which the internal tissue of the setts turns red and black. Nodes act as partial barriers to the spread of rotting, but with susceptible varieties, entire seed pieces may become colonized by the fungus. The disease severely retards bud germination, shoot development and early shoot vigor. (Raid 1990).

Wilt disease: A fungal infection that spreads through setts and has a negative impact on germination, caused by Cephalosporium sacchari. In the end, weak germination has an impact on cane production and root development.

Gumming disease: The symptoms include large chlorosis of developing leaves, vascular reddening and cavity formation in invaded stems, white leaf stripes with necrotic zones at leaf edges, side shoot production, fast wilting, and plant death. A pathogen that invades xylem can spread through mechanical means, wind-blown rain, cuts, and other means (Birch 2011).

Smut from sugarcane. Ustilago scitaminea is the causative organism of sugarcane smut disease. It is found over most of the world and is dispersed by wind-blown spores, infected seed cane, and infected soil (Nzioki 2010).

SOIL AND NUTRIENT MANAGEMENT

The most stressed components of agro-technology to boost crop productivity and sugar output are soil and nutrient management. All nutrient management techniques must be applied to the soil on which the crop is to be produced, therefore understanding the texture, composition, and other characteristics of the soil is necessary. Because the area's soils differ greatly from one place to another, so do the agronomic practices. Inadequate soil management techniques have been the primary cause of land deterioration in tropical regions. Wawire (2006).

An essential component of agriculture and sustainable land use is the control of soil and nutrients. Enhancing plant health, minimizing environmental deterioration, and increasing crop yields all depend on the effective management of soil and nutrients. The following are some essential ideas and methods for managing nutrients in soil:

Testing of Soils: Test the soil frequently to determine its pH, nitrogen content, and other crucial characteristics. The precise nutrient requirements of crops are ascertained with the aid of soil testing, which also directs fertilizer application.

Fertilizer Application: To treat specific nutrient deficits, apply fertilizers based on soil test results. Make use of fertilizers that contain the proper ratios of secondary and micronutrients along with vital nutrients like potassium (K), phosphorus (P), and nitrogen (N).

Management of organic matter: Adding organic matter to the soil will increase its ability to hold water, retain nutrients, and enhance its structure. Utilizing crop wastes, compost, and cover crops will raise the amounts of organic matter in the soil.

Crop rotation: To disrupt the cycles of pests and diseases and improve soil fertility, crops should be switched around. Crops vary in their nutrient requirements and their contribution to the soil's general health.

Conservation Tillage: To lessen soil erosion, conservation tillage techniques ought to be used. These no-till or reduced-till farming techniques support soil structure preservation, erosion control, and improved water retention.

Water Management: Soil erosion and nutrient leaching are avoided by effective irrigation techniques. Rainwater harvesting and drip irrigation are two examples of water-saving techniques and technologies that ought to be used.

Cycle of nutrients: Utilize cover crops and organic materials to encourage the cycle of nutrients in the ecosystem. As organic matter and crop leftovers break down, nutrients are released back into the soil.

Precision farming involves applying inputs (water, fertilizer, etc.) more precisely according to particular field conditions by using precision agriculture technologies. Sensors and GPS-guided devices can aid in resource optimization.

Mulching: To minimize evaporation, suppress weed growth, and lower the average soil temperature, mulch should be spread throughout the soil's surface. As organic mulches break down, they also add organic matter to the soil.

The goal of integrated nutrition management (INM) is to maximize nutrient availability by balancing the use of organic and inorganic nutrient sources. INM seeks to lessen environmental impact and boost nutrient use efficiency.

Monitoring and record keeping: Crop health, nutrient levels and soil condition should be monitored regularly. Detailed records of nutrient use, crop yield and soil management practices should be kept to make informed decisions.

IRRIGATION MANAGEMENT

A crop with a high water requirement is sugarcane. Moisture stress, which can affect a crop from the start to the finish, is caused by the soil's lack of water. The main signs of water stress in plants are a reduction in the length of their stalks and leaves, while the last stages of the crop exhibit a drop in the accumulation of sucrose. Because of this, irrigation plays a significant role in sugarcane growth. This has been the subject of extensive research from the outset and will likely continue in the future as water supplies continue to rise.

It is clear from the current weather that the amount of rain falls is highly irregular, unpredictable, and unequal. In certain areas, its allotted time is also changing. In central India, two to three seasons of heavy rainfall are typically followed by a dry spell or a period of low precipitation. Since sugarcane has a high water demand and requires irrigation during nearly every stage of plant growth, along with the accompanying increase in irrigation costs, cost-effective management is currently necessary in nearly all sugarcane growing locations. In addition, the amount of water that is available for agriculture must be used wisely because of the increased demand and consumption by home, private, and public sources. According to estimates from NCIWARD (1999), India's current irrigation water demand is between 543-557 billion cubic meters (BMC), with potential increases to 628-807 BMC in 2050 and 826-852 BMC in 2065. But before 2050, it is anticipated that demand for water would certainly outpace supply (Jain 2011).

Depending on the water availability, soil properties, and topography of the location, many conventional irrigation techniques are used for the crop, including flood irrigation, huge furrow irrigation, serpentine irrigation, alternate skip irrigation, and contour irrigation. Most irrigation techniques consume more water than is necessary, and some water is lost altogether—particularly during flood irrigation. Drip irrigation is therefore a widely used technique nowadays. Because of the high water depth and little rainfall in central India, this method is mostly favored there. In addition, it is appropriate for practically all soil types, conserves water, lowers labor expenses, and uses less electricity. Additionally, just like with flood control, the unrestricted flow of illnesses and pests is inherently forbidden. Sprinklers are also becoming more widely used. The kind of soil and the climate of the area have a major influence on irrigation; nevertheless, fertilizers, manure types, and planting techniques also play a role. Because most of the land in North India is fertile and alluvial, only minimal irrigation may be needed. More water is needed in areas with hot, dry winds. The trench form sowing method is less cost-effective. The quantity and frequency of irrigations needed for the crop are also restricted by the types of soil and sugarcane varieties. Irrigation should always be used to avoid water-logging because it hinders crop growth.

3. BIOTECHNOLOGICAL APPROACHES

A key factor in the development of improved sugarcane varieties is biotechnology. In order to improve sugarcane in the following areas, Tiwari et al. (2010) proposed biotechnology approaches: Molecular testing of plants for clonal fidelity, variety identification, molecular characterization of various traits, understanding the molecular basis of sucrose accumulation, developing genetic maps using molecular marker technology, introducing novel genes into commercial cultivars, detecting sugarcane pathogens molecularly, identifying varieties, and developing cell and tissue culture for rapid propagation, genetic transformation, and molecular breeding. The creation of transgenic plants and marker-assisted breeding have received a lot of attention. In order to help plants adapt to climate change, biotechnological techniques may be able to increase a range of plant features, including as early vigor, water and nitrogen usage efficiency, water logging tolerance, frost resistance, heat tolerance, and pest and disease resistance. The creation of genetically modified cultivars or molecular markers for these features is being studied. The solution to deal with the problems caused by climate change would actually be genetically modified sugarcane. With the aid of biotechnology, new stress-tolerant, high-yielding varieties may be developed, thus expanding the potential uses for sugarcane.

4. CONCLUSION

Different meteorological conditions and agronomic practices necessary for improved sugarcane development are unique to a given local setup. For the crop to grow sustainably, growers of sugarcane are extremely concerned about the changing global climate. In majority of the regions that produce sugarcane, a review of numerous climatic conditions and agronomic indicators strongly supports adapting modern techniques that are being developed at the regional level. Since the crop's continued growth depends solely on these factors, meticulous planning is required for both the first phase of land preparation and planting material. Preparing land for cultivation necessitates a careful examination of the local soil and climate, which might change according on the temperature, amount and quality of precipitation, and sunshine. It is recommended to choose planting material from kinds that can withstand the local climate and fend off pests and illnesses. Given that sugarcane is a long-standing crop that is subject to significant climatic variations as well as biotic and abiotic influences, frequent soil and fertilizer management, pest and disease control, and appropriate irrigation are necessary. It is also recommended that growers follow the advice of professionals in order to improve cane quality and yield. The government provides such expertise locally through its agriculture offices and research institutions. Additionally, almost all agricultural universities, colleges, and research centers work with farmers to ensure the successful development of crops, including sugarcane. You can get the same

5. REFERENCE

[1] FNP. 2009. AGRIANUAL 2020 - Anurio da Agricultura Brasileria, Sâo Paulo, P497.

[2] Garside AL, Bell MJ. 2021. Management of legume residues to maximize the nitrogen benefits to the following sugarcane crop. Proceedings of International Society of Sugarcane Technologists 26: Sugarcane Agronomy.

[3] Garside AL, Bell MJ. 2009. Row spacing and planting density effects on the growth and yield of sugarcane. 1. Responses in fumigated and non-fumigated soil. Crop Past Sci 60 (6): 532-543.

[4] Gawander J. 2007. Impact of climate change on sugarcane production in Fiji. WMO Bull 56 (1): 34-39.

[5] Hannah L, Lovejoy TE, Schneider SH. 2005. Biodiversity and climate change in context. In: Lovejoy TE, Hannah L. (eds.) Climate change and biodiversity. Yale University Press, New Haven.

[6] Huang B. 2000. Role of root morphological and physiological characteristics in drought resistance of plants. In: Wilkinson, R. F. (Ed.) Plant-Environment Interactions, Mercel Dekker, New York.

[7] Jaipal S. 1991. Infestation and severity of damage by black bug, Cavelerius sweeti to shoots of nineteen sugarcane accessions and cultivars. Ann Appl Biol 118 (Suppl.) 12: 120-121.

[8] Nikolaos C, Stott PA, Brown JS. 2011. The role of human activity in the recent warming of extremely warm daytime temperatures. J Climate 24 (7): 1922-1930.

[9] Rao VP. 1970. The sugarcane scale insect, Melanaspis glomerata Green. Indian Sugar 20: 279-282.

[10] Rao VLVP, Rao NV, Rao SS. 1991. Influence of seasons on buildup of scale insect Melanaspis glomerata (G.), insecticidal performance and their effect on yield and quality in sugarcane. Indian J Plant Protect 19 (1): 17-22.

[11] Sallam MS. 2006. A review of sugarcane stem borers and their natural enemies in Asia and Indian Ocean Island: an Australian perspective. Annales de la Societe Entomologique de France 42 (3-4): 263-283

[12] Srivastava AK. 1984. Soil compaction: a problem in sugarcane culture. Indian Sugar 34: 503-504.

[13] Stewart MJ. 1955. A survey of chemical weed control in sugarcane. Proc 29th Ann Congr South African Sugar Technol Assoc 29: 126-133

[14] Varun CL, Singh S, Singh HN. 1993. Cultural control of sugarcane scale insect (Melanaspis glomerata Green.) in Bhat soil. Indian J Entomol 55 (2): 219-220.

[15] Malavolta E. 1994. Nutrient and fertilizier management in sugarcane. International Potash Institute. Basel, Switzerland.

[16] Mann RS, Suri KS, Sharma S. 2006. Population dynamics of insect pests of sugarcane in Punjab. Indian J Plant Protect 34 (2): 198-201

[17] NCIWARD. 1999. Report of the National Commission for integrated Water Resources Development, Ministry of Water Resources, Government of India, New Delhi

[18] Nzioki HS, Jamoza JE, Olweny CO, Rono JK. 2010. Characterization of physiologic races of sugarcane smut (Ustilago scitaminea) in Kenya. African J Microbiol Res 4 (16): 1694-1697.

[19] Raid RN. 1990. Fungicidal control of pineapple disease of sugarcane. J Amer Soc Sugarcane Technol 10: 45-50.

[20] Srikant J, Singaravelu B. 2011. White grub (Holotrichia serrata) as a pest of sugarcane and its management. Extension Publication 197, Sugarcane Breeding Institute, Coimbatore Publication, 1-5.

[21] Srivastava AK. 1984. Soil compaction: a problem in sugarcane culture. Indian Sugar 34: 503-504.

[22] Tripathi N, Omkar, Shukla GS. 1985. Role of air currents in the dispersal of sugarcane scale insect crawlers. Agric Sci Digest, India 5 (3): 148- 149.

[23] Vijaya HK, Kulkarni S, Yashoda R, Hedge YR. 2007. Chemical control of sett rot of sugarcane caused by Ceratocystis paradoxa. Karnataka J Agric Sci 20 (1): 62-64.

[24] Vishwanathan R, Padnabhan P. 2008. Handbook on sugarcane diseases and their management. Sugarcane Breeding Institute, Coimbatur Publication.

[25] World Bank. 2004. Cities, seas and storms: Managing Change in the Pacific Islands, Volume II Managing Pacific Towns. The World Bank, Washington D.C.

[26] Yadav RA. 2003. Assessment of losses caused by black bug Cavelerius (Excavatus) sweeti to sugarcane in yield and quality parameters. Indian J Entomol 65 (3): 409-415.